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SIMATIC S5

**IP 246
Positioning Module**

Manual

**Order No. 6ES5998-5SA23
Release 04**

We have checked the contents of this manual for agreement with the hardware and software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly and any necessary corrections included in subsequent editions. Suggestions for improvement are welcomed.

Technical data subject to change.

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Guidelines for Handling Electrostatically Sensitive Devices (ESD)

1 What is ESD?

VLSI chips (MOS technology) are used in practically all SIMATIC S5 and TELEPERM M modules. These VLSI components are, by their nature, very sensitive to overvoltages and thus to electrostatic discharge:

They are therefore defined as
“Electrostatically Sensitive Devices”

“ESD” is the abbreviation used internationally.

The following warning label on the cabinets, subracks and packing indicates that electrostatically sensitive components have been used and that the modules concerned are susceptible to touch:



ESDs can be destroyed by voltage and energy levels which are far below the level perceptible to human beings. Such voltages already occur when a component or a module is touched by a person who has not been electrostatically discharged. Components which have been subjected to such overvoltage cannot, in most cases, be immediately detected as faulty; the fault occurs only after a long period in operation.

An electrostatic discharge

- of 3500 V can be felt
- of 4500 V can be heard
- must take place at a minimum of 5000 V to be seen.

But just a fraction of this voltage can already damage or destroy an electronic component.

The typical data of a component can suffer due to damage, overstressing or weakening caused by electrostatic discharge; this can result in temporary fault behavior, e.g. in the case of

- temperature variations,
 - mechanical shocks,
 - vibrations,
- change of load.

Only the consequent use of protective equipment and careful observance of the precautions for handling such components can effectively prevent functional disturbances and failures of ESD modules.

2 When is a Static Charge Formed?

One can never be sure whether the human body or the material and tools which one is using are not electrostatically charged.

Small charges of 100 V are very common; these can, however, very quickly rise up to 35000 V.

Examples of static charge:

- Walking on a carpet	up to 35000 V
- Walking on a PVC flooring	up to 12000 V
- Sitting on a cushioned chair	up to 18000 V
- Plastic desoldering unit	up to 8000 V
- Plastic coffee cup	up to 5000 V
- Plastic bags	up to 5000 V
- Books, etc. with a plastic binding	up to 8000 V

3 Important Protective Measures against Static Charge

- Most plastic materials are highly susceptible to static charge and must therefore be kept as far away as possible from ESDs.
- Personnel who handle ESDs, the work table and the packing must all be carefully grounded.

4 Handling of ESD Modules

One basic rule to be observed is that electronic modules should be touched by hand only if this is necessary for any work required to be done on them. Do not touch the component pins or the conductors.

Touch components only if

the person is grounded at all times by means of a wrist strap

or

- the person is wearing special anti-static shoes or shoes with a grounding strip.

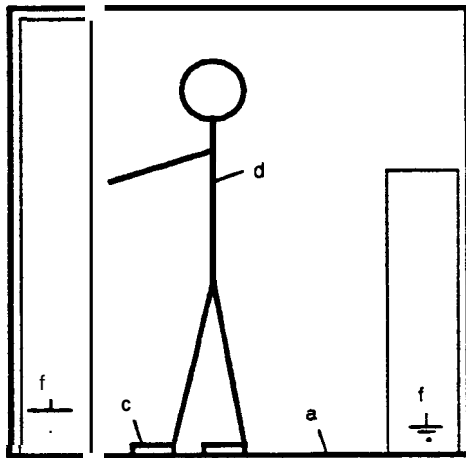
Before touching an electronic module, the person concerned must ensure that (s)he is not carrying any static charge. The simplest way is to touch a conductive, grounded item of equipment (e.g. a blank metallic cabinet part, water pipe, etc.) before touching the module.

Modules should not be brought into contact with insulating materials or materials which take up a static charge, e.g. plastic foil, insulating table tops, synthetic clothing, etc.

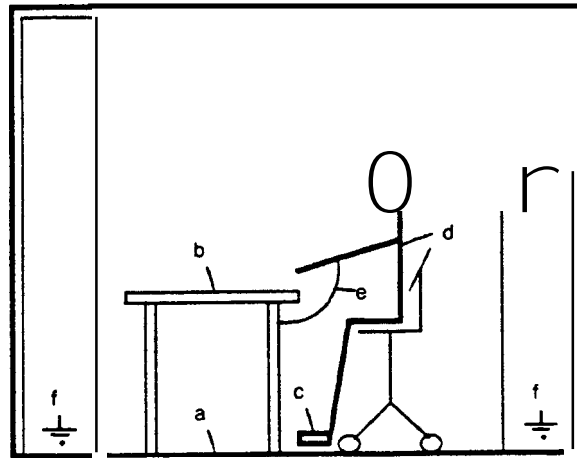
Modules should only be placed on conductive surfaces (table with anti-static table top, conductive foam material, anti-static plastic bag, anti-static transport container).

Modules should not be placed in the vicinity of monitors, TV sets (minimum distance from screen > 10 cm).

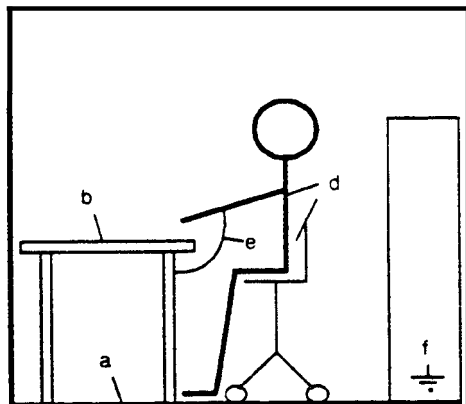
The diagram below shows the required protective measures against electrostatic discharge.



Standing position



Standing/sitting position



Sitting position

- a Conductive flooring
- b Anti-static table
- c Anti-static shoes
- d Anti-static coat
- e Grounding wrist strap
- f Grounding connection of the cabinets

5 Measurements and Modification to ESD Modules

- Measurements on modules may only be carried out under the following conditions:
 - The measuring equipment is grounded (e.g. via the PE conductor of the power supply system) or when electrically isolated measuring equipment is used, the probe must be discharged (e.g. by touching the metallic casing of the equipment) before beginning measurements.
- Only grounded soldering irons may be used.

6 Shipping of ESD Modules

Anti-static packing material must always be used for modules and components, e.g. metalized plastic boxes, metal boxes, etc. for storing and dispatch of modules and components.

If the container itself is not conductive, the modules must be wrapped in a conductive material such as conductive foam, anti-static plastic bag, aluminium foil or paper. Normal plastic bags or foils should not be used under any circumstances.

For modules with built-in batteries ensure that the conductive packing does not touch or short-circuit the battery connections; if necessary cover the connections with insulating tape or material.

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SIMATIC S5

IP246 Positioning Module

Incremental 6ES5246-4UA31/ -4UA41
Absolute 6ES5246-4UB11/ -4UB21

How to Use this Manual

Notes

C79000-B8576-C650 -02

Notes on How to Use this Manual

This manual describes a system for closed-loop position control of two independent drives.

The system comprises the following components:

- IP246 positioning module, absolute version (catalog name IP 246A) or incremental version (catalog name IP246I)
- communications software COM246 (catalog name COM246R)
- standard function blocks FB164 and FB165 (catalog name FB164E and FB165E)

The IP246 positioning module represents the link between your plant and the programmable controller (PC). The standard function block FB164 is used for operating and monitoring, and FB165 for assigning parameters to the IP246. With the programming package COM246, you can generate, save and print machining programs and machine data. COM246 is **also used to test** the IP246 online with the plant connected.

This manual refers to the following products:

The module IP246

- The incremental version for ventilated operation (in the S5 135, S5 150 or S5 155), order number 6ES5 246- 4UA31.
- The incremental version for non-ventilated operation (in the S5 115), order number 6ES5 246- 4UA41.
- The absolute version for ventilated operation (in the S5 135, S5 150 or S5 155), order number 6ES5 246- 4UB1 1.
- The absolute version for non-ventilated operation (in the S5 115), order number 6ES5 246- UB21.

The communications software COM246

- From issue A03.0, order number 6ES5 895- 4UB21.

The standard function blocks FB164 and FB165

- For the S5 115, order number 6ES5 845- 8TA01.
- For the S5 135 with CPU922 or 928, order number 6ES5 842- 8TB01.
- For the S5 150, order number 6ES5 844- 8TA01.
- For the S5 155, order number 6ES5 846- 8TA01.

The manual is structured to allow you to become familiar with the system and can later be used as a reference work to look up specific points.

Part 2:

Part 2 “Fundamentals of Positioning” introduces terms you require to work with the positioning module, e.g.:

- machine data,
- machining programs,
- axis attributes,
- messages.

By familiarizing yourself with these terms, you will also gain a better understanding of the functions and concept underlying the IP246.

Part 3:

Part 3 “Hardware” deals with the hardware requirements necessary to use the IP246 in a variety of situations. This encompasses the following:

- connections,
- jumper settings,
- switch settings.

Part 4:

Part 4 “Functions” introduces you to the operating concept of the IP246. This is based on the following:

- operating functions,
- monitoring functions.

These functions and their effects are described.

Part 5:

Part 5 “Communications Software COM246° explains how to assign parameters to the IP246 and how to test it using this software package. The following aspects are covered:

- generating machine data and machining programs,
- saving the generated data,
- storing the data in the memory of the PG,
- printing machine data records and machining programs,
- testing the IP246 with the plant connected.

Part 6:

Part 6 “**Standard Function Blocks FB164 and FB165**” describes the assignment of parameters, operation and monitoring of the IP246 by the CPU. This description discusses the following:

- FB164 for operating and monitoring the IP246,
- FBI 65 for assigning parameters to the IP246,
- the structure of the machine data and machining programs in a STEP 5 data block,
- examples of parameter assignment for an axis.

Part 7:

Part 7 “**Planning, Installation and Service**” contains the following:

- notes on planning the drive and the machine data,
- guidelines for installing and starting the module,
- an overview of troubleshooting routines,
- instructions for diagnosing problems,

Part 8:

Part 8 “**Index**” lists the most important terms used in the handbook.

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SIMATIC S 5

IP246 Positioning Module

Incremental 6ES5246-4UA31 / -4UA41

Absolute 6ES5246-4UB1 1 / -4UB21

Fundamentals of Positioning

Reference Manual

C79000-B8576-C651-02

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1 Introduction

This part introduces you to the IP246. It provides you with certain information about positioning and briefly describes the function of the IP246 positioning module and its firmware, which represents the heart of the module.

The following terms, which must be familiar when working with the IP246, are then explained:

machine data,

machining programs and

axis attributes.

Finally, this part provides you with information about the digital inputs and digital outputs made available by the IP246 and an explanation of the limit switch concept and its effects with the IP246.

2 A Brief Introduction to the IP246

Using the positioning module IP246, you can move and position two independent axes. From the positioning jobs, the machine data and the signals from the position encoders, the module continuously calculates a speed setpoint, so that the axis reaches the required target at the selected speed without exceeding the technical specifications of the drive.

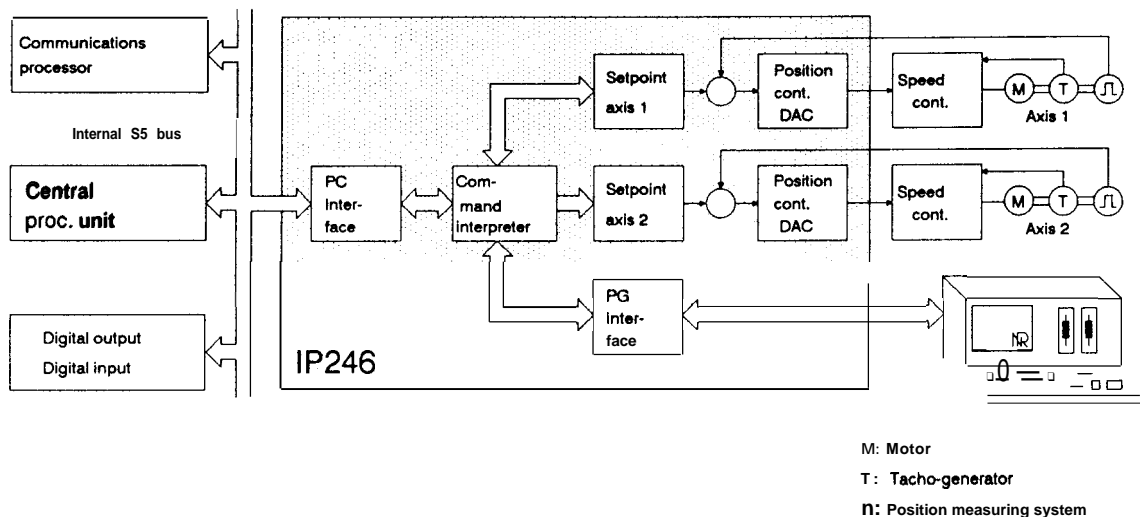


Fig. 2-1: The IP246 in the SIMATIC S5 system

Due to its adaptability, the module must have parameters assigned to it. Parameter assignment is simple and is performed at the monitor of a programmer (PG) using the software package COM246. The IP246 can be assigned parameters via the PC interface, however, without the user-friendly support of the COM246 software package.

In the test mode, the COM246 software package allows you to test all the functions of the IP246 and therefore the positioning functions of your plant.

Two standard function blocks FB164 and FB165 are used to incorporate the functions of the IP246 in a user program, allowing all the functions of the IP246 to be executed from the CPU. These are stored in an EPROM cartridge in the CPU. The data handling blocks for communications processors are subordinate to the function blocks.

The module can be operated both from a PG and from a PC, however, the functions of the interfaces differ from each other. Using the software package COM246, the PG is used for user-friendly parameter assignment, starting up and testing the module. The PC interface is used to execute the functions of the IP246 during normal plant operation.

Jobs can be sent to the IP246 via the PG interface and via the PC interface simultaneously.

When requested, the IP246 sends status messages via both interfaces.

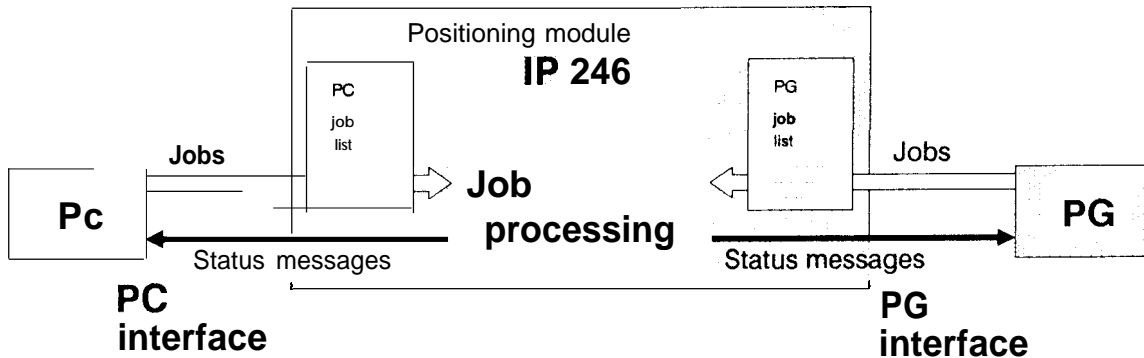


Fig. 2-2: Communication with the PC and PG

Each positioning operation of the IP246 is based on a machine data record specific to the axis, which must be transferred to the memory of the IP246 via one of the two interfaces. An axis is only functional when a correct machine data record exists on the module. By making entries in this data record, you stipulate the electrical and mechanical limits of your plant. These include the maximum acceleration of the axis, the maximum speed, the pulse evaluation, whether you are operating a linear or rotary axis and the permitted traversing range of your axis.

With the IP246, positioning jobs can be issued in two ways, as follows:

- machining programs, i.e. a connected series of traversing jobs, dwell times, corrections and changes, which are stored in the memory of the IP246,
- single jobs, sent to the IP246 via an interface.

The input and deleting of a machining program is possible both via the PG and the PC interface.

It is possible to take into account differing tool lengths and to execute zero point offsets. In addition, a slight drift resulting from an incorrectly adjusted power unit, can be compensated.

3 Positioning Axes

3.1 What is Positioning?

Positioning means approaching a previously specified point or previously specified coordinate automatically following a procedure established by parameter assignment. Such an operation can be controlled by either closed-loop or open-loop control systems.

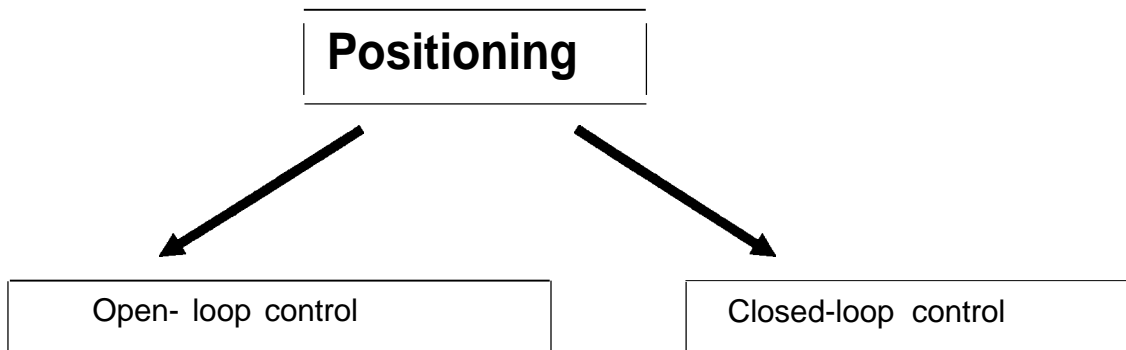


Fig. 3.1 -1: Types of positioning

When using closed-loop control, the physical value to be controlled is measured and compared and matched to another value. For the positioning module IP246, the value to be controlled is the position of the axis.

Once parameters can be assigned for the positioning operation, a setpoint generator is necessary, regardless of whether closed-loop or open-loop control is to be used. This setpoint generator supplies an output value, which depends both on the difference between the current position of the axis and the required target point, as well as on the parameters, e.g. speed, acceleration or deceleration. The more opportunities for parameter assignment and for modifying parameters during the positioning operation provided by the setpoint generator, the more complex and comprehensive is its structure. In the simplest version, the output value of the setpoint generator is switched on and off. Specifying the maximum speed and maximum acceleration and deceleration according to the mechanical capabilities of the plant improves the efficiency of the operation. If various speeds can be preset and if the speed can be changed during the positioning operation, the whole operation can be better matched to the particular plant or to the particular task.

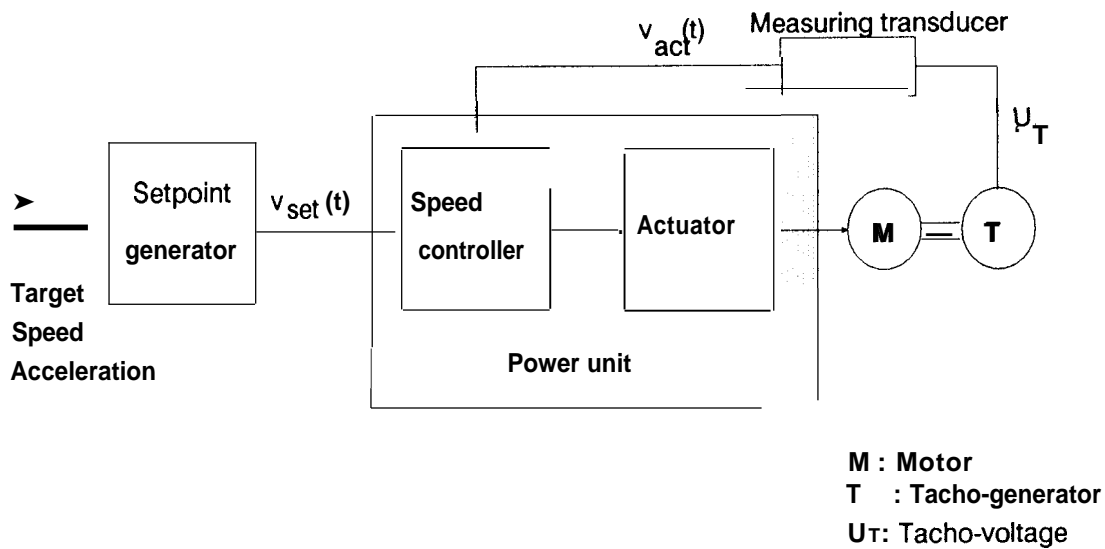


Fig. 3.1 -2: Open-loop position control

When using open-loop position control, the setpoint generator provides a time-dependent speed setpoint $v_{set}(t)$, taking into account the parameters mentioned above. The area below the $v_{set}(t)$ curve corresponds to the distance to be travelled, i.e. the difference between the start and target position of the axis. The distance traversed is not fed back to the controller; the distance traversed is not checked. The output value of the setpoint generator, i.e. the speed setpoint $v_{set}(t)$, is output and the power unit (actuator) move the axis. Generally, the power unit also includes a speed controller along with the actuator, as well as a current controller subordinate to the speed controller. Since the position of the axis is not checked in open-loop position control, this principle can only be used when it is guaranteed that the required target position is reached following the positioning operation and that the axis remains in this position.

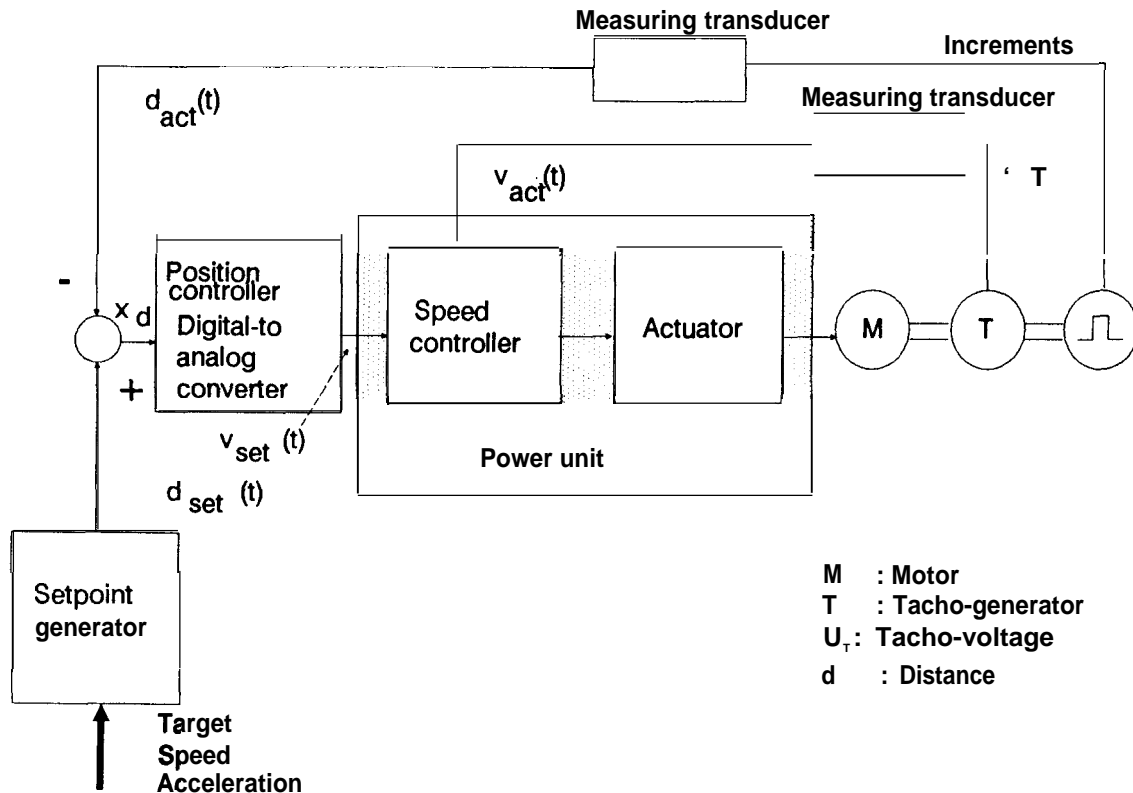
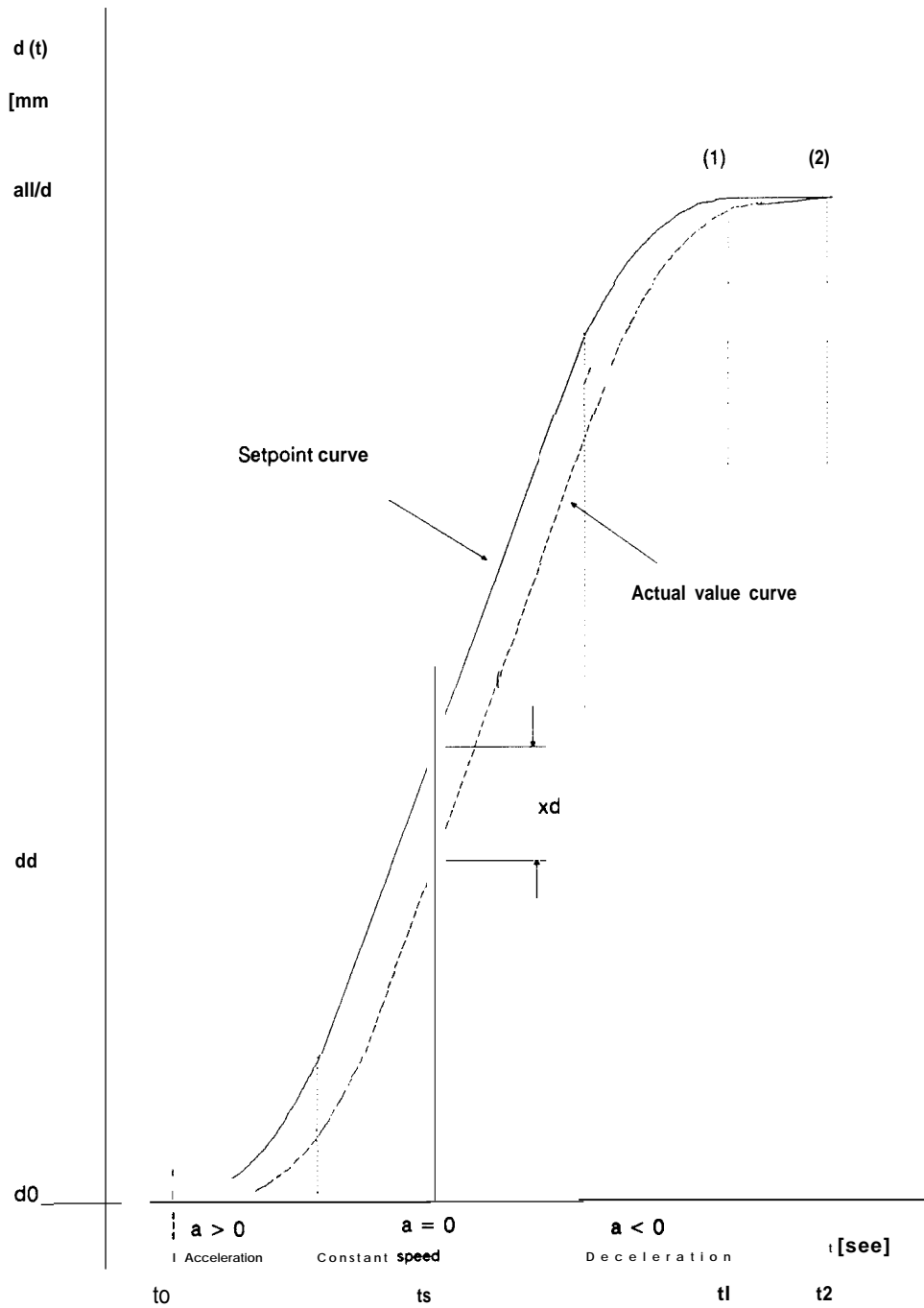


Fig. 3.1-3: Closed-loop position control

In closed-loop position control, the output value of the setpoint generator is the position setpoint $d_{set}(t)$. The actual position value is continuously measured and fed back. This is compared with the position setpoint generated by the setpoint generator. Deviations are detected during the whole traversing movement. These deviations (x_d) are supplied to a position controller, which outputs a speed setpoint $v_{set}(t)$. This output value is changed by the position controller during the positioning operation so that the actual position value follows the distance curve generated by the setpoint generator as exactly as possible. This ensures that the required target position of a traversing movement is reached. The final position is maintained, since disturbances are recognized by the position controller and compensated.

In closed-loop position control, the actual position value $d_{act}(t)$ always lags behind the position setpoint $d_{set}(t)$ during the positioning operation. The difference between the setpoint and actual value is the following error x_d . The following error must be optimized for the particular application by suitable assignment of parameters to the position controller and by suitable selection of the speed, acceleration and deceleration.

The following figure shows the two position curves (position setpoint and actual position value) for a closed-loop position control operation.



x_d : Following error at time t_s

(1) : Position setpoint at time t_1 t_1 : Setpoint has reached target point

(2) : Position setpoint at time t_2 t_2 : Actual value has reached target point

a : Acceleration

Fig. 3.1 -4: Position setpoint curve $d(t)$ in closed-loop position control

The relationship between the acceleration or deceleration $a(t)$, speeds, $v(t)$ and the corresponding distances $d(t)$ in closed-loop position control is illustrated below.

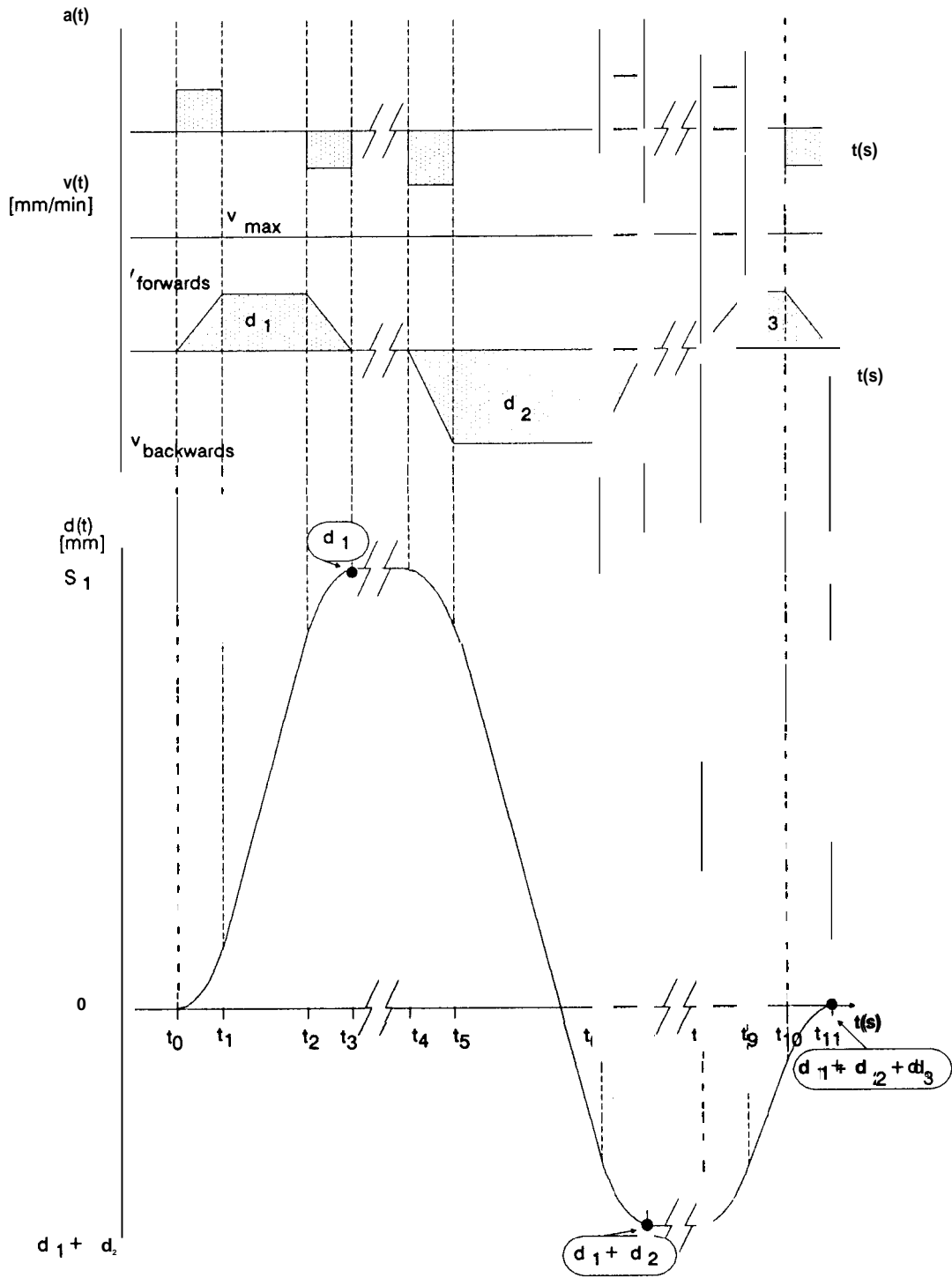


Fig. 3.1-5: Relationship between acceleration or deceleration, speed and distance

Instead of generating the position setpoint $d_{set}(t)$ in the setpoint generator, a different principle of closed-loop position control involves supplying the total difference between the current position and the required target to the position controller. Parameters, e.g. the traversing speed or the acceleration, which determine the positioning operation, are then not taken into account by the position controller. Using this principle, the output value of the position controller, i.e. the speed setpoint, is limited accordingly.

If there is also a speed and current controller in addition to the position controller, the control loop contains three secondary loops. The effects of such a system can generally be modified by different mutually interactive parameters.

The following conditions must therefore be fulfilled:

- the power unit and the motor must be carefully matched with each other,
- the drive must have a sufficient power reserve,
- the drive is exactly adjusted,
- the individual parameters are carefully determined and matched to the situation and
- there is no backlash within the position control loop.

3.2 How does the IP246 Position an Axis?

The module contains a setpoint generator. This setpoint generator produces a position setpoint which changes during the course of the positioning operation. The type of change depends on the specified target coordinates, the current position and on the mechanical and electrical conditions of the axis as assigned in the machine data record.

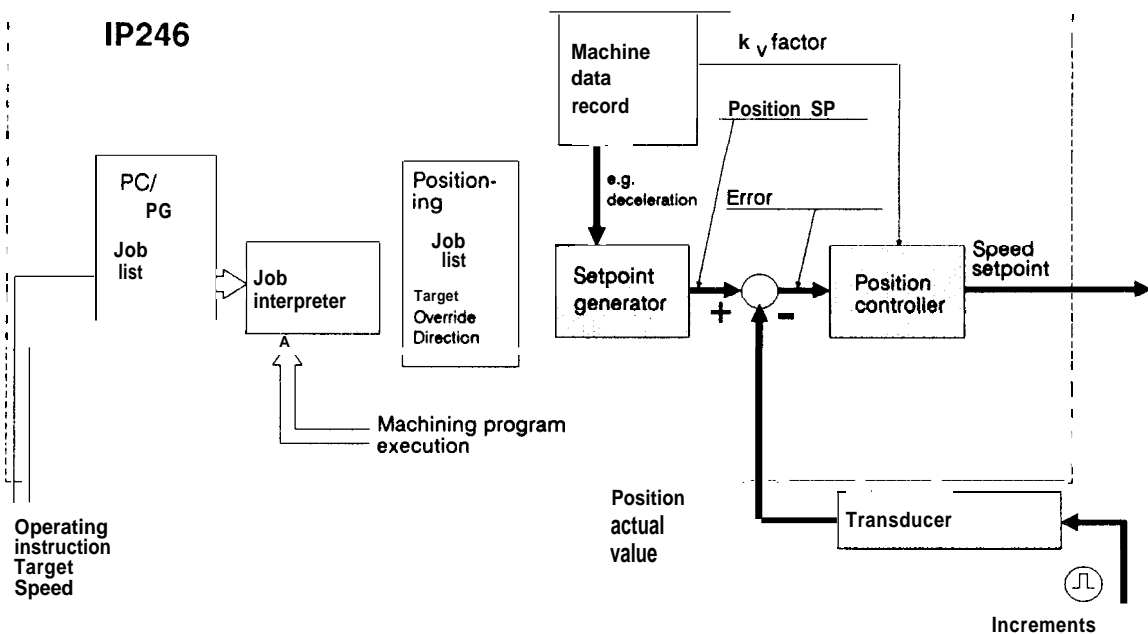


Fig. 3.2-1: Structure of job processing

Traversing jobs received via the PG or PC interface are entered in the appropriate job list. The job interpreter generates positioning jobs from these and sends them to the setpoint generator for processing. Each axis can only process one job at a time.

Depending on the conditions stipulated in the machine data (e.g. acceleration, deceleration, ...), the setpoint generator supplies the current position setpoint at fixed intervals (the sampling time). The position controller operates using the same clock pulse. It generates a speed setpoint output signal from the difference between the position setpoint and the current actual position value using a suitable algorithm. This output signal is sent as a setpoint to a speed controller (subordinate to the position controller) located in the power.

The control algorithm of the position controller is a P-algorithm (proportional controller) in the IP246. The error or the following error x_d is obtained from the difference between the position setpoint and the actual position. The speed setpoint is obtained by multiplying this error by a gain (k_v) factor selected in the machine data record. This speed setpoint is output as an analog value via a digital-to-analog converter. The output voltages are in the range +/- 10 volts.

For the position controller, therefore, the total difference between the start position and the target point is not relevant as the control error. The position setpoint approaches the target point step by step. If the actual position value lags behind, this results in an error (following error) which the position controller attempts to compensate. This algorithm is illustrated in the following flow diagram.

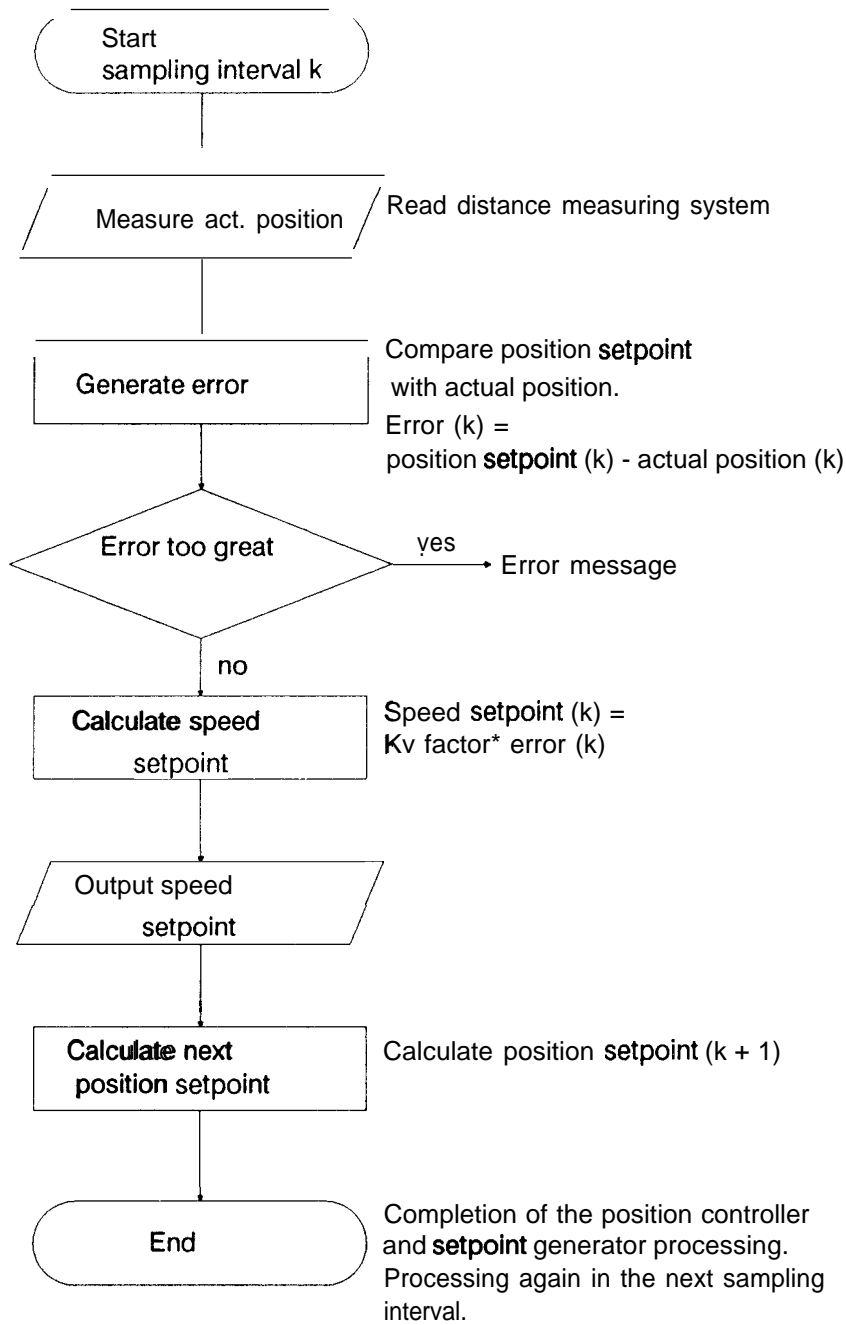


Fig. 3.2-2: Principle of the position controller

3.3 Resolution of the Speed Setpoint

The smallest distance which can be measured by the IP246 is one increment, (with the absolute version one step) of the position encoder, The distance corresponding to a single increment or step depends on the design of your plant (leadscrew pitch, position encoder,).

A further factor to be considered is the accuracy of the speed setpoint, which is output via a 12-bit D/A converter (11 bits plus sign) with a reference switchover (reference voltage 1.25 V or 10 V). At the analog output, it is therefore possible to distinguish between voltages, which in the lower range at a reference voltage of 1.25 V have a value of $v_{max}/16384$ and for a reference voltage of 10 V have a value of $v_{max}/2048$.

The accuracy of the analog voltage (speed setpoint) should always be determined by the D/A converter; or in other words, the technical data of your drive should always be selected so that the speed setpoint calculated in the firmware of the IP246 is more accurate than can be output via the D/A converter.

For:

$$v \text{ [mm/min]} = \frac{60}{1000} \cdot k_v \text{ [l/see]} \cdot x_d \text{ [urn]}$$

where $x_d \text{ [urn]} = x_{di} \text{ [pul]} \cdot R \text{ [um/pul]}$ results in

$$v \text{ [mm/min]} = \frac{60}{1000} \cdot k_v \text{ [1/sec]} \cdot x_{di} \text{ [pul]} \cdot R \text{ [um/pul]}$$

The smallest measurable distance x_{di} is 1 increment. With the voltage limit values shown above, which can still be distinguished by the D/A converter (v_{min}), the following applies:

$$\frac{1}{2048} \cdot v_{max} \text{ [mm/min]} \geq \frac{60 \cdot R \text{ [um/pul]}}{1000} \cdot k_v \text{ [l/see]} \text{ for a reference voltage of } 10 \text{ volts or}$$

$$\frac{1}{16384} \cdot v_{max} \text{ [mm/min]} \geq \frac{60 \cdot R \text{ [um/pul]}}{1000} \cdot k_v \text{ [l/see]} \text{ for a reference voltage of } 1.25 \text{ volts}$$

- v_{max} = Maximum speed
- k_v = Gain of the position controller
- R = Resolution ("distance per encoder revolution"/"pulses per encoder revolution")
- x_d = Error in units of distance
- x_{di} = Error in increments

Depending on the resolution, k_v factor and maximum speed, situations can arise in which the internal firmware calculation of the speed setpoint is less accurate than the resolution of the D/A converter.

The following diagram represents this relationship at a D/A converter reference voltage of 10 V. Two examples are provided, as follows:

- At a maximum speed of 10000 [mm/min] and a resolution of 8 [urn/pulse] the kv factor setting should not exceed a value of 10.1 [l/see].
- At a maximum speed of 80000 [mm/min] and a resolution of 20 [urn/pulse] the kv factor setting should not exceed a value of 24.4 [l/see].

The advisable range is therefore always to the left below the bold arrows of the corresponding example.

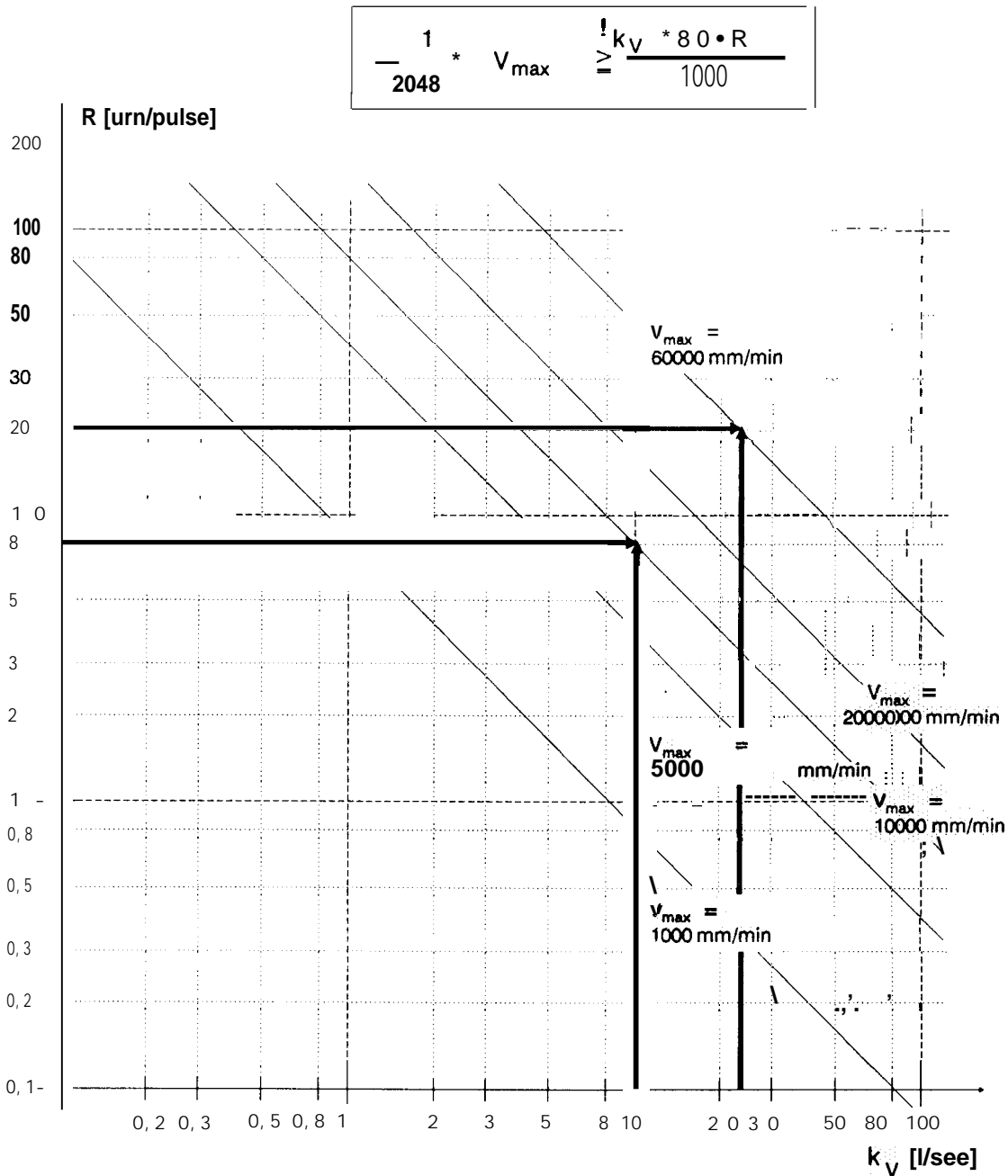


Fig. 3.3-1: Resolution of the speed value

4 Machine Data and their Structure

Before a positioning module such as the IP246 can execute a positioning operation automatically, it must be provided with information about the connected drive, the position measuring system etc. This information is known as machine data. Machine data is stored in a data block. This has a constant length and can be divided into the following parameter groups:

- axis type
- Position measurement and resolution,
- traversing range,
- speeds,
- acceleration rates,
- controller parameters
- correction parameters (offsets) and
- other parameters.

Using the COM246 software package, machine data records can be generated efficiently and easily at the programmer and transferred to the positioning module. Once on the module they can be read again, corrected or deleted. Both COM246 and the module perform consistency checks. If machine data are sent to the IP246 via the PC interface, they are only checked by the IP246. It is therefore possible to assign bad machine data to an axis on the module.

Bad in this case means that either data in the machine data record exceed the stipulated limit values, or that certain combinations of machine data are not permitted.

If a bad machine data record is transferred to the positioning module, the IP246 signals the error "error in machine data" via the PG and PC interface. The type of error itself, e.g. "wrong axis or module number" is stored by the firmware of the positioning module in the machine data block (> "Planning, Installation and Service, Installation Guide"). If you enter the machine data using the COM246 software package, the type of machine data error is displayed in plain text in the error message line on the PG. The message "error in machine data" is then overwritten.

If you wish to position using both axes of the IP246, a machine data block (DB) must be present on the module for each axis. Axis 1 and axis 2 can be assigned a machine data block with the same DB number.

If no correct machine data are stored on the IP246 for an axis, the axis is not operational. The position controller remains disabled and the operational signal "FUM" is not set. If operating instructions are sent to the axis, the job is rejected with the error message "wrong or no machine data".

If you edit the machine data record using the COM246 software package, all the required machine data are requested in plain text using a menu technique. Following the input field, the default dimensional unit and the permitted range of values is displayed. This is explained in detail in *Communications Software COM246, User's Guide*.

Since no special software is available for planning the machine data in the CPU, the following description of the individual machine data includes the data formats as required for entry or storage in the CPU. A table in "Standard Function Blocks FB164 and FB165, User's Guide" provides an overview of these formats.

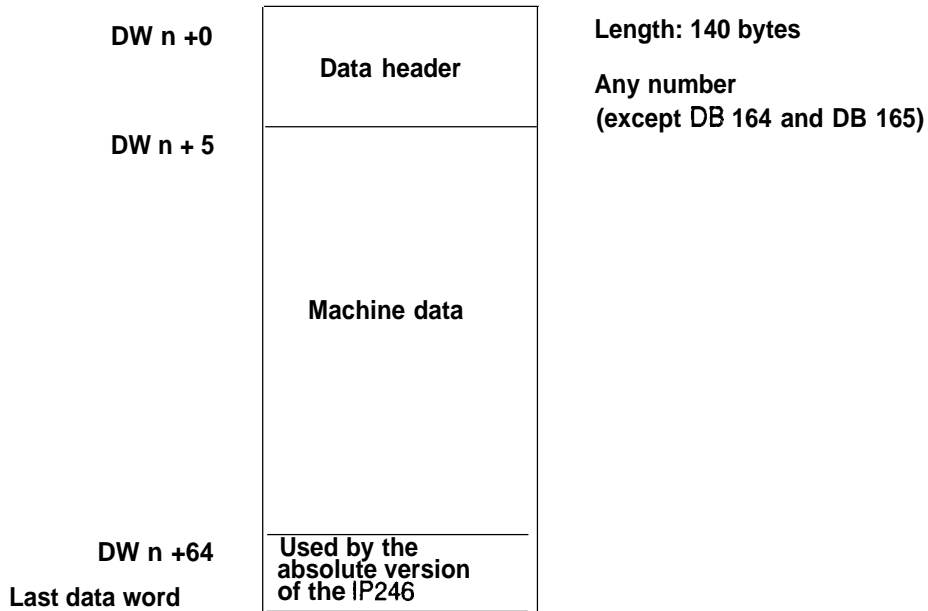
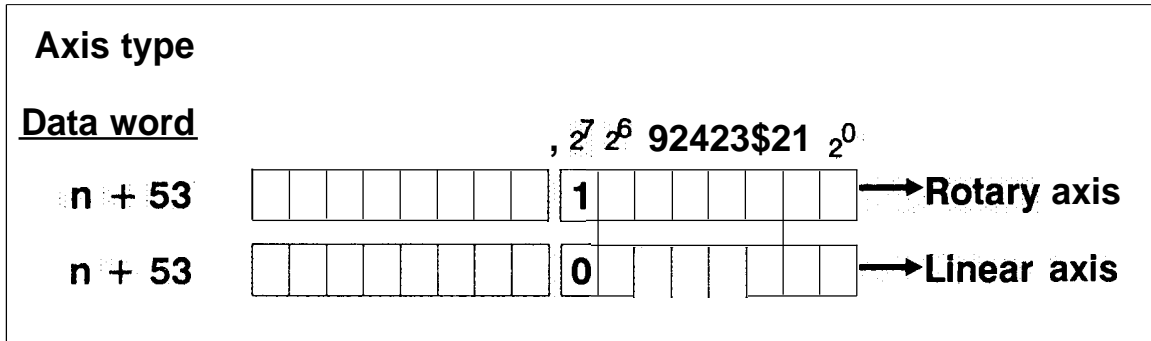


Fig. 4-1: The machine data record in the CPU

4.1 Axis Type (Linear or Rotary Axis)



The axes of a module can be assigned parameters as linear axes or as rotary axes independently. From version A03.0 onwards, the software package COM246 supports rotary axes.

The assignment of the following parameters depends on whether you selected a linear axis or a rotary axis as the “axis type”

- the software limit switches or range limits and
- the resolution.

Operator input also depends on the type of axis

- with incremental approach,
- with zero or tool length offsets and
- in the automatic mode.

These differences are explained in detail in the appropriate section. Some fundamental aspects are, however, discussed below.

4.1.1 The Linear Axis

A linear axis or open axis is an axis with a limited traversing range. The traversing range of a linear axis is limited with the IP246 by assigning the software limit switches. This is effective only after calibrating the axis, i.e. when the reference/home point exists.

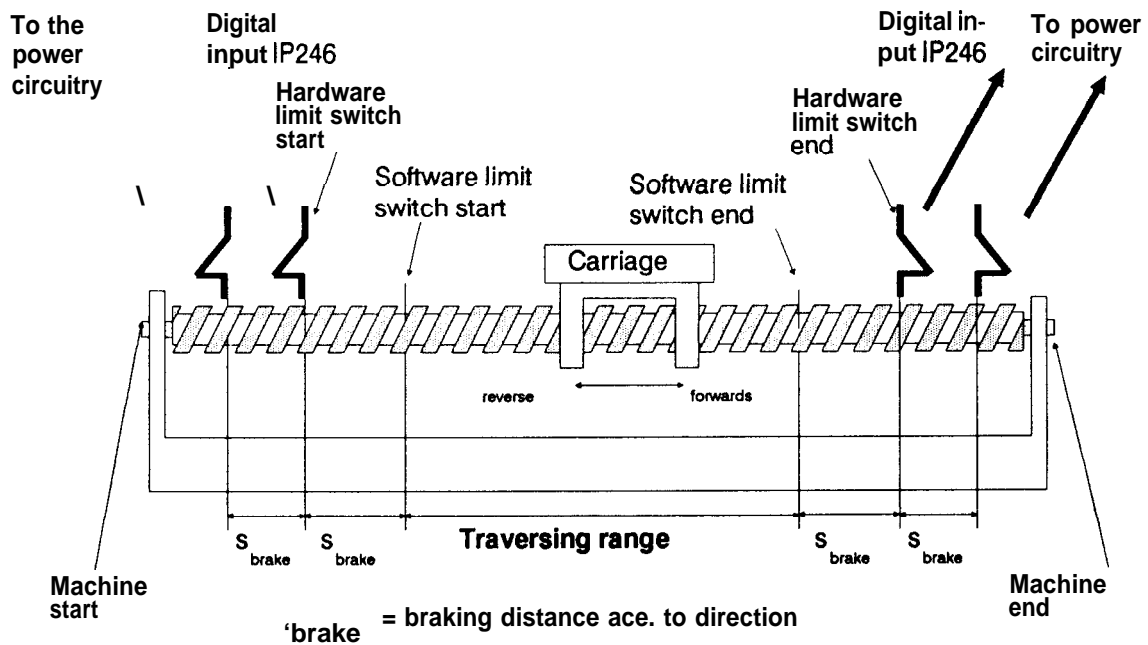


Fig. 4.1.1 -1: Linear axis with limit switches

If the permitted traversing range of a linear axis is exceeded, the equipment will almost always be damaged. For this reason, particular care must be taken that the axis type and the assignment of limit switches are correct.

Note:

If the axis type "rotary axis" is accidentally selected instead of a linear axis, the values assigned in the data double words $DD\ n + 21$ and $DD\ n + 23$ (machine data in the CPU) will not be evaluated as limit switches. The data double words are then only used to identify the display range for the actual value. If these values are exceeded, the drive is not stopped.

4.1.2 The Rotary Axis

A rotary axis or closed axis is an axis without restrictions in terms of the traversing range. This might be, e.g.

- a round table (e.g. 360 degree divisions),
- continuous tape which can be divided into metric units or
- a tape winder.

With a rotary axis, the start of the range and end of the range are physically the same point on the axis (closed axis). If degrees are used as the dimension, the traversing range is not limited to 360 degrees.

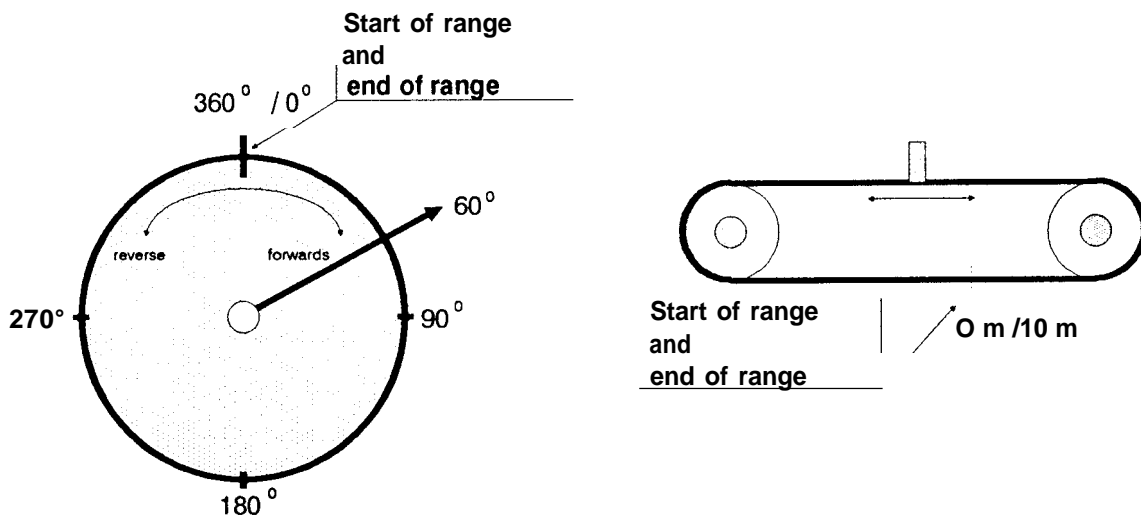


Fig. 4.1 .2-1: The rotary axis and range limits

The absolute coordinate range of a rotary axis is between the start of the range and the end of the range. If the actual position value exceeds the end of the range, the actual value indication is automatically set again to the coordinate of the start of the range.

Absolute targets must remain within the specified traversing range. If, however, a traversing movement is specified relative to the current actual value (e.g. 500 degrees forwards), distances greater than the traversing range can also be travelled.

With the rotary axis, there is no limitation of the traversing range by software limit switches. The digital inputs of the hardware limit switches are, however, evaluated and can be used to limit the traversing range to values less than 1 revolution or as additional safety switches.

4.2 Position Decoding and Travel Resolution

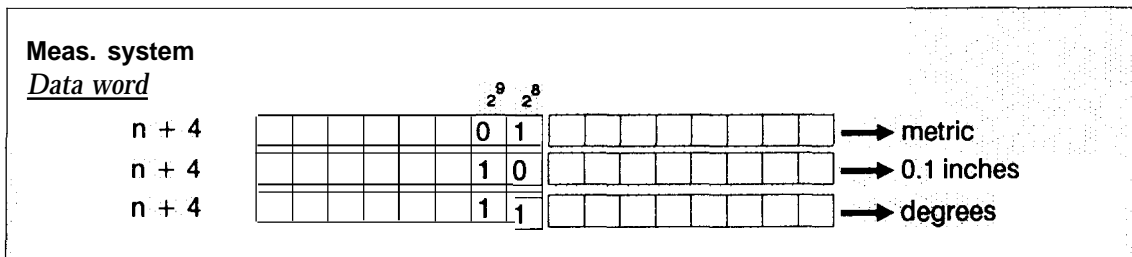
Depending on whether the position is encoded by an incremental or an absolute position encoder, the following parameters affect position decoding and travel resolution:

- dimensional unit
- pulse evaluation for incremental position encoder,
- number of revolutions of an absolute position encoder,
- pulses/steps of the position encoder per encoder revolution and
- distance travelled per encoder revolution.

The last two parameters determine the resolution. This is a relationship between the position encoder signals and the corresponding distance travelled on the axis.

The specification "forwards" or "clockwise" always indicates the direction which leads to the position encoder turning in a clockwise direction, the specification "reverse" or "anti-clockwise" always indicates the direction which leads to the position encoder turning in an anti-clockwise direction.

4.2.1 Measurement System

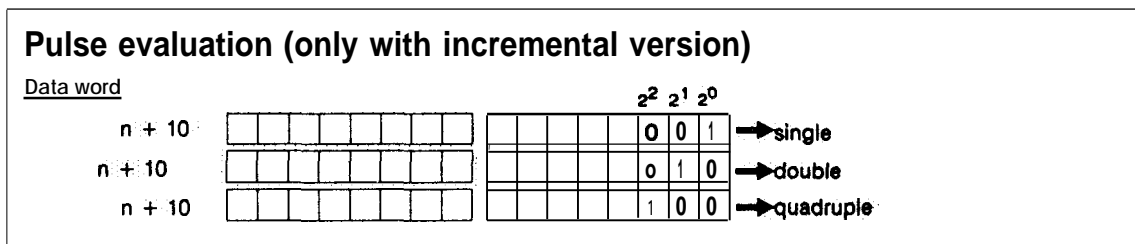


Regardless of whether you operate *your* axis as a linear or rotary axis, the IP246 allows the following dimensional units to be used:

- metric system with a basic unit of 0.001 mm,
- inches with a basic unit of 0.0001 inches and
- degrees with a basic unit of 0.001 degrees.

The basic units are the smallest values permitted in machine data, machining programs and command inputs. All positions, speeds, acceleration rates and the resolution relate to the dimensional unit selected for the axis.

4.2.2 Pulse Evaluation



In the incremental version of the positioning module, two pulse trains (signal A and signal B) with a 90 degree phase displacement are evaluated (see "Hardware, Instructions"). The direction of rotation of the position encoder and therefore the drive is established from the order in which signals A and B are detected. The distance travelled is determined by counting the signal edges.

There are three possible types of evaluation as follows:

Single evaluation: only the rising edges of the pulse train of signal A are counted

Double evaluation: both edges of pulse train A are counted

Quadruple evaluation: both edges of pulse A and of pulse B are counted.

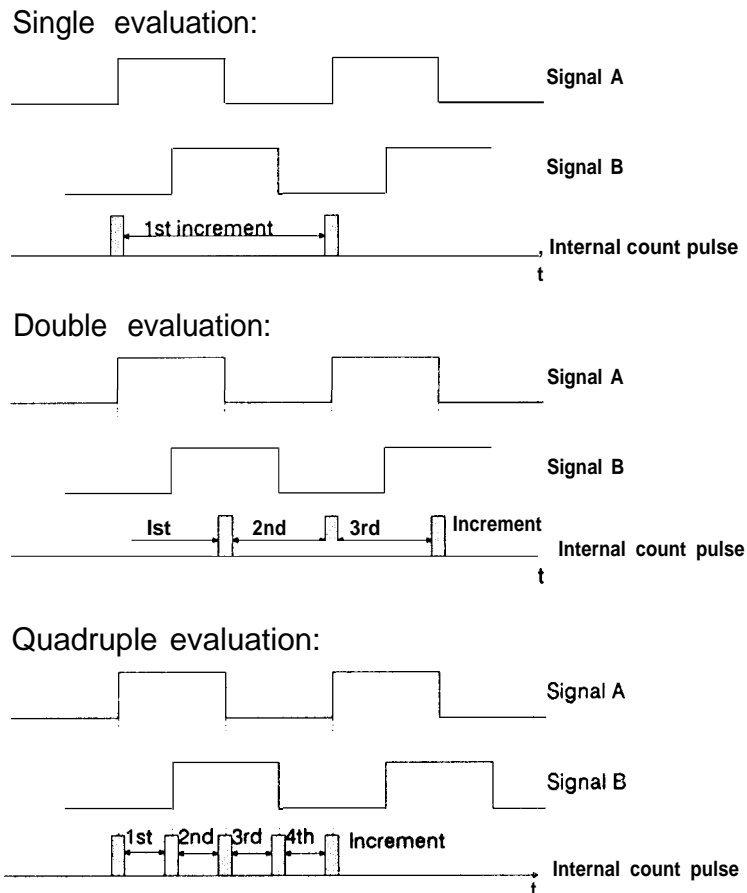
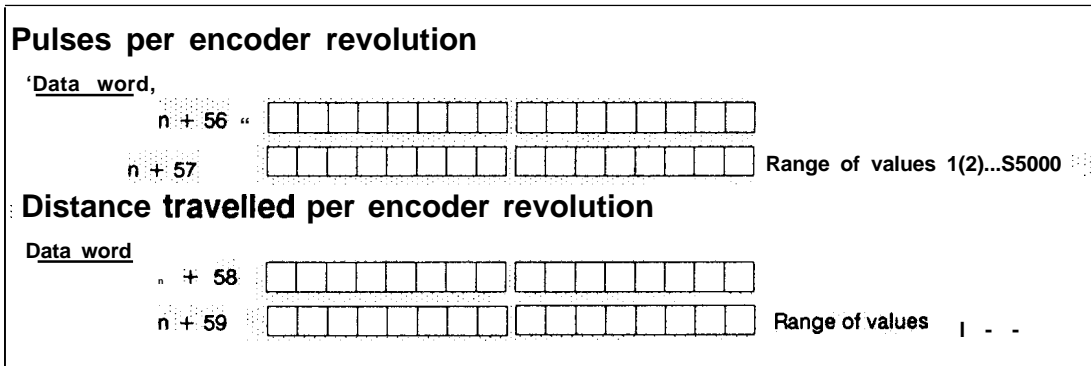


Fig. 4.2.2-1: Pulse evaluation

An increment is the distance between two consecutive internal counter pulses.

With the absolute version, no multiplication of the pulses is possible.

4.2.3 Resolution



The resolution is a relationship between the position encoder signals and the position of its axis.

Note:

If you use double or quadruple evaluation with the incremental version, the resolution depends on the edges to be evaluated, not to the actual pulses of the position encoder.

The range of values of the resolution is always as follows:

0.1 to 99.9 mm per 1000 pulses.

The same applies to degrees and units of 0.1 inch. With the absolute version, the upper limit is not 99.9 but 100.

Example:

A rotary incremental position encoder has 1000 pulses per revolution. If it turns once, this means 3 mm travelled. This information can be used as it stands for single evaluation. This results in a resolution of 3 urn per pulse or 3 mm per 1000 pulses. If you select double evaluation, the resolution is then 1.5 mm per 1000 pulses. With quadruple evaluation, the resolution would be 0.75 mm per 1000 pulses.

The resolution is, however, not specified directly but in the form of two values. These areas follows:

- “distance travelled per encoder revolution” in the selected basic unit and
- “pulses/steps per encoder revolution”

The resolution [urn/pulse] is obtained by dividing these two values.

The value “distance travelled per encoder revolution” takes into account any gearing between the position encoder and axis. The following range of values is possible:

0.001...400.000.

This means that you can assign values of 1 urn to 400 mm per encoder revolution in metric units, 0.001 to a maximum 400 degrees per encoder revolution using degrees as the unit and 0.0001 inch to 40 inches when using inches.

The range of values for “pulses/steps per encoder revolution” is as follows:

- 1 . . . 65000 for the incremental version and
- 2...65000 for the absolute version.

With the incremental version, you must refer “pulses per encoder revolution” to the edges to be evaluated and not to the actual pulses of the position encoder. If, for example, you have a position encoder with 1000 pulses per revolution and quadruple evaluation for “pulses per encoder revolution”, you must enter 4000 and not 1000. Despite this large range of values, the actual resolution is limited to the range described above.

Restrictions with the absolute version

When you specify the parameters “distance travelled per encoder revolution” and “steps/pulses per encoder revolution” with the absolute version, you must always refer to a single and complete revolution of the position encoder. If parameters for a rotary axis are assigned with the absolute version and a multi-turn position encoder is used, you must remember that you can only enter the distance travelled per encoder revolution with three decimal places.

Example:

A multi-turn absolute position encoder with 256 revolutions and 1024 steps per revolution is connected to a round table with a ratio of 1 :256. One revolution of the round table is 360 degrees. This results in a distance travelled per encoder revolution of

$$\frac{360 \text{ [degrees]}}{256 \text{ [revolutions]}} = 1.40625 \text{ [degrees/revolution]},$$

which cannot be entered.

With the absolute version, there is always a close relationship between the position encoder (resolution) and the assigned traversing range. For more information, refer to Section 4.3 “The Traversing Range”.

Restrictions with the incremental version

When assigning the parameters “distance travelled per encoder revolution” and “pulses per encoder revolution” for a rotary axis with the incremental version, you must also refer to a single complete revolution of the position encoder. Only then is the reference point reproducible during the reference point approach. The parameter “pulses per encoder revolution” indicates the number of edges of the encoder signal to be evaluated and not the number of pulses per position encoder revolution.

For the incremental version, an additional data word DW n + 11 is provided in the machine data record for the resolution, which also appears in the software package COM246 in the machine data. A value entered in this field has no significance. If machine data are generated or edited with the COM246 software package, a value within the specified limits must nevertheless be entered in this input field. The actual value of the resolution is calculated from the two values discussed above.

Even with a resolution greater than 1 urn per pulse, positions can be entered accurate to 0.001 mm. Values which can no longer be distinguished owing to a less accurate resolution are automatically rounded up or down by the positioning module. This also applies to the other dimensional units.

4.2.4 Decoding and Evaluation of the Absolute Encoder Value

Number of encoder revolutions	
<u>Data word</u>	
n + 54	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
n + 55	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> Range of values 1...65000
Number of steps per encoder revolution	
<u>Data word</u>	
n + 56	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
n + 57	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> Range of values 2...65000

An absolute position encoder is described by the two following parameters:

- “number of encoder revolutions” and
- “number of steps per encoder revolution”.

Both single-turn position encoders (number of revolutions = 1), and multi-turn position encoders (maximum 6500 revolutions) can be connected, The total number of steps of the absolute position encoder is obtained from the product of the two parameters. This is restricted to 2^{20} . The absolute version of the IP246 only processes signals from encoders which produce Gray code or Gray excess X code. A Gray code cannot be processed in BCD.

A Gray excess X code is a form of Gray code in which the same number of steps of the code are omitted in both the lower and upper range; the required number of steps is “cut out” of the next higher power of 2. The Gray code then remains single step even with a zero crossing.

Example:

Required number of steps = 12. The next power of 2 is 16 (2^4)

=> the code disk of the position encoder is a disk with 16 positions of which two have been omitted in the upper and two in the lower range. This is a Gray excess X code, whereby X stands for the number of steps omitted at one end.

In this example: Gray 16 excess 2 code.

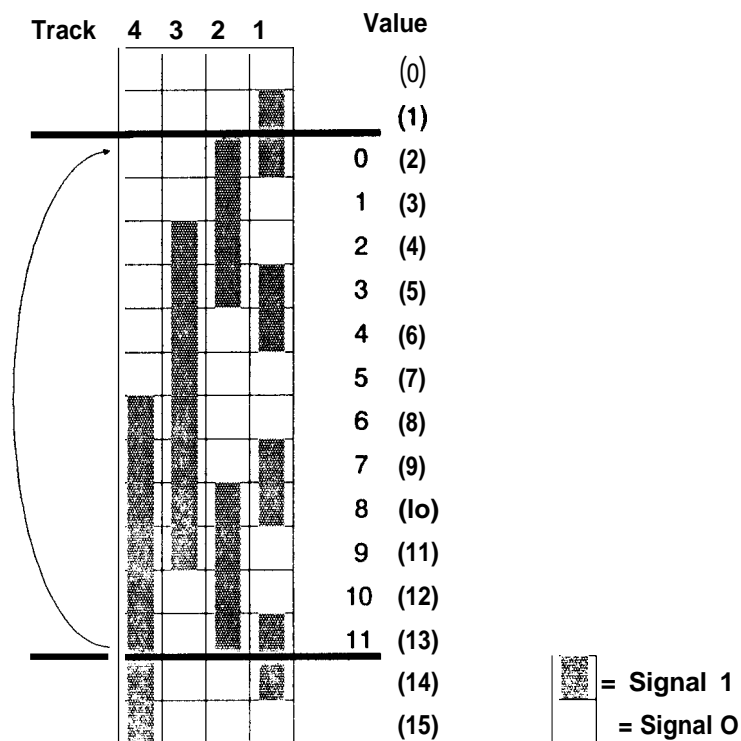


Fig. 4.2.4-1: Gray excess X code

The module automatically calculates a Gray excess value (if used), i.e. without any specific entry in the machine data record. If the total number of steps assigned is not equal to a power of 2, it is assumed that an absolute position encoder with a Gray excess X code is being used.

Note:

To obtain a correct actual value from the signals of the absolute position encoder, the parameters

- "number of encoder revolutions" and
- "number of steps per encoder revolutions"

must be correct in the machine data record.

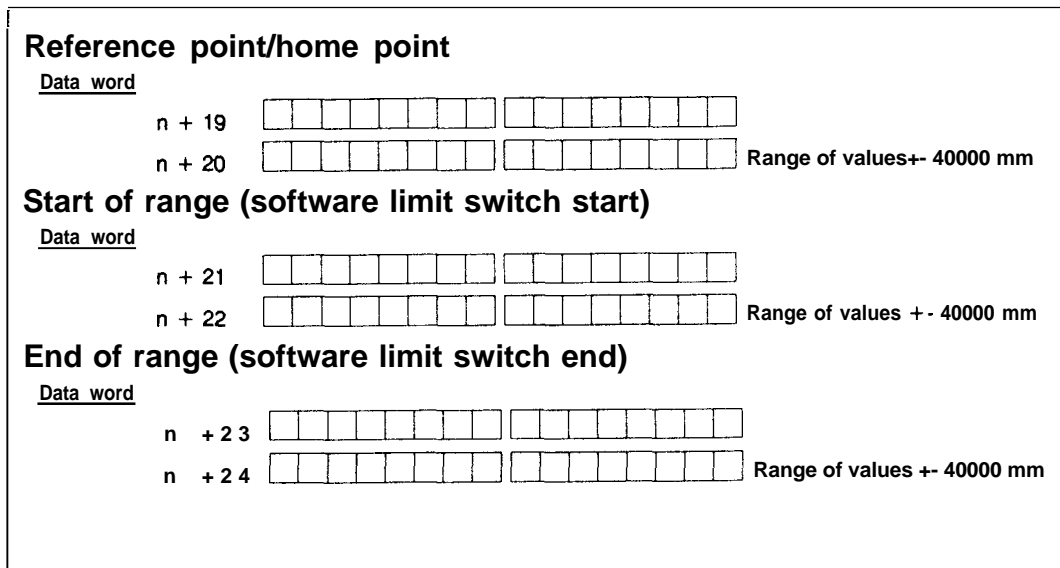
The maximum number of steps of the absolute position encoder being used must be absolutely identical to the assigned maximum number of steps resulting from the multiplication of these two parameters.

If an absolute encoder count occurs during operation which cannot occur with the parameters assigned for the absolute position encoder or which is outside the usable range with a reference point set (= > Section 4.3 "The Traversing Range"), e.g. because the actual total number of steps of the absolute position encoder is greater than the assigned total number of steps, the error message "illegal absolute encoder reading" is output and the control system changes to the following error.

If an absolute encoder is used with a total step number less than the assigned total number of steps, this encoder does not supply an illegal value. During operation, however, this may lead to a jump in the actual value, (zero crossing of the encoder), which is not permitted at this point. If the jump is sufficiently large, the error message "illegal change of absolute encoder value" is output and the module changes to the following error mode.

In these two exceptional cases, the following error mode can also be terminated by changing the machine data record (= > "Functions, Reference Manual"; Section 3.3 "Following Error Mode (Operating Mode 4)").

4.3 The Traversing Range



All distances are specified in the dimensional unit selected in the “measurement system” parameter. The traversing range is characterized by the following:

- the start of the traversing range (software start limit switch),
- (software end limit switch) and
- the reference or home point coordinate.

For a linear axis, the start of the traversing range is the software start limit switch and the end is the software end limit switch. Targets can only be approached within this range. If a software limit switch is tripped during operation, the axis is braked with the deceleration selected for the particular direction in the machine data record.

Example rotary axis:

A round table is divided into 360 degrees. The start of the range is at 0 degrees, and the end of the range at 360 degrees. 0 and 360 degrees are the same point on the round table and can both be specified as the target coordinate.

When using degrees, the traversing range is not necessarily from 0 degrees to 360 degrees. It may, e.g. be from 400 degrees to 800 degrees. The *only* restrictions are the numerical range of the individual parameters and the rule that the coordinate for the start of the range must be smaller than the coordinate for the end of the range.

The reference point with the incremental version of the IP246 corresponds to the home point with the absolute version. Both are used to calibrate the axis. With the reference point approach, or when setting reference or home points, the reference or home point is assigned the coordinate value stored in the machine data record. With this, the machine zero point is also fixed, the

software limit switches on the linear axis are evaluated and absolute positions can be approached.

The traversing range must be at least twice as great as the resolution ("distance travelled per encoder revolution" / "pulses/steps per encoder revolution"). If this is not the case, "wrong resolution" is entered in the data record.

Example:

For a resolution of 4 urn/increment, the traversing range must be at least 8 um.

4.3.1 Restrictions for the Absolute Version

With the absolute version of the IP246, there is a close relationship between the traversing range and the data of the position encoder used and the resolution.

For a linear axis

Each point which can be physically reached by the axis must be covered "uniquely" by the absolute position encoder, i.e. no encoder reading can occur twice. This means the following:

[distance travelled per encoder revolution] · [number of encoder revolutions]

must at least correspond to the physical length (from limit stop to limit stop) of the axis.

The machine data record contains no information about the physical limits of the axis or the position of the hardware limit switches. The traversing range is delineated solely by the coordinates of the software limit switches. This means that it is possible to use a particular section of a given axis as the traversing range and to use an absolute position encoder which does not cover the total physical length of the axis uniquely. Under the following conditions, it is also possible to ensure that no incorrect (not unique) actual value is detected (= > "Functions, Reference Manual", Section 3.4.3 "Setting the Home Point"):

1.) When the hardware limit switches are installed with a clearance corresponding to the braking distance

$$d_{\text{brake1}} [\text{mm}] = \frac{v_{\text{max}}^2 [\text{mm}^2/\text{min}^2]}{2 \cdot a [\text{mm}/\text{d}^2] \cdot 3600}$$

from the software limit switches. Whereby d_{brake1} is the required braking distance, v_{max} the maximum speed as stipulated in the machine data and a is the deceleration forwards or backwards.

2.) When the second hardware limit switches, which directly influence the power unit, are positioned with a clearance corresponding to the braking distance

$$d_{\text{brake2}} [\text{mm}] = \frac{v_{\text{max2}} [\text{mm}^2/\text{min}^2]}{2 \cdot a_{\text{max}} [\text{mm}/\text{d}^2] \cdot 3600}$$

behind the first hardware switches. Whereby, d_{brake2} is the maximum required braking distance at maximum deceleration, v_{max} is the maximum speed stipulated in the machine data and a_{max} the maximum deceleration.

Remember that all braking distances can be extended by a maximum of

$$d_{\text{corr}} = v_{\text{max}} [\text{mm/min}] / 8000$$

This value results from the response time of the firmware.

When the machine data are input, the firmware of the IP246 checks whether the position encoder covers at least the following:

- Traversing range (defined by the software limit switches)
- plus
- $2 \cdot d_{\text{brake1}}$ in the forwards direction
- plus
- $2 \cdot d_{\text{brake1}}$ in the reverse direction
- plus
- $4 \cdot d_{\text{corr}}$

This value will be called the usable range from now on.

The range covered by the position encoder can, of course, be greater than the usable range. In this case, only part of the range of the absolute position encoder is used. The zero crossing of the position encoder can lie within this range, outside it or exactly on a software limit switch.

If the range uniquely covered by the encoder is exceeded during operation, the correct actual position will still be detected, although a unique actual value can no longer be expected from the absolute position encoder. This information is, however, lost following a power down (failure of the battery back up from the PC or removal of the module).

For a rotary axis

If the axis type rotary axis is specified, the traversing range (end of range - start of range) must match exactly the range covered by the absolute position encoder. The end of the range describes the same physical point as the start of the range. This means that the absolute position encoder must once again supply the same value when the whole traversing range has been travelled once.

The following equation must apply:

$$[\text{Distance travelled per encoder revolution}] \cdot [\text{number of encoder revolutions}] = [\text{range end} - \text{range start}].$$

The starting point is the maximum speed (data word n + 35/36). This is the speed at which the drive travels when there is a rotational speed setpoint of 10 V at the analog output of the module. This speed must be determined exactly from the technical specifications of the drive.

Example:

At 10 V, the motor rotates at a rated speed of 2000 rpm. If 5 mm are travelled for each revolution of the motor, the maximum speed is 10000mm/min.

Note:

The speed and resolution are closely related. Both must be specified exactly. If this is not done, it may nevertheless be possible for the positioning control to function. In this case, the speeds and distances travelled will, however, be indicated in the wrong scale.

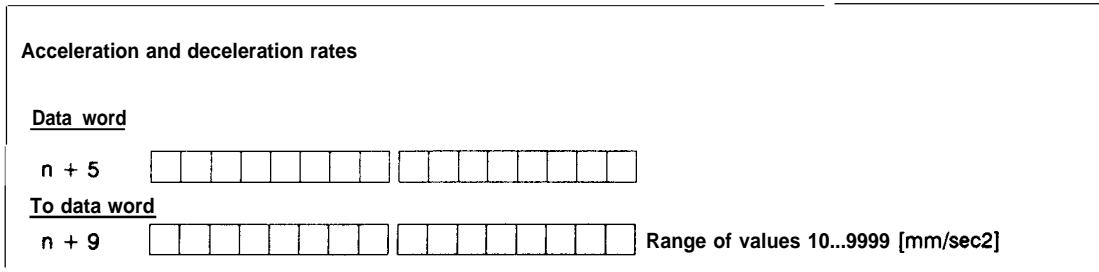
For all other speeds, the general rule applies that they must not exceed the maximum speed.

The speeds to be specified areas follows:

- jog speed 1 for the first jog mode, separately for the forward and reverse directions, data word n +37/38 jog speed 1 forwards and data word n +39/40 jog speed 1 reverse,
- jog speed 2 for the second jog mode, separately for the forward and reverse directions, data word n +41/42 jog speed 1 forwards and data word n +43/44 jog speed 1 reverse,
- the incremental speed for the modes absolute and relative incremental approach (data word n +45/46),
- reference speeds 1 and 2 for the reference point approach with the incremental version of the IP246. Reference speed 1 (data word n +47/48) is the speed at which the axis travels to the reverse point and from there in the reference direction to the start of the preliminary contact. This speed must not exceed the maximum speed. Reference speed 2 (data word n + 49/50) applies from the start of the preliminary contact until the reference signal is generated. This speed must not exceed reference speed 1. (= > “Functions, Reference Manual”, Section 3.4.1 “Reference Point Approach”).

The parameter reference direction (= Section 4.8 “Other Parameters”) also belongs to the reference speeds. This specifies the direction from which the reference point is to be approached. This is either forwards, i.e. in the direction of the end of the range, or reverse, towards the start of the traversing range.

4.5 Acceleration and Deceleration Rates



Depending on the selected dimensional unit, acceleration and deceleration rates must be entered as follows:

- in mm/s² for metric input,
- in 0.1 inch/s² for input in inches or
- in degrees/s² for input in degrees.

The range of values is 10...9999 in all cases.

First of all, a maximum deceleration (data word n+5) must be entered. This is used to brake the axis when a digital input signals that a hardware limit switch has been tripped or when a stop command is received via a digital input (external stop). To protect the drive and to compensate for changing loads, various speed changes can be assigned for normal traversing operations, as follows:

- acceleration forwards (data word n +6)
- deceleration forwards (data word n+ 8),
- acceleration reverse (data word n +7) and
- deceleration reverse (data word n +9).

These rates are only restricted in that they must not exceed the maximum deceleration.

The acceleration and deceleration rates depend on the particular drive and the inertia and load torques arising.

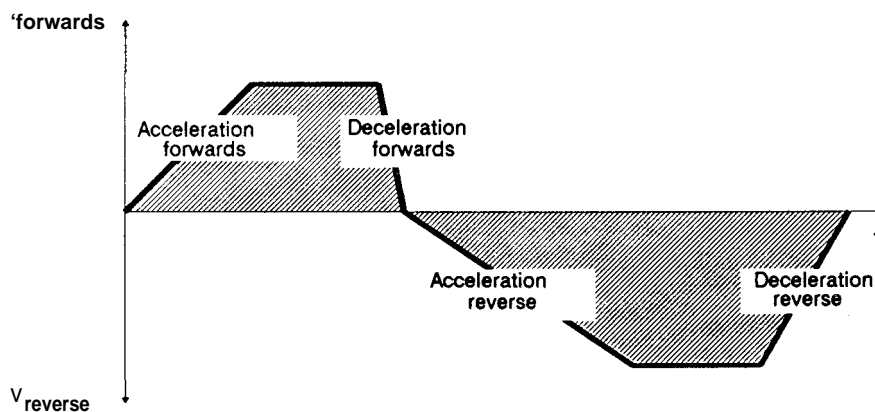


Fig. 4.5-1: Acceleration and deceleration rates

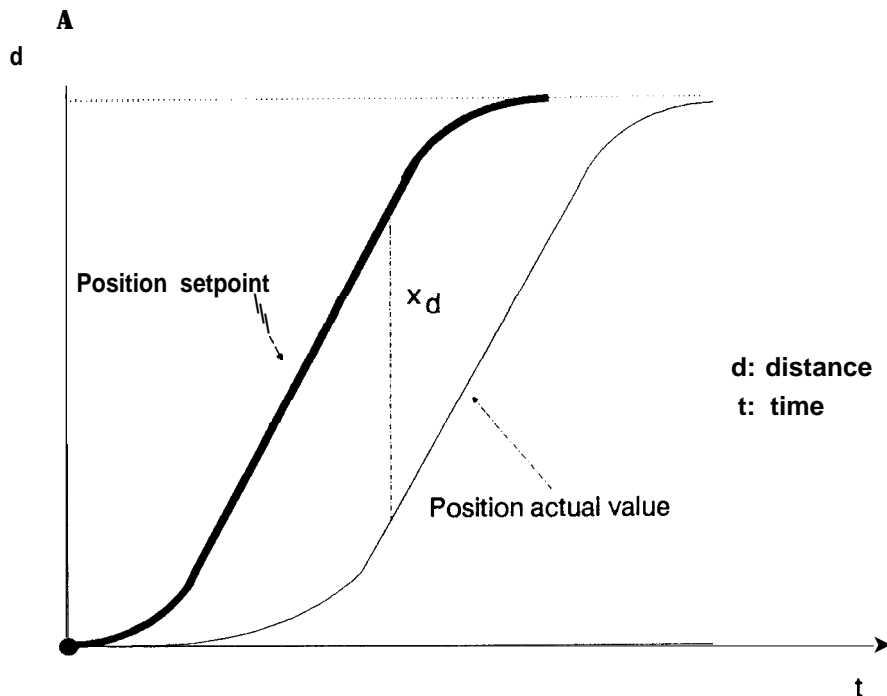


Fig. 4.6.2-1: The following error

The following error depends on the speed at which the axis travels (see above). The maximum following error must therefore be selected so that the difference in position occurring at the required speed is included.

Correct monitoring of the following error depends on the correct assignment of parameters to the axis (resolution, maximum speed), i.e. the parameters match the physical conditions of the drive. The higher the acceleration and the greater the inertia of the drive, the greater the following error.

If the following error monitoring responds, the current traversing job will be abandoned with the error message "max. following error exceeded". The axis brakes at the selected deceleration rate. The position controller remains enabled and the axis only stops when the current following error has been eliminated. The following error monitoring only responds if the following error exceeds the selected maximum value despite the movement of the axis. If during the traversing movement of the axis, no change of position is detected, e.g. owing to position encoder failure or the power unit being switched off, the following error increases and with it the output voltage of the IP246 up to 5 V. If the 5 V limit is exceeded, the current job is abandoned, the error message "position loop interrupted" is generated and the system automatically switches to the following error mode (mode 4).

The range of values of the maximum following error is between 0.001 and 99.999.

You can disable the following error monitoring by assigning the value 99.999 as maximum value for the following error in the machine data.

4.6.3 Standstill Monitoring

Standstill monitoring	
<u>Data word</u>	
n + 15	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
<u>Data word</u>	
n + 16	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> Range of values 0.001...64.999 mm

Standstill monitoring monitors the following error while the axis is at a standstill. The following error is much less during a standstill than during traversing, the range of values for the monitoring can be correspondingly reduced.

The range of values in this case is between 0.001 and 64.999.

If the standstill monitoring responds, the error message “standstill monitor tripped” is set, however, there is no further reaction.

The maximum following error and the standstill monitoring are specified in the selected dimension (mm, 0.1 inches or degrees). The standstill monitoring value must not exceed the maximum following error.

4.7 Correction Parameters

Correction parameters include zero offsets, tool offsets and the backlash compensation.

4.7.1 Backlash Compensation

Backlash compensation value	
<u>Data word</u>	
n + 13	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
<u>Data word</u>	
n + 14	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> Range of values 0.000...64999 mm

The backlash compensation value is used to compensate mechanical backlash when the axis changes direction, which is outside the closed position control loop.

If there is backlash greater than zero when the position is detected indirectly, there is a discrepancy between the detected actual value and the real distance travelled whenever the direction is reversed. The actual value of the axis position is displaced by the amount of the backlash. Using the backlash compensation parameter, this error can be adjusted, providing the backlash is measured exactly. Whenever the direction is changed, the positioning module includes the backlash in the distance to be travelled and therefore eliminates the backlash of the mechanical equipment. Since the actual position of the axis does not change until the backlash has been taken up when the direction is reversed, the actual value also remains unchanged in this area, although the motor or position encoder is turning.

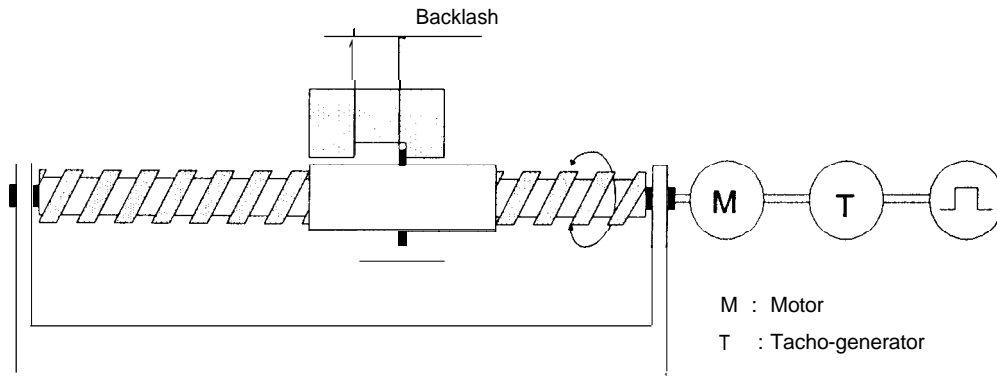


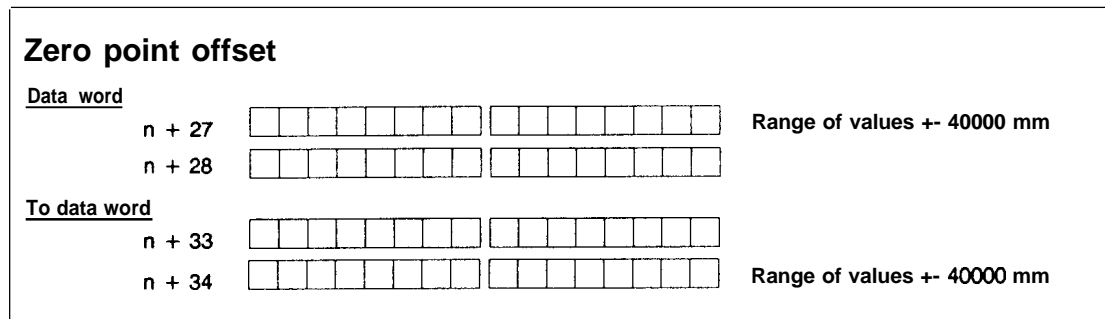
Fig. 4,7.1-1: Backlash external to the position control loop

The backlash can be a value between 0 and 64.999 mm (0...64.999 0.1 inch or 0...64.999 degrees).

The backlash can only be correctly compensated for when the carriage can be moved directly by the drive. This is always the case when a distance greater than the backlash has been travelled. In a reference point approach this is fulfilled providing the distance travelled before recognizing the zero marker was greater than the backlash (= > "Functions, Reference Manual", Section 3.4.1 "Reference Point Approach"). After "setting" the reference or home point you must make sure that this movement takes place. You do not need to make sure of this movement if there is no play between the axis and the drive in the direction in which you wish to traverse.

The compensation value is ignored until a distance is travelled which is equal to or greater than the selected backlash compensation value. Correct detection or display of the actual position is not affected.

4.7.3 Zero Point Offset



A total of four zero point offsets can be assigned in the machine data record and can be called in machining programs using the G-functions (= > Section 5.6 "The G-Functions"). These can have values throughout the whole traversing range (+/- 40 m).

If a zero offset is executed, all coordinates (software limit switches, reference or home point coordinates and actual value) are corrected by the amount of the offset.

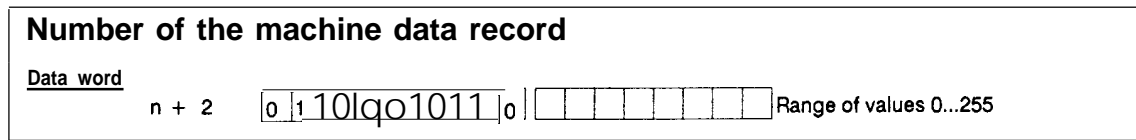
When the machine data are entered, the IP246 checks whether one of the four assigned offsets exceeds the permitted traversing range of +/-40 m (+/- 4000 inches, +/- 40000 degrees). Such offsets are not permitted and not executed, and cause an error message.

The zero offsets are called in machining programs using functions G54 to G57 and are cancelled with G53. They can only be enabled as alternatives. If an offset has already been executed with the zero offset modes (= > "Functions, Reference Manual"), the offsets activated by G54 to G57 are added to those already existing. For this reason, a check is made during the execution of a machining program to ensure that the activation of a zero offset does not exceed the maximum range. If the maximum range would be exceeded by the offset, the machining program is stopped.

4.8 Other Parameters

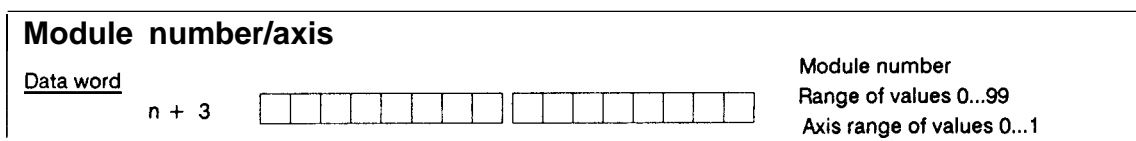
This section discusses the following parameters:

- number of the machine data record,
- module number,
- axis (number), for which the machine data record is valid,
- machine data errors,
- polarity of the hardware limit switches,
- coding of position specifications sent from the CPU to the IP246 and
- direction of approach to the reference point.

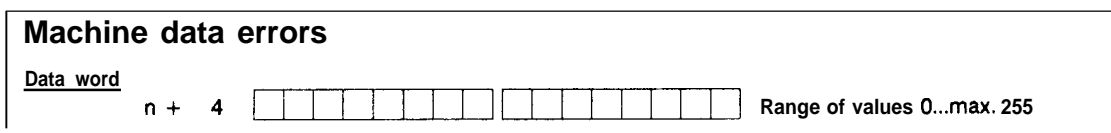


A DB number from 0...255 can be assigned to a machine data record.

Each positioning module can control two axes, with the fixed designation axis 1 and axis 2. Each module is also assigned a module number between 0 and 99. This information uniquely identifies an axis. To be able to assign a machine data record to an axis, this must contain both values.



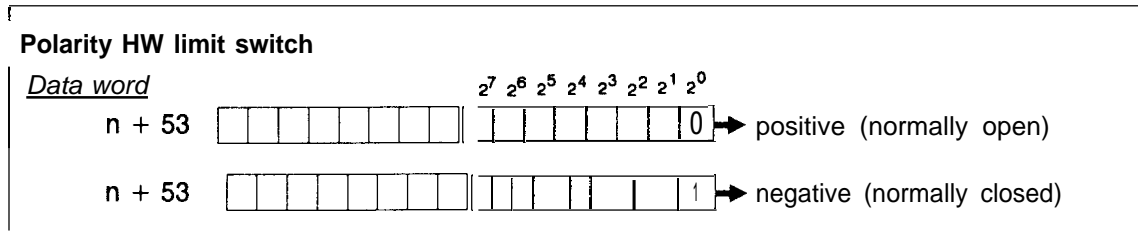
Each machine data record also contains an error variable. Some of the possible input errors



made when generating the machine data record on the programmer are detected by the software package COM246. Further checks are made when the machine data are entered into the positioning module by its firmware. If an error is detected, the corresponding error number is written to the error variable of the machine data record and the error message "error in machine data" is output.

The absolute version of the IP246 can indicate the current actual position value after removing the module without recalibrating it (=> "Functions, Reference Manual", Section 3.4.3 "Special Features when using Absolute Position Encoders") if a machine data record with a valid home point has been transferred to the axis. This requires two additional values in the machine data record (data word 61 and data word 62/63). These values cannot be displayed with COM246 and can therefore not be edited. Data word 61 indicates whether the home point entered in the data record is "valid" ("I") or "invalid" ("O").

4.8.1 The Polarity of the Hardware Limit Switches

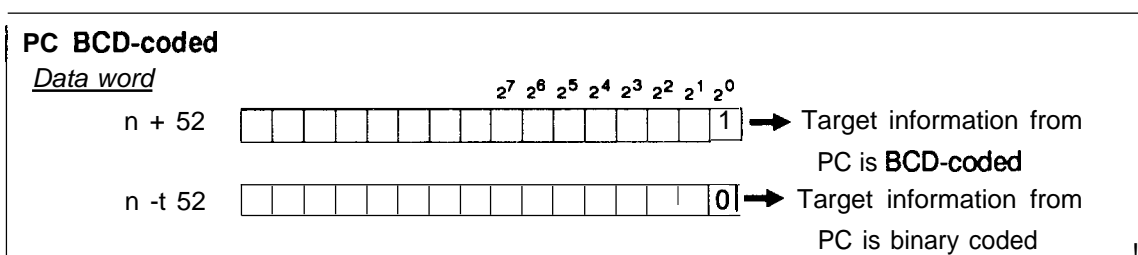


In addition to the software limit switches, two hardware limit switches are also evaluated via digital inputs. These should normally be after the software limit switches. If they are in front of the software limit switches, they limit the traversing range instead of the software limit switches.

These hardware limit switches can either both be stipulated as normally closed (“I”) **or** both as normally open (“O”) using the parameter “polarity HW limit switch”. A normally open switch generates a **positive edge** at the corresponding digital input and is therefore high-active. A normally closed switch generates a **negative edge** and is therefore low-active. For safety reasons, you should use normally closed switches as the hardware limit switches. The **IP246** then recognizes a wire break during operation as the tripping of a limit switch and stops the movement. The tripping of a hardware limit switch is, however, only recognized when the axis is moving or should move in the direction of the activated switch.

If machine data are transferred to the module, the assignment of parameters for the hardware limit switches is checked. The **IP246** can only detect incorrect parameter assignment when neither of the hardware limit switches is active when the machine data are input. If a rotary axis has been selected, the digital inputs for hardware limit switches are also evaluated. If, however, no limit switches are connected, the polarity must be set to “normally open” (pos “O”).

4.8.2 Target Information from PC is BCD-Coded



Using the parameter “PC BCD-coded” you can inform the module whether target information, tool offsets and zero offsets sent by the PC to the **IP246** are in binary or **BCD** format.

Remember that each position, each tool offset and each zero offset of the corresponding axis is interpreted in the selected format by the **IP246** and this selected format will be used until a different coding is specified **in the machine data record**.

5 Machining Programs and their Structure

5.1 General

A machining program is a connected series of traversing jobs, dwell times and offsets. Machining programs comprise individual statements. Each statement is itself a complete and feasible job for the positioning module. The machining programs can be stored in the RAM of the positioning module, from there they are executed either as a series of statements or in the single statement mode. The machining programs accepted by the positioning module generally correspond in terms of their structure to a subset of the representation described in DIN 66025. Only this subset is explained here. COM246 provides you with user-friendly support when generating a machining program. Deviations from the permitted subset of DIN 66025 are signalled immediately when generating the program.

Note:

- . Machining programs are independent of the axes. A machining program can be executed simultaneously both on axis 1 and axis 2. It is of little importance whether the particular axis is linear or rotary.
- . Machining programs do not include dimensions. Position information and speeds are always interpreted in the unit assigned to the axis in the machine data record.

The programs consist of a sequence of ASCII characters. The following restrictions apply:

- a maximum total of 10000 ASCII characters can be stored on the IP246
- these can be divided into 255 programs
- a maximum of 1023 ASCII characters are permitted per program.

Repeat loops and subroutines are possible in the programs.

If a statement is inserted in an existing machining program using the machining program editor of COM246, or if a statement is appended to a program, 50 characters are reserved for this statement. If the maximum length of a machining program would be exceeded by this addition, COM246 generates an error message.

A machining program generated with COM246 cannot be loaded in the CPU directly. If you wish to store a machining program in the CPU, you must transfer the machining program of the IP246 to an S5 data block on the CPU. The machining program number is entered in the machining program header. Program numbers 0...255 are permitted.

A machining program is structured as follows:

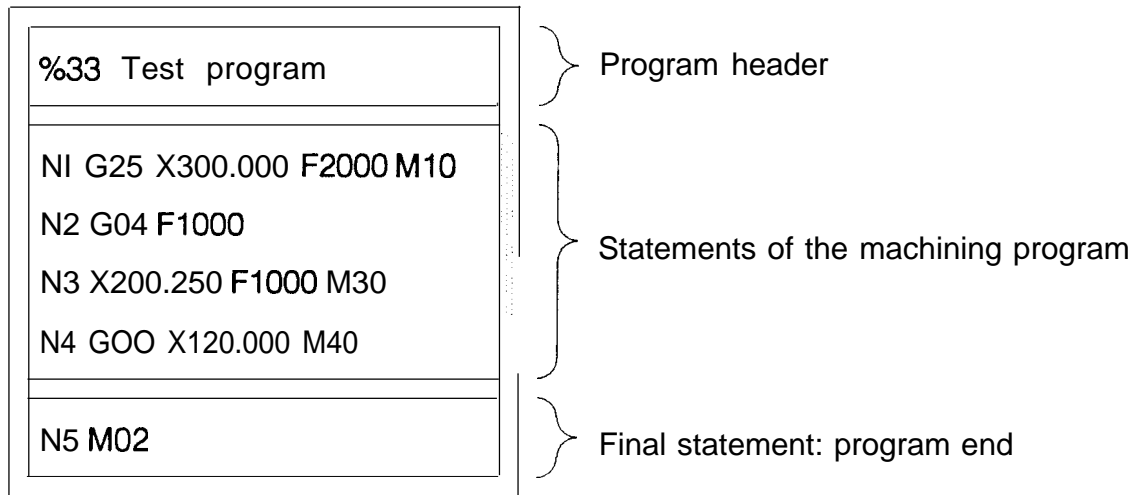


Fig. 5.1 -1: Structure of a machining program with program number 33

The machining program always has a program header and a final statement. The final statement has the special identifier M02 at the end. The length of individual statements can vary.

5.2 Program Header

The program header is generated automatically by COM246 when the machining program is created at the PG.

The header includes the following:

- The program identifier:
 - % = main program
 - L = subroutine,
- The program number (maximum three characters) = DB number of the data block
- A text with a maximum of 58 characters (selected as required by the user)
- <LF> (line feed) to complete the header

Example:

```

%05      this is a main program in DB5 cLF >
L12      this is a subroutine in DB12 <LF >
  
```

The difference between main programs and subroutines is simply of documentary interest, the module does not distinguish between them, so that a program can be used both as a main program and a subroutine. Recursive or reciprocal program calls are, however, not permitted.

5.3 Program Statements

A statement in a machining program consists of a series of functions which have a fixed order and must be separated by at least one blank. Each statement must be completed by a line feed (<LF>). The length of a statement is limited to 50 characters, including <LF>. Blanks before and after the line feed are not necessary, but permitted. Blank lines following a line feed are included in the length of the next statement.

The following functions are available:

- N-function statement type and statement number
- L-function subroutine call
- G-function preparation of traversing conditions
- X-function target function
- F-function speed, time, loop execution
- M-function auxiliary function

It is not necessary to include all functions in a statement, however, they must not occur more than once in a statement. All the functions used must be in the order listed here. Some functions must be the last in a statement or can only be followed by certain other functions, cf. Fig. 5.10-1 "Syntax diagram" on page 64.

The N-function in a statement and the completion by <LF> are obligatory, as is the function M02 in the final statement of the machining program. No further statement can follow this.

Example

%9 program example	
N10 G74 M10	approach the already known reference point M10 is output at the start of the statement
N20 G24 F5	beginning of a repetition loop with five repetitions
N30 L36	call subroutine 36
N40 X50 F2000	approach point 50 mm at 2000 mm/min *
N50 G20	end of the repetition loop
N60 M02	final statement, program end

*The example applies to the presetting "dimensional unit mm" and "target specification absolute".

5.4 The N-function

The N-function is the first function in a statement and specifies the number of the statement. This function is obligatory and consists of the character 'N', followed by a maximum three digit number between 0 and 999.

The statement numbers can be entered in any order, and can be used more than once in a machining program.

The execution of the statements is always in the order in which they are entered in the machining program.

All statements are treated as "normal statements" according to DIN 66025. The statement identifiers "/N" for skippable statement and ":N" for main statement are permitted, are, however, of no significance.

5.5 The L-Function

A different program can be called as a subroutine in a program statement. This call must follow the N-function immediately. The function consists of the character 'L' followed by the machining program number of the program to be called.

No further functions can follow the L-function and the statement is completed with <LF>.

Examples:

N10 L123 <LF>	call subroutine 123
N20 L5 c LF>	call subroutine 5

Subroutines can be nested. The nesting of loops and subroutines must not exceed a nesting depth of 5.

5.6 The G-Functions

A G-function can follow an N-function. It is identified by the letter 'G', followed by a two digit number. Only one G-function is permitted in a statement. Only the following G-functions are permitted:

- G00: rapid traverse
- G04: dwell time
- G10: flying change
- G20: loop end
- G24: loop start
- G25: approach target by shortest route (*)
- G26: approach target in clockwise direction (*)
- G27: approach target in anti-clockwise direction (*)
- G40: clear tool offset
- G43: positive tool offset on
- G44: negative tool offset on
- G53: clear offsets
- G54: offset 1 on
- G55: offset 2 on
- G56: offset 3 on
- G57: offset 4 on
- G70: dimensions in 0.1 inches (*)
- G71: dimensions in mm (*)
- G74: reference point approach
- G90: position specifications absolute (*)
- G91: position specifications incremental (*)

(*) = latching (retentive) functions

At the beginning of a program the following G-functions are automatically active:

- G25: approach targets by the shortest route
- G90: dimensions absolute

If the machine data of the axis on which the machining program is to be executed are in mm, G71 (dimensions in mm) is also the default. If the machine data are in 0.1 inches, then G70 (dimensions in 0.1 inches) is the default.

If degrees are selected, neither G70 nor G71 are defaults, since it is not possible to change the dimensional unit.

With the G-functions implemented on the IP246, the following preparatory conditions, offsets or switchovers can be executed.

5.6.1 -G00: Rapid Traverse

The target position programmed in this statement is approached at the maximum speed (see machine data). Specifying the speed using the F-function is then not permitted.

Example:

N50 G00 X1000 M23	output the auxiliary function M23 at the beginning of the statement.. At maximum speed to target point 1000.
-------------------	---

5.6.2 -G04: Dwell Time

A dwell time is executed in this statement. The duration can be set using the F-function in units of 100 msec.

Example:

N38 G04 F10 M34	output of auxiliary function M34 at the beginning of the statement. Wait for 10 • 100 msec = 1 sec.
-----------------	--

5.6.3 -G10: Flying Change

The statement following the statement containing G10 is carried out without stopping the axis. The following can therefore be achieved:

- speed changes during a traversing movement (example 1) or
- changing the M-function during a continuous traversing movement (example 2).

Example 1: initial point at program start x = 0

N30 (G10) X50 F1000 M30	to target point 50 mm at 1000 mm/min
N32 (G10) X100 F500 M31	to target point 100 mm at 500 mm/min
N34 X150 F1000 M32	to target point 150 mm at 1000 mm/min
N36 M02	final statement/program end

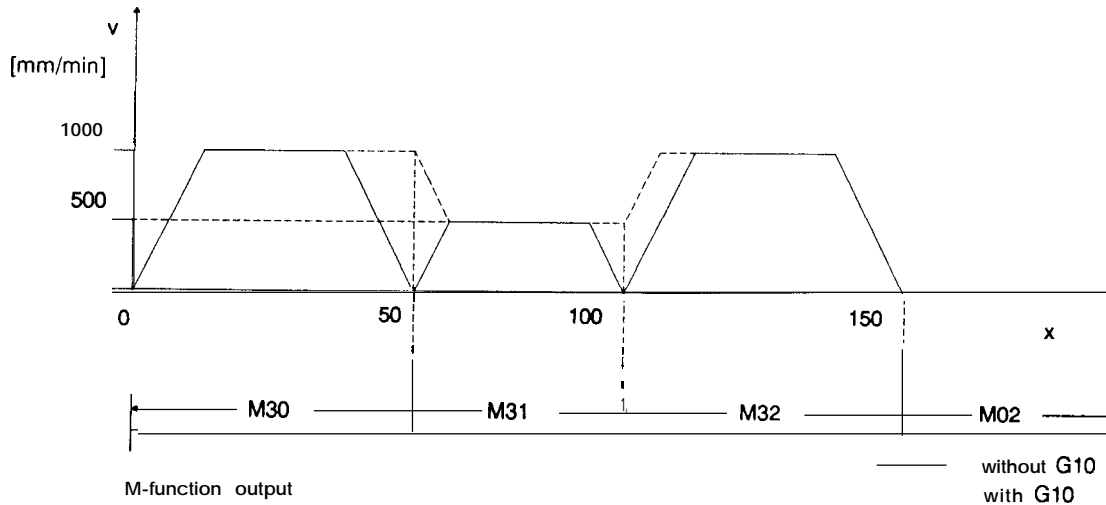


Fig. 5.6.3-1 Flying change with speed change

Example 2:

Initial point at program start $x = 0$

N40 (G10) X50 F1000 M40

N42(G10) X100 F1000 M41

N44 X150 F1000 M42

N45 M02

to target point 50 mm with 1000 mm/min

to target point 100 mm at 1000 mm/min

to target point 150 mm at 1000 mm/min

final statement/program end

If no different M-functions were required, the movement could be brought together in one statement (e.g. N10 X150 F1000 M40).

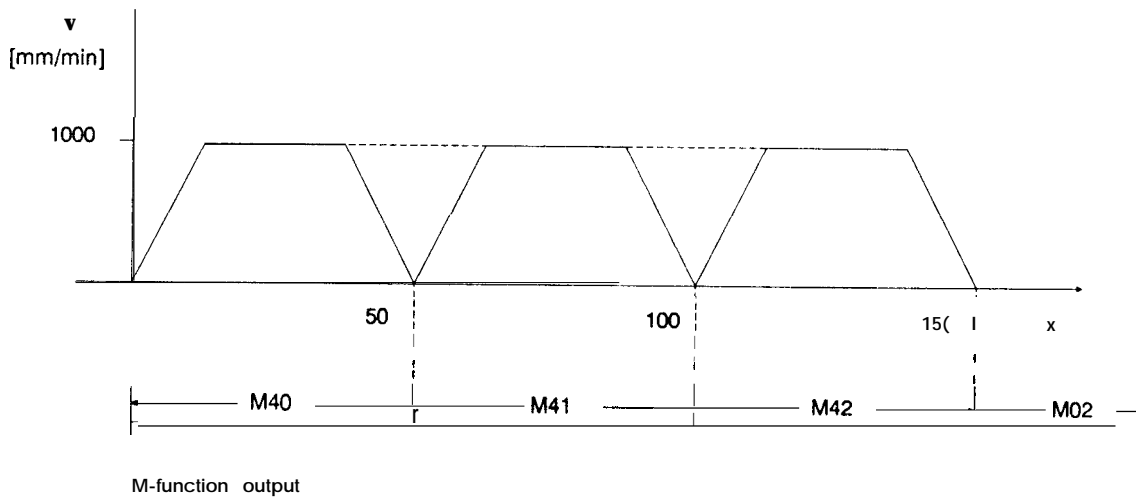


Fig. 5.6.3-2 Flying change without speed change

Reaching the target of the statement containing G10 depends only on the internal position set-point. The actual position value is ignored. This means that if there is a large following error, the execution of the statement following the flying change will be started (a programmed M-function is already output) when the actual position value is still at a distance from the target corresponding to the following error.

Example

N10 G24 F0	start of a closed-loop
N20 G74	approach to reference point
N30 G24 F5	start of a loop with 5 repetitions
N40 L30	call subroutine 30
N50 G04 F10	wait one second
N60 L30	recall subroutine 30
N70 G20	end of the inner loop
N80 G20	end of the closed-loop
N90 M02	final statement/program end

5.6.5 Direction of Approach to the Target Point with a Rotary Axis

With a rotary axis, absolute target points can either be approached by the shortest route (G25) or clockwise (G26) or anti-clockwise (G27). If machining programs containing these G- functions are executed on a linear axis, they are ignored.

-G25: approach target by shortest route (default at program call)

With a rotary axis, the function G25 means that all absolute targets are approached by the shortest route. The module itself determines the direction of approach. If the distance to the target is the same both in a clockwise and anti-clockwise direction, the clockwise direction will always be selected (= preferred direction). When deciding the direction of approach, backlash compensation is ignored.

Example:

A backlash compensation of 60 degrees was selected in the machine data. The target (180 degrees) is to be approached by the shortest route (G25). The current position is 0 degrees. Ignoring the reversal backlash, the traversing distance is the same in both directions. The traversing direction of the previous job was anti-clockwise.

=> The distance travelled is longer owing to the backlash (180 degrees + 60 degrees). The traversing movement therefore takes longer in the preferred direction than in the opposite direction.

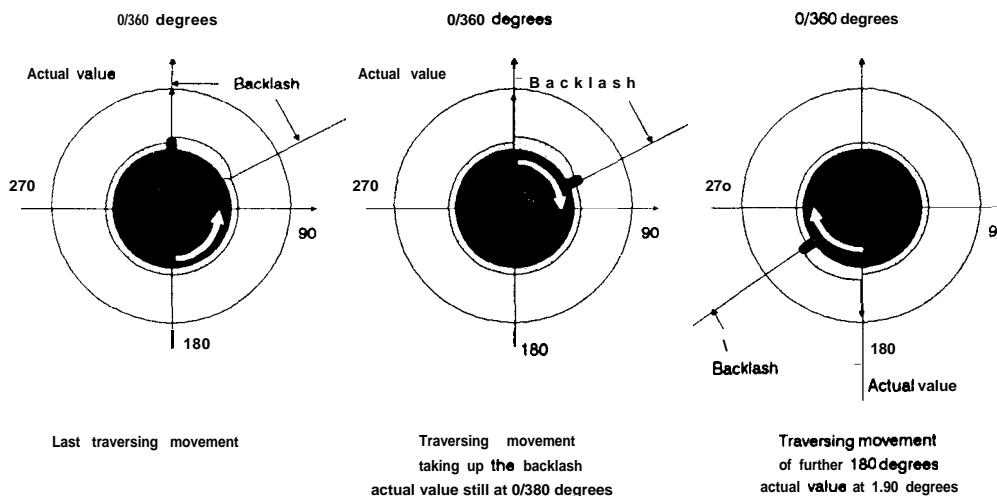


Fig. 5.6.5-1: Reversal backlash with a rotary axis

-G26: approach target in clockwise direction

All **absolute targets** are approached in a clockwise direction (forwards) when **G26** is selected. On a linear axis, a **G26** is ignored and does not cause a stoppage of the machining program.

-G27: approach target in anti-clockwise direction

All **absolute targets** are approached in an anti-clockwise direction (reverse) when **G27** is selected. On a linear axis, a **G27** is ignored, and does not cause a stoppage of the machining program.

Example:

Rotary axis, traversing range 0 degrees to 360 degrees	
N10 G74 M10	approach the reference or home point by the shortest route
N20 G27	change direction: reverse
N30 XI 80 F1000 M30	approach 180 degrees in reverse direction
N40 G25 XO F500	approach 0 degrees/360 degrees by the shortest route, here the preferred direction forwards
N50 G26	change direction: forwards
N60 XoF1000 M60	one revolution of the rotary axis forwards
N70 G25 X360 F500	switchover to the shortest route. No traversing movement since shortest route.
N80 M02	final statement/program end

Note:

The G-functions **G26** and **G27** are only effective when "dimensions absolute" (**G90**) is set.

5.6.6 Tool Length Offset

By using tool offset in the machining program, a change in the length of the tool during execution of the program (usually wear on the tool) can be taken into account. This is added to a tool offset executed with mode **BA15** ("**tool offset**"). The value of the tool offset used in the machining program is stored in the machine data. Each time a tool offset is called in the machining program, the value stored in the machine data record is added to the already existing offset. The following limit values apply to the resulting tool offset:

- value of the offset maximum 40 m,
- software end limit switch + offset value < 40 m and
- software start limit switch + offset > -40 m
- for a rotary axis: offset less than the traversing range. (Range end - range start).

If the **tool offsets** implemented by a machining program during its execution are not reset with **G40** ("clear tool offset"), they are retained on completion of the machining program. The offset implemented in the machining program can then only be cleared using mode **BA16** ("**tool offset off**"). However, a basic tool offset activated by **BA15** ("**tool offset on**") is also deleted. If a new tool offset is activated by **BA15** when a machining program is completed, the cumulative tool offset achieved during the machining program is no longer effective.

	Tool offset BA 15/16	Tool offset machining program	Total
Tool change			
BA 15; 100 mm, forwards ↓	100mm	0	100mm
Machining program start			
G44	100mm	-10mm *	90mm
G44	100mm	-20mm *	80mm
Machining program end			80mm
↑			
Tool change			80mm
↓			
BA 15; 200 mm, forwards	200mm	0	200mm

* In the machine data record: tool offset = 10 mm

Table 5.6.6-1: Tool offset

-G40: clear tool offset

A statement containing G40 switches off all the active, positive or negative tool offsets in this machining program. This also applies to subroutines. The "G-function G40 does not affect the tool offset set with mode BA15 ("tool offset on").

-G43: positive tool offset on

A statement containing G43 causes a tool offset in a forwards direction by the length specified in the machine data (= > "Functions, Reference Manual", Section 3.13 "Tool Length Offset"). This occurs each time the function is executed.

-G44: negative tool offset on

A statement containing G44 causes a tool offset in a reverse direction by the length specified in the machine data (= > "Functions, Reference Manual", Section 3.13 "Tool Length Offset"). This occurs each time the function is executed.

Example:

The tip of a tool with a basic length of 40 mm must approach coordinate O. During each machining operation, the tool is reduced in length by 5 mm. The tip of the tool is at position -65 mm before the first machining operation. The home position of the tool holder is -105 mm.

The following must be programmed:

in the machine data: tool offset = + 5mm

in the machining program: N10XOF1000
 N15 G44 X-65 F2000

This means that the tip of the tool is at the same position following each machining operation.

In this example, the tool holder does not return to the home position when it is retracted. (Fig. 5.6.1-2a.)

If the tool holder must always return to the basic position when it is retracted (e.g. owing to interlocks), you should set the reference point at this position. In a reference point approach, or with G74 in an automatic program, the tool holder always returns to the same position both with or without offsets. However, the corrected value (coordinates of the tip of the tool) are displayed as the actual value (Fig. 5.6.6-2 b).

The machining program is then as follows:

```
N10XOF1000
N15 G74
N20 G44
```

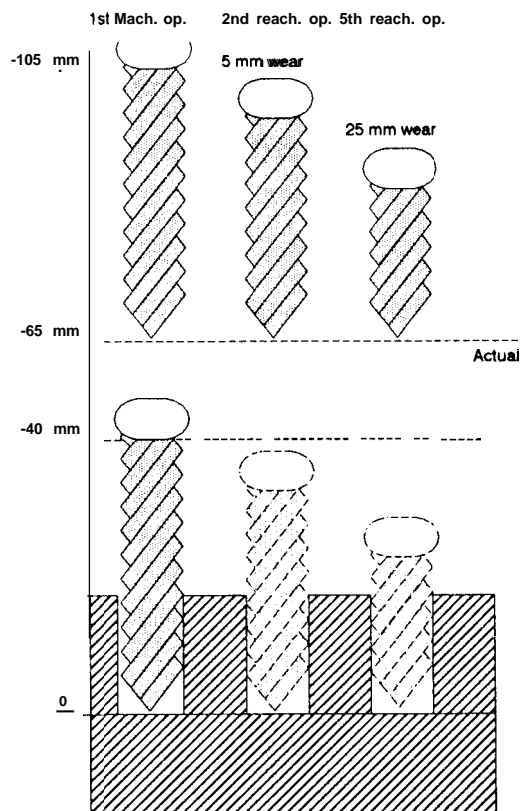


Fig. 5.6.6-2a: Tool offset

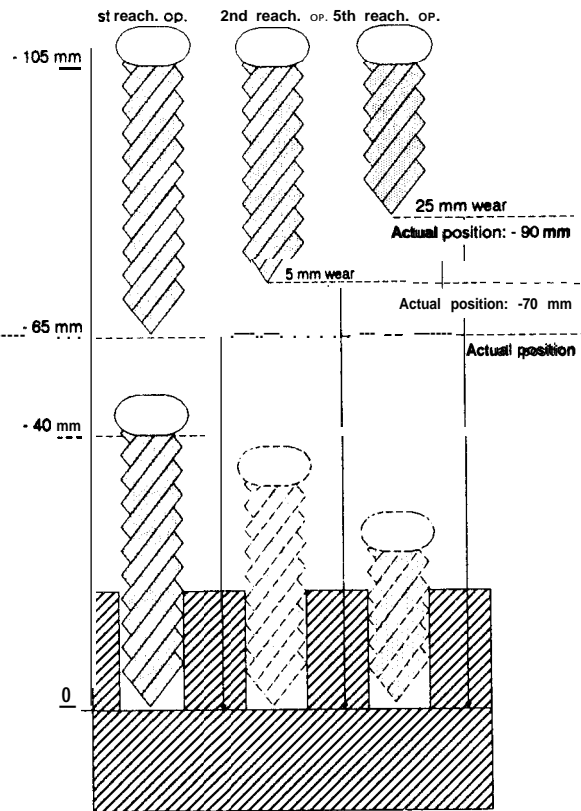


Fig. 5.6.6-2b: Tool offset

5.6.7 Zero Point Offset

You can program a relative displacement of the coordinate system of your axis during a machining program. This offset is added to offsets executed with mode BA12 (“zero offset absolute”) or BA13 (“zero offset relative”).

In machining programs, only one of the four offset values selected in the machine data can be activated (G54...G57). If a second zero offset is activated, the first is no longer effective.

The direction of the offset depends on the sign in the machine data.

On completion of a machining program, the offsets activated in the machining program are automatically switched off again. This is, however, not the case if the machining program stops owing to an error message or because of a stop command. In this case, the basic coordinate system can only be established again by clearing all offsets with operating mode BA14 (“clear zero offset”).

Zero offsets executed in a subroutine are not cleared following the return to the main program. They are only reset on completion of the main program.

A zero offset changes the limits of the traversing range, the reference or home point and the actual position value according to the value of the offset. With a positive zero offset, the zero point of the coordinate system is displaced in a positive direction, i.e. the individual points on the axis have a more negative coordinate value. A negative zero offset has the opposite effect.

-G53: clear offsets

G53 deactivates all the zero offsets active in the machining program. Zero offsets activated in subroutines are also cleared. Offsets set with the mode “zero offset absolute or relative” (= > “Functions, Reference Manual”, Section 3.10 or 3.11 “Zero Offset Absolute or Relative”), are not changed.

-G54-G57: offsets 1-4 on

A statement containing one of the G-functions G54-G57 executes a relative zero offset.

- G54 = > zero offset 1
- G55 = > zero offset 2
- G56 = > zero offset 3 and
- G57 = > zero offset 4

The following example (Fig. 5.6-6) contains both types of zero offset. After stipulating the coordinate system

BA 5, run

a relative zero offset 10 mm forwards is executed.

BA 13, +10 mm, forwards

The actual position value is displaced from 0 mm to -10 mm. Following this, a traversing movement to point 0 mm is executed.

BA6, 0 mm, start

Here, machining program 1 is started.

BA8, program 1, start

Subroutine 9 is called in machining program 1. By means of **M10**, this program controls the drilling of three holes (at 0 mm, 10 mm and 20 mm). The three coordinates are specified as absolute values. Following each execution of subroutine 9, coordinate 40 mm is approached in machining program 1 and a relative zero offset of 40 mm is executed via **G54**, an offset of 80 mm by **G55** and of 120 mm by **G56**. The values of the offsets are assigned in the corresponding machine data record. Subroutine 9 is called a total of three times. Before the end of the program, the tool holder is brought to its home position at the reference point by **G74**. Since the offsets are still effective, the actual position value is now displayed as -130 mm. At the end of the main program, all the zero offsets activated in the machining program are cleared again. An offset of +10 mm remains, which was executed at the beginning with **BA13**.

Example:

Values in the machine data:

zero offset 1 : 40 mm
 zero offset 2 : 80 mm
 zero offset 3 : 120 mm

Machining programs:

%1 main program	
N1 L9	call subroutine 9
N2 X40.000 F500	to coordinate 40 mm at 500 mm/min
N3 G54	zero offset by 40 mm
N4 L9	call subroutine 9
N5 X40.000 F500	to coordinate 40 mm at 500 mm/min
N6 G55	zero offset by 80 mm/ G54 no longer effective
N7 L9	call subroutine 9
N8 X40.000 F500	to coordinate 40 mm at 500 mm/min
N9 G56	zero offset by 120 mm/ G55 no longer effective
N10 G74	approach reference point
N11 M02	program end
L9 subroutine	
N2 G04 F50 M10	wait 5 sac
N3 X10 F100	to coordinate 10 mm at 100 mm/min
N4 G04 F50 M10	wait 5 sec
N5 X20 F100	to coordinate 20 mm at 100 mm/min
N6 G04 F50 M10	wait 5 sec
N7 M02	program end

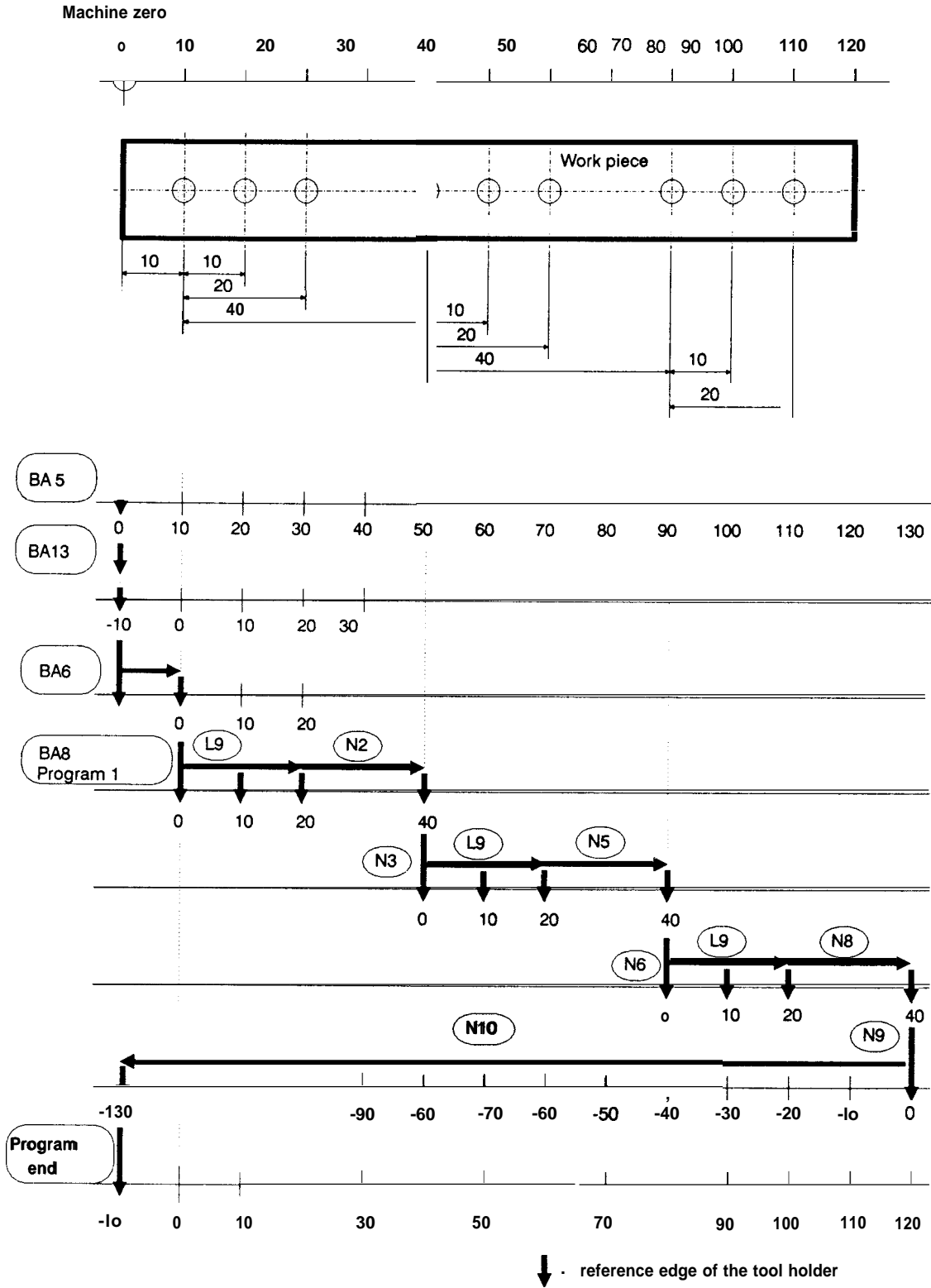


Fig. 5.6.7-1: Example of zero offsets

5.6.8 Dimensional Units in Machining Programs

The IP246 positioning module interprets machining programs in the dimensional unit specified in the machine data, i.e.:

- machine data in 0.1 inches = > G70 default
- machine data in mm = > G71 default
- machine data in degrees = > G70 and G71 disabled

-G70: dimensions in 0.1 inches

Following the function G70, all further distances are interpreted in 0.1 inches and all further speeds as 0.1 inches/rein.

-G71: dimensions in mm

Following the function G71, all further distances are interpreted in dimensional unit mm and all further speeds as dimensional unit mm/min.

5.6.9 -G74: Reference/Home Point Approach

A statement containing G74 moves the carriage or tool holder to the known reference or home point at the incremental speed.

No reference point approach for calibration purposes is executed.

The carriage always moves to the physically stipulated reference or home point, regardless of whether the reference or home point coordinates have been changed by a zero offset. Following the movement, the display of the actual position value takes into account both a zero offset and a tool offset.

Example:

reference point coordinate	= 0 mm
effective zero point offset	= +500 mm and
effective tool offset	= 20 mm

After G74 is executed, the axis is positioned at the physically specified reference or home point. The tip of the tool juts out 20 mm from this point. -480 mm is indicated as the actual position.

Following G74, only an M-function is permitted in the statement.

5.6.10 Absolute and Relative Dimensions

-G90: position specifications absolute (default at program call)

All target information (X-functions) following the G90 is interpreted as absolute until G91 is entered.

-G91: position specifications relative

All target information (X-functions) after G91 is interpreted as relative until G90 is entered.

5.7 The X-Function

The X-function is the target function of the statement. It consists of the character "X", followed by an optional sign and a number which specifies a distance in the units mm, 0.1 inches or degrees. The number consists of five digits and three decimal places,

The maximum range of values is

$$X-40000.000..X + 40000.000$$

Examples:

$$X50, X50., X-.5, X + 12345.678,...$$

If the decimal point is missing, it is assumed to be at the last place in the number.

5.8 The F-Function

The F-function describes one of the following:

- the speed,
- a dwell time or
- the number of loop repetitions.

It consists of an 'F' and a maximum five digit, signless whole number.

- As a speed, it indicates the units mm/min, 0.1 inches/rein or degrees/rein. The range of values is then 10...65000.
- As a dwell time, it specifies a multiple of 100 ms and can have values between 1 and 65000.
- If the F-function is interpreted as a number of loop repetitions, the whole range of 0 to 65000 is possible. If 0 is specified, the loop is repeated continuously.

5.9 The M-Function

The M-function consists of the character 'M' and a two digit number. Permitted values are 0...99. The significance of the number is only fixed for M02 and M00.

An M-function is only output in conjunction with a traversing job (X-function or G74) or a dwell time (G04) to the programmable controller and to the programmer. M-functions standing alone in a statement or alone with **switchovers** or offsets in a statement are ignored (exception: M00).

Each M-function is output at the beginning of the execution of a statement (traversing job or dwell time) and remains valid until the next M-function at the start of the next statement (traversing job or dwell time) containing an M-function is output.

In the control program, M-functions can be used to trigger user-specific actions, e.g. the switching on and off of plant during the traversing movement of the axis.

If several statements with consecutive different M-functions are programmed with the help of the "flying change" (G10) for a traversing movement, remember that the M-function change depends on the internal position setpoint which deviates from the actual position value of the axis by the value of the following error.

If statements without M-functions are programmed at the beginning of a machining program, M255 is output. This is output until a statement (traversing job or dwell time) containing an M-function is executed. If a machining program does not contain any M-functions except for M02, then M255 will be output during the whole program.

Examples:

N10 G91	M-function not feasible, output M255
N15 G24 F3	N-function not allowed, output M255
N20 X1000 F2000 M10	output M10
N30 G57	M-function not feasible, output M10
N35 X-500 F2000	output M10
N45 G20	M-function not allowed
N50 G74 M20	output M20
N60 X500 F100 M30	output M30
N65 G26	M-function not feasible, output M30
N70 X1000 F2000 M60	output M60
N75 M02	final statement/program end

Certain special factors apply to M02 and M00 as follows:

M02

M02 means "program end". Main programs and subroutines are completed with M02. It must be specified in the final statement of the machining program. Following this, no further statements can be appended to the machining program. The final statement can simply consist of the N-function and M02. If M02 is specified in a traversing statement, no further M-function can be specified in the statement.

MOO

MOO means “programmed halt. A statement with an **MOO** has the effect that the next programmed traversing movement (X-function or **G74**) or dwell time (**G04**) is only executed following an enter command. Offsets (e.g. **G57** or **G43**) and switchovers (e.g. **G91**) following an **MOO** and before a traversing movement or dwell time are, however, executed before the halt.

N10 X100 F1000 MOO	(! = break point)
N20 ! G04 F200 MOO	program halt before the dwell time
N30 ! X200 F500	program halt before the traversing movement
N40 XI 00 F1000 MOO	
N50 G57 ! X200 F500	break point after the zero offset

If **MOO** “programmed halt” and **G10** “flying change” are programmed in one statement, the programmed halt has priority.

N10 G10 X100 F500 MOO	(! = break point)
N20 ! X200 F1000	separated owing to MOO

MOO can stand alone or alone with an offset or a switchover following the N-function in a statement. In this case, **MOO** acts as if it is programmed in conjunction with a traversing job with traversing distance **O**. This means that several enter commands may be required following a stop to start the next traversing movement or dwell time.

N10 X100 F1000 MOO	(! = break point)
N20 ! MOO	
N30 G56 ! MOO	
N40 ! X500 F1000	three enter commands are required from X100 to X500

If a machining program is to be stopped directly before the **M02** (program end), **MOO** must be programmed alone or alone with an offset or switchover after the end function in a statement. If in conjunction with a traversing movement or a dwell time only offsets or switchovers follow the **MOO** or if **M02** (program end) follows directly in the next statement, the machining program is no longer stopped.

N10 X100 F1000 MOO	
N20 M02	MOO no longer effective

N10 X100 F1000	(! = break point)
N20 MOO	
N39 ! M02	MOO is effective

In the mode **BA9** (“automatic single statement”) **MOO** has no further significance, since in this mode each traversing movement and each dwell time is always started by an enter command. The stop does not need to be acknowledged twice.

N10 X100 F1000 MOO	(! = break point)
N10 ! G04 F10	in BA9 only one enter command necessary to continue processing

Remember, however, that each **MOO** either alone or alone with an offset or a switchover following the end function in a statement is handled as a traversing job with a traversing distance of **O**. This means that although the **MOO** in mode **9** is ignored, the traversing job with the traversing distance **O** must still be started with an enter command.

Example of execution in mode 9:

N10 X100 F1000	(! = break point)
N20 ! MOO	halt due to BA9 . After enter, execution of the traversing job with traversing distance O
N30 G57 ! MOO	halt due to BA9 . After enter, execution of the traversing job with traversing distance O

5.10 Programming Restrictions and Syntax Diagram

To generate feasible machining programs, there are several restrictions and relationships between the functions which are automatically checked by **COM246**.

- Following an L-function (subroutine call) only the end of the statement is permitted. In the DIN representation, this means that no further entry can be made in this line, in the text representation, only the selection of another statement is possible.
- The X-function (target) must follow the function G00 (rapid traverse) directly.
- No X-function can follow the function G04 (dwell time), an F-function (time) is required.
- No further function can follow G20 (end of loop) **in the statement**.
- An F-function (number of loops) must follow G24 (end of loop). An M-function is not permitted.
- The X-function (target) is not permitted with G74 (reference or home point approach).
- If an X-function is programmed without G00, the F- function (speed) must follow.
- Unless an X-function, G04 (dwell time) or G24 (repetition) is programmed, no F-function can be used.

The statement syntax is represented in the following diagram.

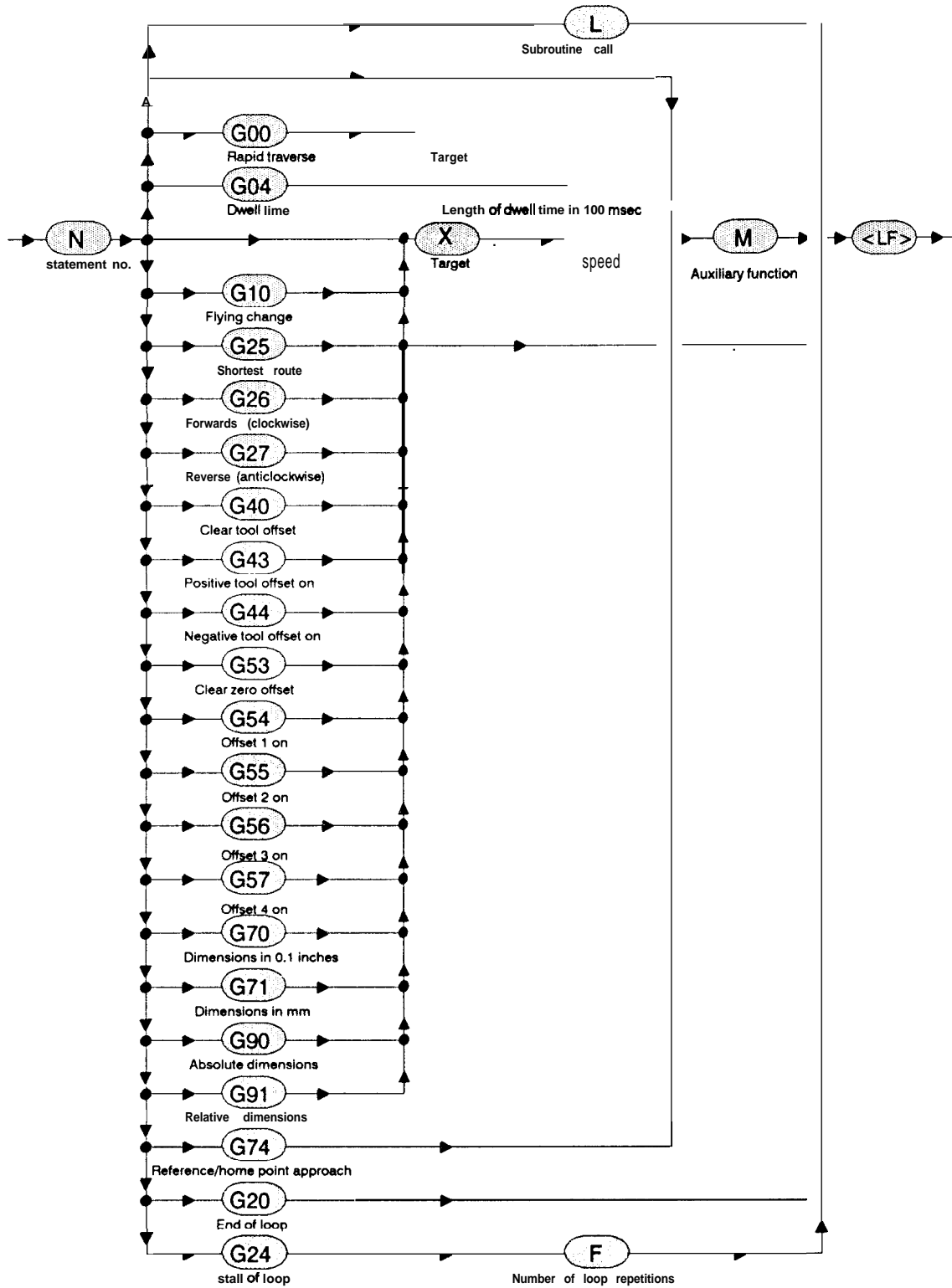


Fig. 5.10-1: Syntax diagram

6 Axis Attributes

The axis attributes contain up-to-date information about the axis as follows:

- the dimensional unit selected for position encoding,
- whether the required position is reached or not, (this signal is also output via a digital output of the IP246),
- whether the closed-loop position controller is on or off,
- whether the teach-in mode is on or off,
- the existence of the reference/home point,
- the existence of the machine data on the axis,
- **the axis status** ("finished" or "running").

The axis attributes are passed onto the control system via FB164 in the checkback signals. (DL (n+ 12) of the axis DB).

(=> "Standard Function Blocks FB164 and FB165, User's Guide", Section 2.7.2 "Structure of the Axis Data Block").

Bit 0	0	} Metric	0	} Inches	1	} Degrees
1	1		0		0	
2	1: imposition			0: not in position		
3	1: position controller on			0: position controller off		
4	1: axis in teach-in			0: axis not in teach-in		
5	1: ref./ <u>home</u> point missing			0: set		
6	1: machine data missing			0: machine data exist		
7	1: job finished			0: job running		

Fig. 6-1: The axis attributes

Apart from the two axis attributes which indicate whether the required position has been reached or not and whether machine data are **available** for the axis or not, all axis attributes are indicated directly in the test axis selection and modes mask in COM246 (= > "Communications Software COM246, User's Guide", Section 8 'Test').

6.1 Machine Data Missing

The bit indicating that machine data are missing is only **cleared** in the axis attributes (**checkback signals**) **when the machine data for an axis are transferred**. The machine data which are then located on the module, may, however, still contain errors. This is ignored at this point. Operating instructions only cause the axis to move when the machine data are free of errors.

6.2 Measurement System

In the test mask of COM246, the dimensional unit is displayed beside the actual position value, the following error (or speed) and the distance to go.

6.3 Reference/Home Point Missing

Movements to an absolute target are only possible when a coordinate system has been fixed. The coordinate system is fixed using mode BA5, "reference point approach" or "set reference or home point". Following this, the axis attribute indicating the absence of the reference/home point is reset.

6.4 Teach-in On

The axis attribute "teach-in on" indicates that the current actual position values of the axis can be stored in a machining program as target information (X-functions). Teach-in operation is activated with mode BA1 O and deactivated with mode BA11.

6.5 Closed-Loop Position Controller On

The axis attribute "position controller on" indicates the status of the position controller. Both closed-loop (position controller on) or open-loop (position controller off) operation is possible. Normally, positioning is carried out under closed-loop control. Open-loop operation only occurs with the modes "jog open-loop" and "following error".

6.6 Axis Status "Finished" or "Running"

An axis can only be switched from one mode to another in the axis status "finished". Providing the job itself is correct, the axis status is changed from "finished" to "running". In this respect, there is no difference between traversing jobs and jobs which do not lead to a traversing movement, e.g. coordinate transformations, drift compensation or data transfer. On completion of the current job, the axis status once changes to the "finished" status. In automatic operation, the axis status is only set to "finished" on completion of the machining program (see next section).

6.7 “Position Reached” Message

The “position reached” axis attribute is closely related to the axis status. In positioning jobs with absolute or relative target specifications, the “position reached” message signals the correct completion of the job. The “position reached” message is set when the following conditions are fulfilled:

- The position **setpoint** must have reached the specified target coordinate and the actual position value must be within the standstill monitoring.

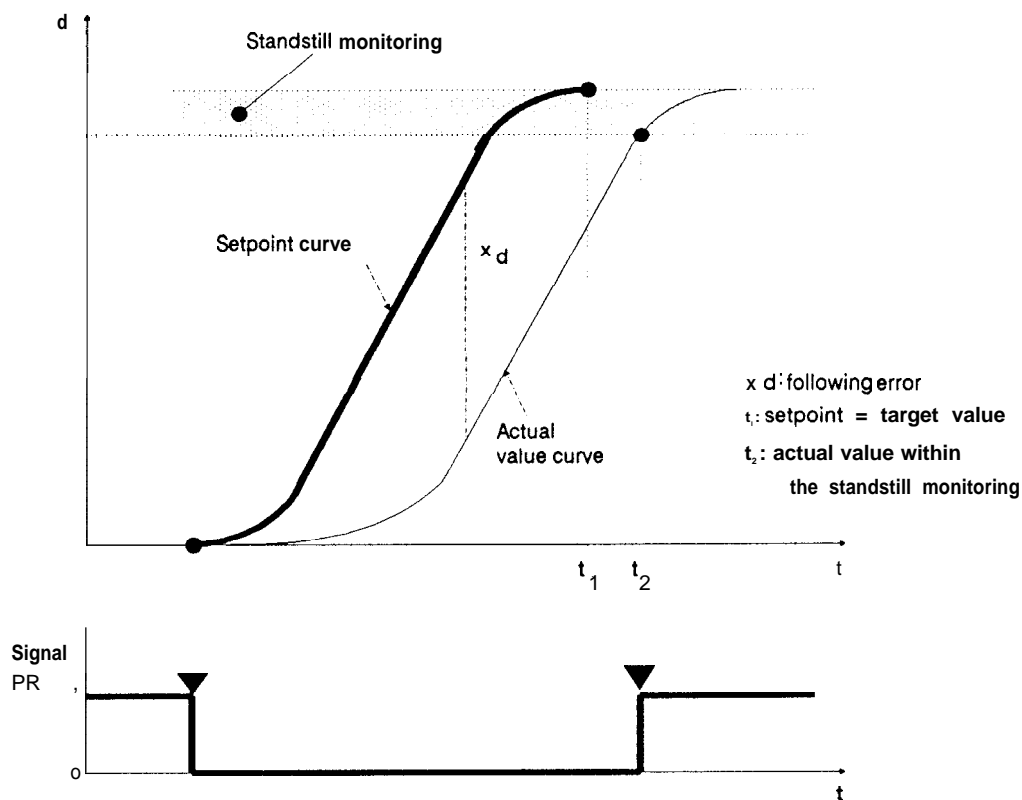


Fig. 6.7-1: The “position reached” message

As soon as the “position reached” message is output, the axis status changes from “running” to “finished”.

One exception is to be found in automatic operation. While the axis status in automatic operation only changes from “running” to “finished” on completion of the whole machining program, the “position reached” message is generated after each traversing statement and each dwell time.

In the jogging modes BA1 and BA2, the module calculates the target position following a “stop command” from the current actual position and the braking distance. At this target position, the “position reached” signal is generated as described above.

In the “jog open-loop” mode BA3, the axis status is set to “finished” as soon as the actual position value no longer changes at each scanning interval of the module. The “position reached” signal is set simultaneously.

Response to abnormal termination of positioning jobs

If a job with absolute or relative target information is terminated before the conditions for “position reached” are fulfilled, this axis attribute is not set. The remaining distance to go from the current position setpoint to the actual target point remains indicated and is continuously updated until the start of a new traversing job. It is also updated, if you subsequently activate the following error mode or execute a tool offset. You can now send a relative traversing job with the indicated “distance to go” to the module. The originally required target is then reached.

Timer monitoring when approaching the target

If the position setpoint is already at the target and the actual position value remains outside the standstill monitoring owing to a load or a drift in the power unit, a waiting time of approximately 5 sec is started. If no movement towards the target occurs during this time, the job is terminated with the error message “target position not reached” and the axis status set to “finished”. The “position reached” message in this case is not set. Each time there is movement towards the target, the waiting time is reset again. If the axis does not come to a standstill in the “jog open-loop” mode BA3 following a “stop” owing to drift in the power unit or mechanical load, although the position setpoint is already constant, the timer monitoring is also activated. A standstill in open-loop operation occurs when the actual position value does not change from scan interval to scan interval.

7 Digital Inputs/Outputs and their Effects

The IP246 has a total of eight digital inputs and four digital outputs (=> “Hardware, Instructions”, Section 1.2 “Design”). The digital output signals are high-active and are as follows for each axis of the IP246:

- the operational signal (FUM) and
- the “position reached” message (PR).

Digital inputs are also available for each axis, as follows:

- one hardware limit switch to limit the start of the traversing range (ANF),
- one hardware limit switch to limit the end of the traversing range (END),
- one precontact for calculation of the reference point and
- an external start-stop signal (START/STOP).

7.1 The Operational Signal FUM

The digital output FUM is reset after the power to the programmable controller is switched on. After the processor on the IP246 has started up correctly and valid machine data are on the module, the operational signal for the axis is set to “1”.

Note:

For safety reasons, you must only enable the power unit when the operational signal is set by the IP246. This is achieved by interlocking the enabling of the power unit using the FUM signal. If your power unit does not have an enable input, you must make sure that the drive can only be activated when the FUM signal is set to “1”. If this is not the case, it is possible for the drive to be activated without any control if the 24 V power supply fails due to an undefined voltage at the analog output of the IP246.

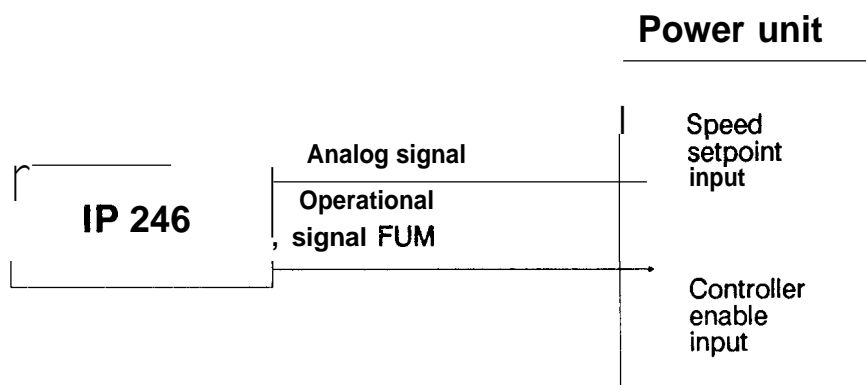


Fig. 7.1-1: Enabling the power unit

The IP246 also has a jumper (disable command output "**BASP**"; => "Hardware, Instructions", Section 3.2.1 "Disable Command Output"), which is set when the module is supplied so that all digital outputs on the module are set to "**zero**" when the CPU stops. If the digital output is connected to the enable input of the power circuitry, the drive is also blocked when the CPU stops.

7.2 The "Position Reached" Message

The "position reached" message is supplied both to the CPU as well as to a digital output. A detailed description of the "position reached" message can be found in Section 6 "Axis Attributes".

7.3 The Digital Inputs for Hardware Limit Switches

The hardware limit switches are evaluated regardless of the axis type. With a rotary axis, hardware limit switches are generally not required, but can be used as an additional safety measure.

The polarity of the two hardware limit switches can be assigned in the machine data record. You can select both limit switches as normally **closed** or both as normally open switches using the "polarity HW limit switch" parameter (= > Section 4.8 "Other Parameters(')).

The hardware limit switches are only detected during a traversing movement or during the following error mode.

If the module recognizes that a hardware limit switch has tripped, the traversing movement is stopped with the maximum deceleration assigned in the machine data record and the current traversing job is terminated. If the tripping of a hardware limit switch is detected in the following error mode, only the corresponding error message is generated. The following error mode remains active.

Note:

A hardware limit switch is only detected if the traversing movement is towards it, or when the axis is not controlled in the direction in which the axis moves or drifts. If a limit switch responds, further movement in the direction of the detected limit switch is not possible. This traversing direction is only enabled again

- when the module has detected that the axis has left the hardware limit switch in the opposite direction or
- when a hardware limit switch has been tripped and is tripped again in the opposite direction.

If a hardware limit switch is tripped either manually or by some other external event, movement in this direction is blocked. This direction can be released again by starting a traversing job in the opposite direction, tripping the hardware limit switch again and then returning it to the neutral position.

If a blocked direction is not released by the measures described above, it will always be released with the incremental version of the IP246 when the axis reaches the precontact.

After completing the parameter assignment and starting up your system, each axis (linear axis) has two software limit switches. These should always be assigned so that the hardware limit switches can never be reached during operation. Since the IP246 only starts to brake when a software limit switch is reached, the hardware limit switches should be set far enough away from the software limit switches to allow for the maximum braking distances.

The maximum braking distance can be calculated according to the direction as follows:

$$d_{\text{brake}} \quad [\text{mm}] \quad = \quad \frac{v_{\text{max}}^2 \quad [\text{mm}^2/\text{min}^2]}{2 \cdot a \quad [\text{mm}/\text{s}^2] \cdot 3600}$$

Whereby: d_{brake} is the maximum required braking distance, v_{max} is the maximum speed stipulated in the machine data and a the deceleration forwards or reverse. The braking distance will be $v_{\text{max}} / 8000$ longer owing to the reaction times of the IP246.

7.4 External Start/Stop

The digital input “external start/stop” has two functions. A signal change from “0” to “1” serves as an “external stop”, the change from “1” to “0” serves as an “external start enable”.

External stop

During the processing of a traversing job, a signal change from “0” to “1” at this digital input causes the error message “external stop occurred”, the traversing job and current mode are terminated. The axis brakes at the maximum deceleration assigned in the machine data record. If the external stop is received while processing a machining program (automatic mode), the machining program is terminated along with the automatic mode.

Note:

In the following error mode (mode 4) “external stop” causes the following error mode to be terminated and the position controller is enabled again.

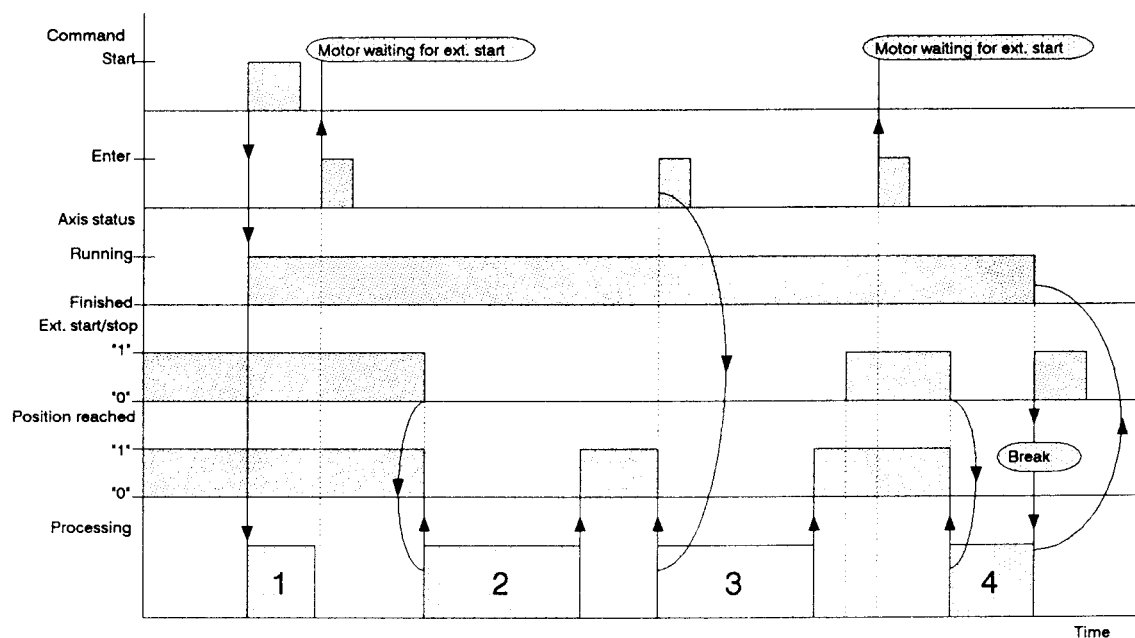
External start

If a “1” is set at this digital input before the start of a traversing job, the traversing job is interpreted by the IP246 but is not executed. If the job is permissible, you will obtain the message “motor waiting for external start”. The negative edge of the signal at the digital input causes the traversing job to be executed.

Only one single job can be waiting for execution. Other jobs during the waiting time are not allowed. If a further operating instruction is sent to the IP246, the job currently waiting for execution is deleted. A stop command in conjunction with any mode causes error-free termination. The message “motor waiting for external start” is reset. Any command other than “stop” leads to the error message “inadmissible job”.

The external start enable is also effective in the automatic mode with traversing jobs and dwell times. If the signal "1" is set at this digital input before the start of the automatic mode (mode 8), the machining program starts with the start command and is executed up to the first traversing job or the first dwell time. The dwell time or traversing job then causes the message "motor waiting for external start". The negative edge at the digital input enables the traversing movement or dwell time. A further statement within the started machining program cannot be stopped with the "external start enable", since the positive edge of the signal at the digital input is then evaluated as "external stop".

If a "1" is set at this digital input before the start of the "automatic single statement" mode (mode 9), the start command also leads to the execution of the machining program up to the first programmed traversing job or first dwell time. The "enter command" then causes the message "motor waiting for external start". The first traversing job or the first dwell time and all the offsets and switchovers programmed after it are then executed on the negative edge of the signal at the digital input. If signal "1" is set again at the digital input during the execution of the traversing job or dwell time, this acts as "external stop"; the machining program is terminated. If, following the completion of the traversing movement ("position reached" message set), a "1" is set at the digital input, the next traversing job or the next dwell time of the automatic program following the enter command will only be triggered by a negative edge at the digital input.



- 1) Processing of offsets and switchovers
- 2) Processing the first traversing job and the following offsets and switchovers
- 3) Processing the second traversing job and the following offsets and switchovers
- 4) Processing the third traversing job.

Fig. 7.4-1: External start/stop in the automatic single statement mode

SIEMENS

SIMATIC S5

IP246 Positioning Module

Incremental 6ES5246-4UA31 / -4UA41

Absolute 6ES5246-4UB11 / -4UB21

Hardware

Instructions

C79000-B8576-C652 -02

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1 Technical Description

The IP246 positioning module is available in various versions for connecting the following:

- incremental position encoders and
- absolute position encoders

Both versions are available as two models, one for ventilated and one for non-ventilated operation.

6ES5246-4UA31 for incremental position encoders, ventilated
 6ES5246-4UA41 for incremental position encoders, non-ventilated
 6ES5246-4UB1 1 for absolute position encoders, ventilated,
 6ES5246-4UB21 for absolute position encoders, non- ventilated.

The incremental versions of the IP246 (-4UA11 and - 4UA21) provide slightly less functions than those described here.

1.1 Application

The IP246 positioning module is used for closed-loop position control of two independent drives

The main areas of application are as follows:

- auxiliary axes in metal processing machines,
- paper and textile machines,
- handling and loading systems and
- feed devices in transfer lines and assembly lines.

It can be operated in the following SIMATIC S5 programmable controllers (PC) and is inserted in the slots for communications processors (CP):

SIMATIC-S5 115U with CPU 941,942,943,944,
 SIMATIC-S5 135U with CPU 922,928,
 SIMATIC-S5 150U and
 SIMATIC-S5 155U with CPU 946,947.

It can also be plugged into expansion units with the central controller bus

EU 185 and
 EU 186

in the CP slots, providing the interface modules AS304/AS314 are used.

1.2 Design

The positioning module IP246 is a double Euroformat, compact module with two 48-pin backplane connectors, which form the interface to the PC. The front panel has two connectors for position encoders, one connector for the output of the two analog setpoints, one connector for digital inputs and outputs and one connector for the programmer (PG). The front panel also includes a RUN and an error LED and a tab connector for the load voltage connection L+.

Connectors on the front panel

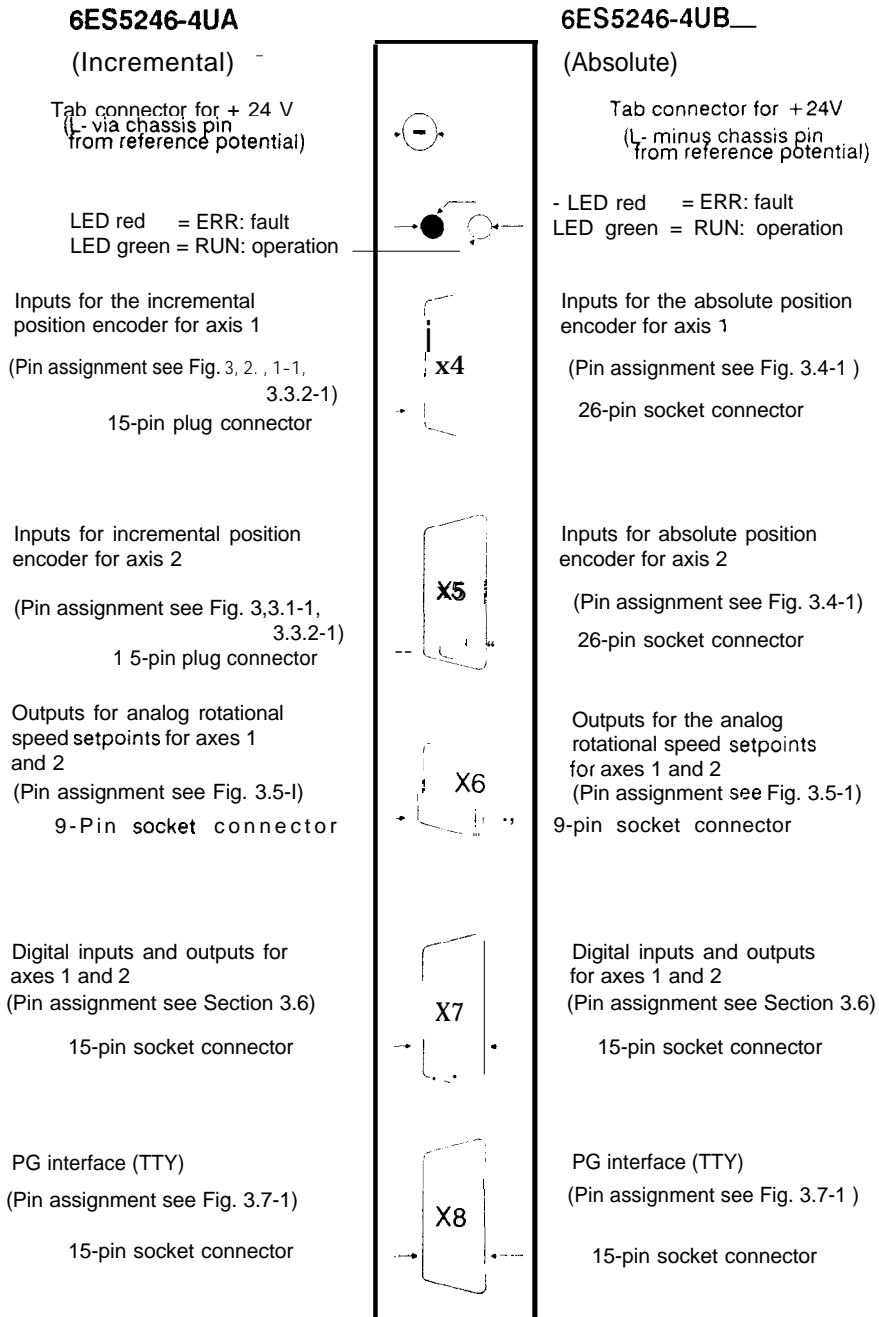


Fig. 1.2-1: Front panel of the IP246

1.3 Mode of Operation

The IP246 decodes and processes the digital pulses from the position measuring systems of two axes (actual position values) and continuously outputs the speed setpoints to the actuators according to the position to be approached.

The module has the following features:

- 16-bit microprocessor with internal timer and interrupt controller (80186)
- 16 Kbyte local RAM, backed up by the PC battery
- EPROM cartridge interface for loading the firmware
- dual-port RAM, backed up by the PC battery
- bus interface to the S5 programmable controllers
- serial interface to the S5 programmable controllers
- two interfaces to incremental or absolute position encoders
- eight 24 V digital inputs
- four 24 V/120 mA digital outputs
- two +/- 10 V analog outputs
- two status displays

The operation of the positioning module is controlled by the microprocessor according to the operating program (firmware) stored in an exchangeable EPROM cartridge.

The parameter assignment, programming and start-up are performed via the PG interface using the software package COM 246 (=> "Communications Software COM 246, User's Guide'). If the data are stored in the CPU, parameter assignment and programming can also be performed via the PC interface, e.g. when exchanging a module. Providing the module remains plugged into a battery-backed PC frame, the machine data and machining programs stored in the RAM of the IP246 are retained if a power failure occurs.

Communication with the programmable controller is via the S5 bus interface and a dual-port RAM with a capacity of 2 Kbytes.

To decode the actual position values, incremental position encoders with 5 V differential signals or 24 V signals can be connected to modules 246 4UA_ The pulses from the position encoders are evaluated by a 16-bit counter according to the direction, and can be doubled or quadrupled. Only one type of position encoder (i.e. 5 V or 24 V) can be connected to any one module.

An absolute position encoder (Gray code or Gray excess X code) with a parallel output signal and a resolution of maximum 20 bits can be connected per axis to the module 246-4UB-. The code is converted by the firmware. Both current sourcing and current sinking encoders can be used. A combination of the two types is, however, not possible.

The position encoders can be supplied with power via the connectors of the module. The voltage for incremental position encoders can be selected with jumpers.

Setpoints are output via two analog voltage outputs. The firmware selects the reference voltage for each channel separately to improve the resolution at lower speeds. The output voltage range is therefore either 0 to +/- 1.25 V or 0 to +/- 10 V in each case with a resolution of 11 bits plus sign.

Signals from limit switches and reference point precontacts are received via the digital inputs (per axis 1 reference point precontact and 2 limit switches); there is also an external start/stop input for each axis. Two digital outputs 24 V/120mA per axis supply the "position reached" (PR) message and the "operational signal" (FUM). The "FUM" signals must be used as the controller release signals for the power unit.

The analog circuits are supplied via a voltage converter 24 V/+ -15 V, which is connected to the 24 V load voltage (L +/L-). The module is reset if the power fails,

Note:

If the 24 V load voltage (L+) is absent, the analog outputs do not assume the value 0 V, but continue to supply a voltage of 2 to 3 V.

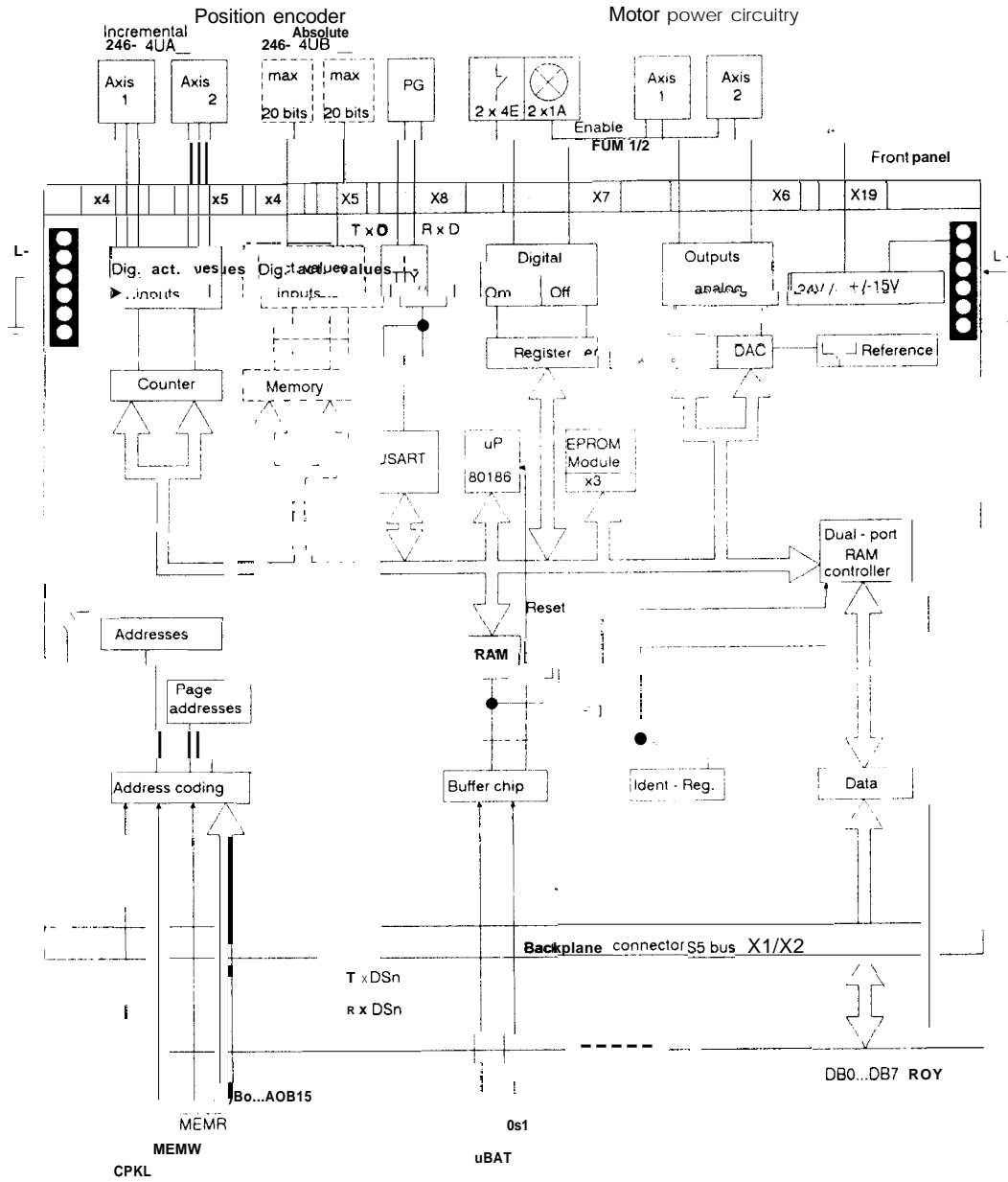


Fig. 1. 3-1: Block diagram of the IP246 positioning module

1.4 Technical Data

Power supply

Power supply from system bus	+ 5V +/-5%
Current input (without encoder supply)	
IP246 - 4UA__ (incremental)	approx 1.00 A
IP246 - 4UB__ (absolute)	approx 0.85 A
Load voltage L+ (front panel connection)	20...30 v
Current input (without encoder supply, digital outputs without load)	
IP246 -4UA__ (incremental)	approx. 90 mA
IP246 -4UB__ (absolute)	approx. 100 mA
Battery voltage (back-up)	2,7 .., 5,25 V
Current from battery	typ. 5 uA; max. 250 UA
Power supply of position encoders via connector X4/X5	
5 V position encoder	max. 300 mA per encoder
24 V position encoder	max. 300 mA per encoder

Inputs for digital actual position values

Incremental encoder 246-4UA__

Input signals (per axis)	
5 V differential signals acc. to RS422 (count and reference pulses from incremental encoders)	2 square wave signals A and B and the inverted signals /A, /B. 1 reference pulse R and /R.
24 V inputs	2 square wave signals A and B. 1 reference pulse R
Input voltage signal O	-33 v + 3 v
Input voltage signal 1	10.5 v ... 33 v
Input current	max. 7 mA
Electrical isolation	no
Counting frequency	
for 5 V differential signals	max. 500 kHz
for 24 V signals	max. 50 kHz

Permissible length of cable max. 32 m shielded
 If the position encoders are supplied externally (not by the IP246), longer lengths of cable are permitted. In this case, you must ensure that the required signal level is reached on the IP246.

Absolute encoder 246-4UB__

Absolute value per axis (= number of digital inputs)	max. 20 bits (Gray code)
Input voltage signal O	-33 v . . . + 3 v
input voltage signal 1	10.5 v ... 33 v
Input current	max. 6.25 mA
Electrical isolation	no
Permissible length of cable	max. 32 m shielded
If the position encoders are supplied externally (not by the IP246), longer lengths of cable are permitted. In this case, you must ensure that the required signal level is reached on the IP246.	

Analog outputs

Number of outputs per axis	1
Voltage range	+/- 10 V/2 mA
Electrical isolation	no
Permitted cable length	max. 32 m shielded

Digital inputs

Number of inputs per axis	4
Input voltage for signal 0	-33 V 3.6 V
Input voltage for signal 1	13v ...33 v
Electrical isolation	no
Two-wire BEROS with a power supply of 22 V -33 V can be connected	

Digital output

Number of outputs per axis	2
Power supply range	20 v ... 30 v
Power supply rated value	24 V
Switching current (short circuit-proof)	120 mA
Total load capacity of the outputs at 60°C	1 000/0

Mechanical data

Dimensions (W x H x D)	
Versions requiring fan	20 mm x 233 mm x 160 mm
Versions not requiring fan	40 mm x 233 mm x 160 mm
Weight	approx. 0.4 kg

Ambient conditions

Operating temperature	
Versions requiring fan	0 60°C
Versions not requiring fan	0 . . . 55°C
Storage and transport temperature	-40 . . . + 70°C
Relative humidity	max. 95% at 25°C
Operating altitude	max. 3500 m above sea level

2 Installation

2.1 Inserting and Removing the Module

The module can only be plugged into the slots intended for CPS in the PC or EU. The module may only be removed when the programmable controller or the expansion unit is switched off **and** the position encoders are de-energized (this also applies to encoders with an external **power supply**).

2.2 Connecting the Signal Lines

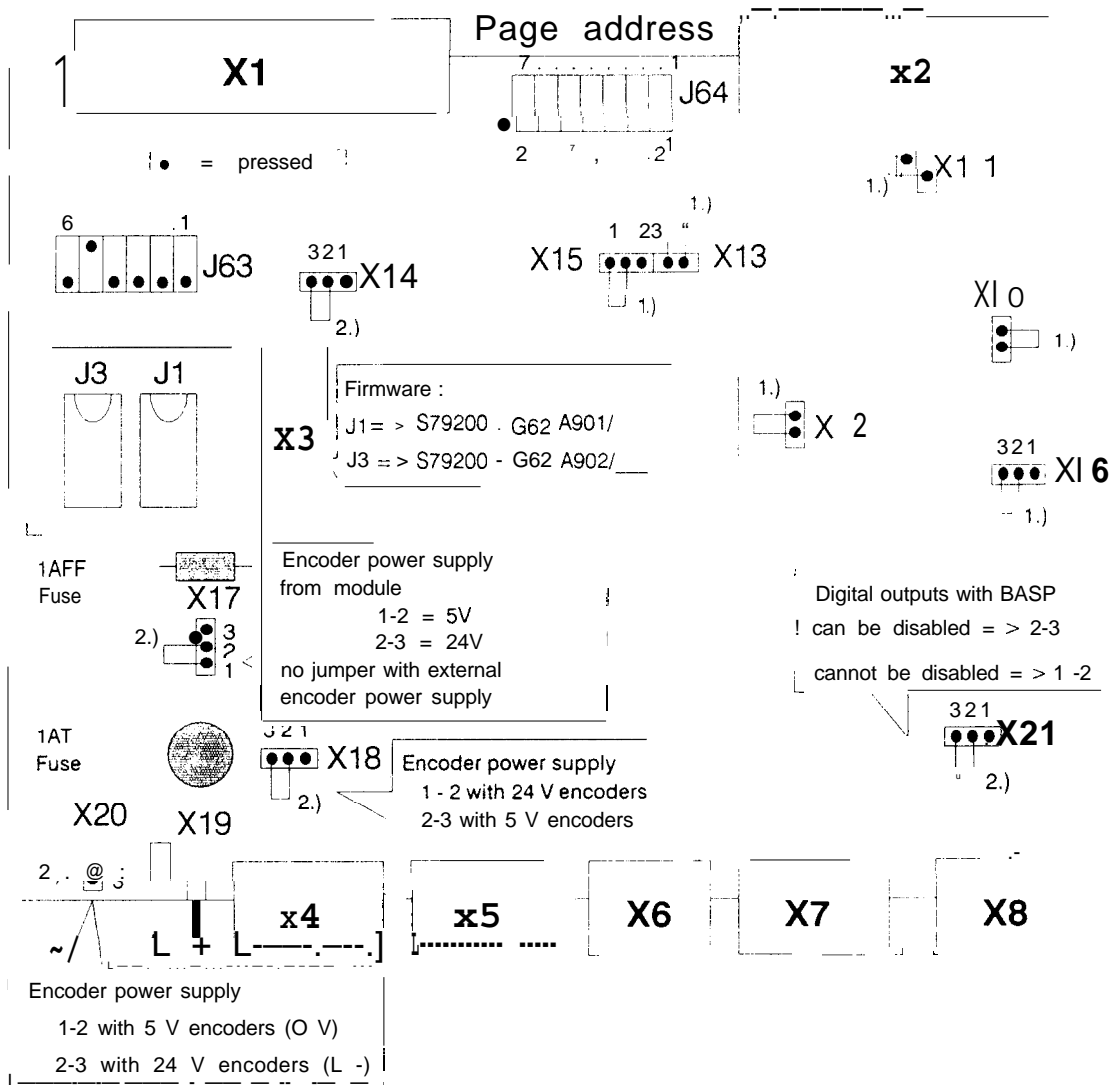
The signal lines are connected via the connectors on the front panel. The braided shield is connected to the metallized part of the connector cover. Connecting cables to the position encoders and to the power circuitry should be laid with shield clamps at the device reference potential, as recommended in the Installation Instructions C79000-B8576-C452, Section 7,7 for the installation of S5 systems, This greatly improves the immunity to interference.

With the exception of the PG interface, the insertion and removal of the front connectors during operation of the module is not permitted.

3 Operation

3.1 Position of the Jumpers and Switches

1.) Test points: jumpers X10, XI 1, X12, X13, XI 4, XI 5, XI 6 must always be plugged in

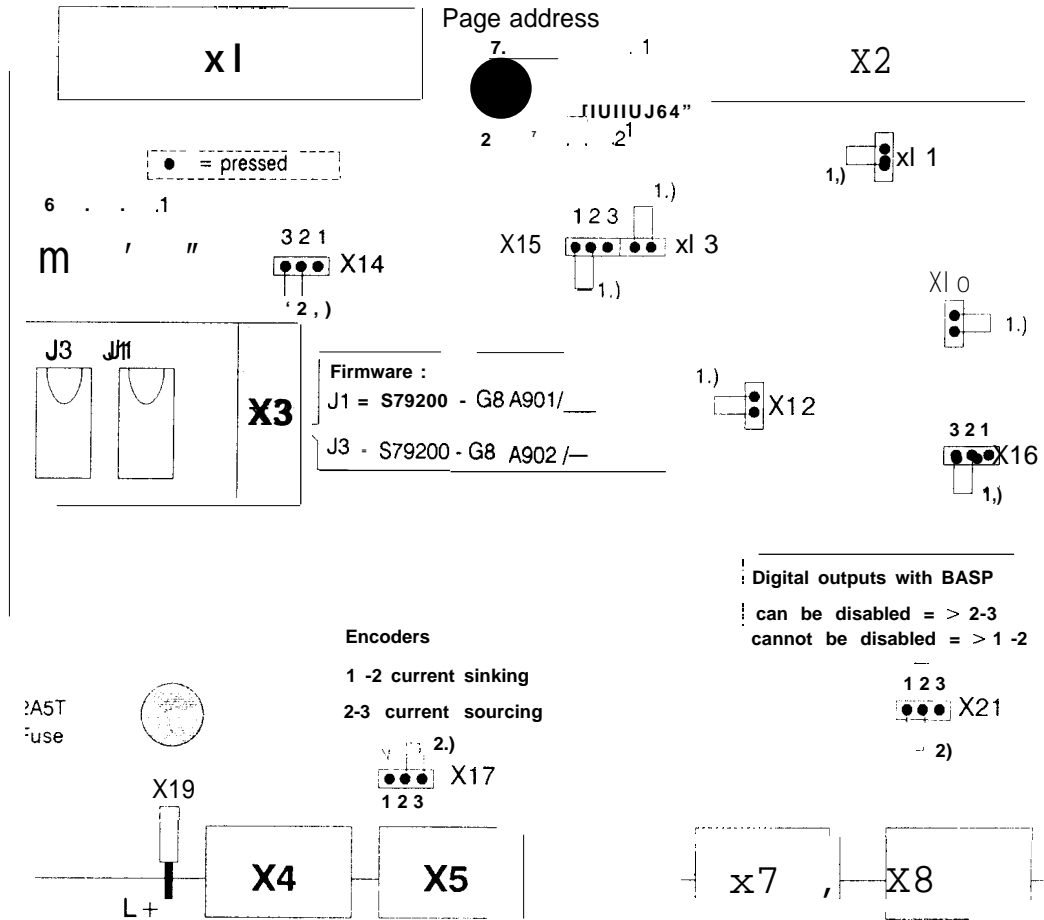


2.) Jumpers inserted at the factory.

Fuses: 1AFF GWK-Nr. C72327-Z87-B12, Pico-Fuse e.g. from Wickmann
 1AT GWK-Nr. W79054-M1O41 -TIOO

Fig. 3.1 -1: Jumpers and switches for the IP246-4UA (incremental version)

Note the different assignment of X21 in the incremental and absolute versions.



- 1.) Test points: jumpers X1 0, X1 1, X1 2, X1 3 must always be plugged in
- 2.) Jumpers inserted at the factory.

Fuse: 2A5T GWK-Nr. W79054-M1041-T250

Fig. 3.1 -2: Jumpers and switches for the IP246-4UB (absolute version)

Note the different assignment of X21 in the incremental and absolute version.

3.2 Setting the Module Address

Data is exchanged between the CPU and the IP246 via the S5 bus interface and a dual-port RAM with a memory area of 2 Kbytes, divided into two "pages". Each axis to be controlled is assigned one page.

The pages are in the address area from 0F400H to 0F7FFH (61 Kbytes to 62 Kbytes -1), which is set at the factory. You must simply set the page number for the first page (first axis).

The two pages of a module must have consecutive numbers. The address for the second page is calculated automatically by the IP246 (address of the second page = set page number + 1).

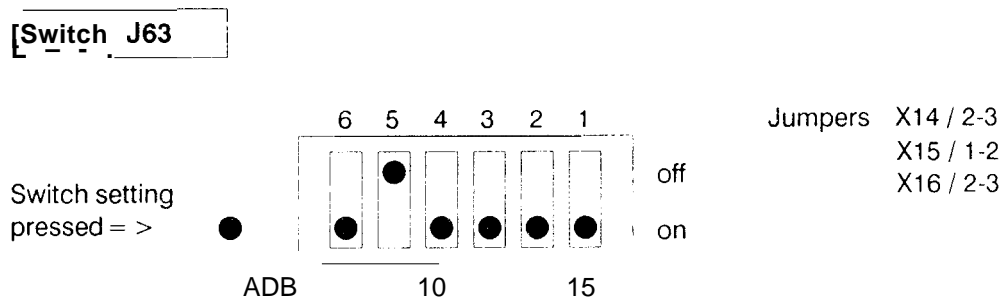
Note:

The switches must not be set with a pencil, since broken leads can lead to short circuits.

When supplied, the address area for page addressing (switch J63 and jumpers X14, X15 and X16) has the same setting on every module.

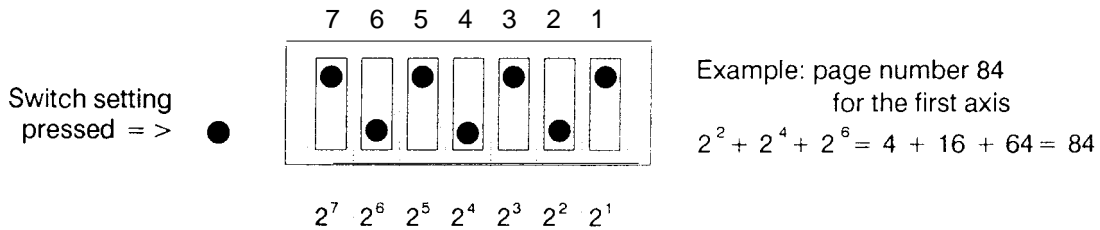
Address area 0F400H to 0F7FFH (61 Kbytes to 62 Kbytes -1)

Check the switch and jumper settings of J63 before starting up the IP246.



You must set the page number of the module (even-numbered base address of the first axis) between 0 and 254 in steps of 2, using switch J64.

Switch J64---1



The page number 85 for the second axis is automatically decoded by the module,

The first page number of the next module can then be set to 86, even if only one axis is being used on the first module.

3.2.1 Disable Command Output

The signal BASP (disable command output), which is triggered by the PC (e.g. when it changes to STOP or if the load voltage drops below 15 V), can be used to disable the digital outputs on the module.

- Jumper X21/1-2 inserted Digital outputs are not disabled when BASP is output
- Jumper X21/2-3 inserted Digital outputs are disabled when BASP is output

3.3 Connecting Incremental Position Encoders to the 246-4UA—

Two incremental position encoders, either with 5 V differential signals or 24 V signals, can be connected to the module (X4, X5). A combination of both types of position encoders with one module is not possible. The position encoders can be supplied with power via the module.

The module requires two square wave signals displaced by 90° and a zero marker per revolution as input signals. With 5 V position encoders, the inverted signals are also required.

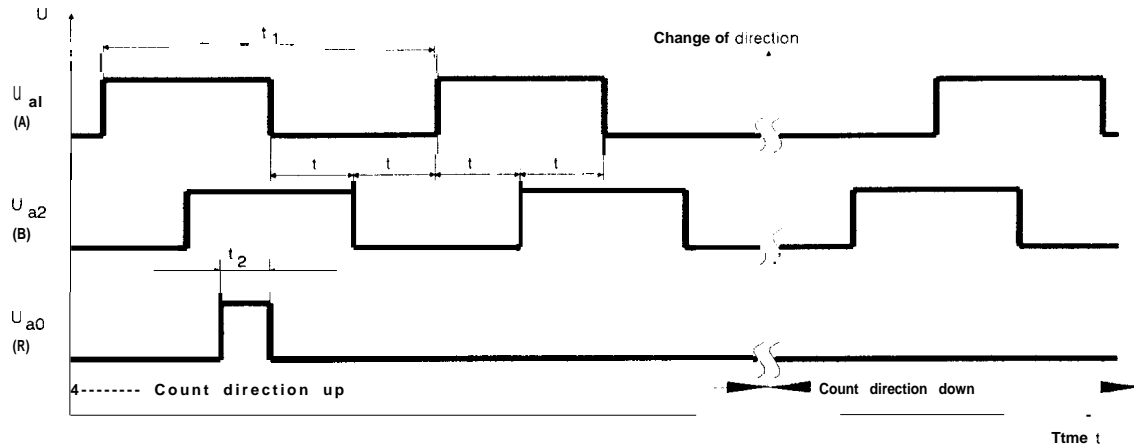


Fig. 3.3-1: Position encoder signals

$t_1 \geq 2500\text{ns}$ U_{a1} = Square wave signal of position encoder -- A
 $t_1 \geq 4 \cdot t$ U_{a2} = Square wave signal of position encoder -- B
 $t_2 \geq 250\text{ns}$ U_{a0} = Reference pulse of position encoder -- R
 A/B/R = Module inputs for relevant signals.

3.3.1 Jumper Settings and Pin Assignment for 5 V Incremental Position Encoders

The following jumper setting must be made on the module:

Jumper XI 8/2-3	inserted	
Jumper X20/1 -2	inserted	(0 volts)
Jumper XI 7/1-2	inserted	for 5 V position encoder supply by the module
Jumper XI 7/1-2	open	for external 5 V encoder supply
Jumper XI 7/2-3	open	

The 5 V position encoder must be connected as shown in Fig. 3,3,1-1.

Note:

Depending on the plant, it may be necessary to swap A and/A to obtain the suitable count and travel direction. (See "Planning, installation and Service, Installation Guide".)

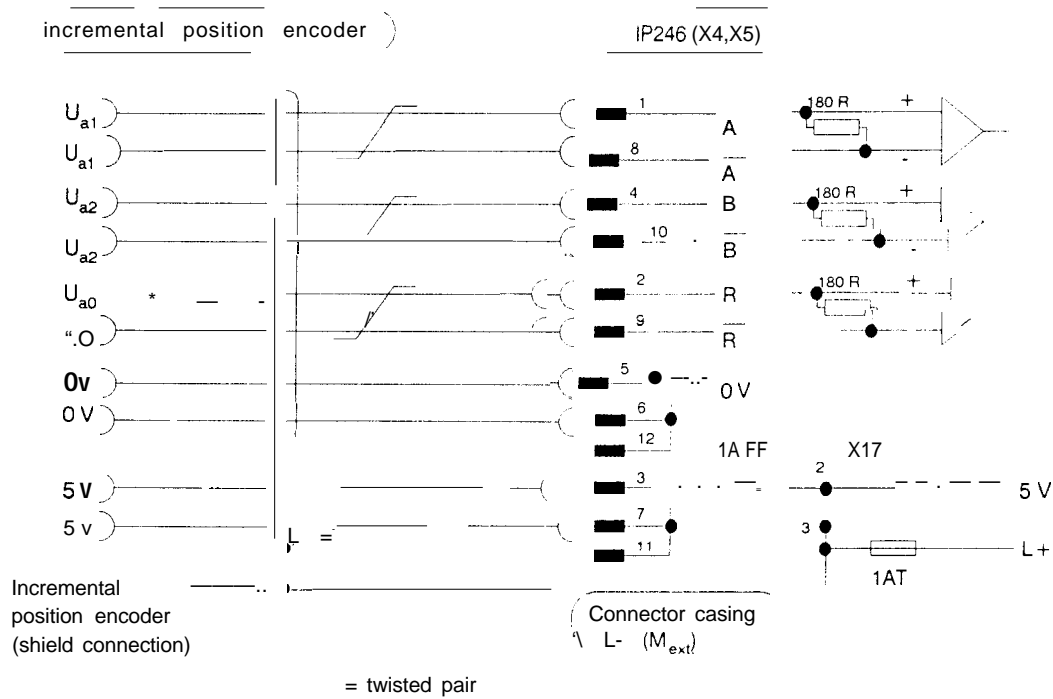


Fig. 3.3.1 -1: Connection of 5 V position encoders to connectors X4/X5 on modules 246-4UA__

3.3.2 Jumper Setting and Pin Assignment for connecting 24 V Incremental Position Encoders

The following jumper setting must be made on the module:

Jumper XI 8/1 -2	inserted	
Jumper X20/2-3	inserted	L-
Jumper XI 7/2-3	inserted	for 24 V encoder supply by the module
Jumper XI 7/1 -2	open	for external 24 V encoder supply
Jumper XI 7/2-3	open	

The 24 V position encoders must be connected as shown in Fig. 3.3.2-1.

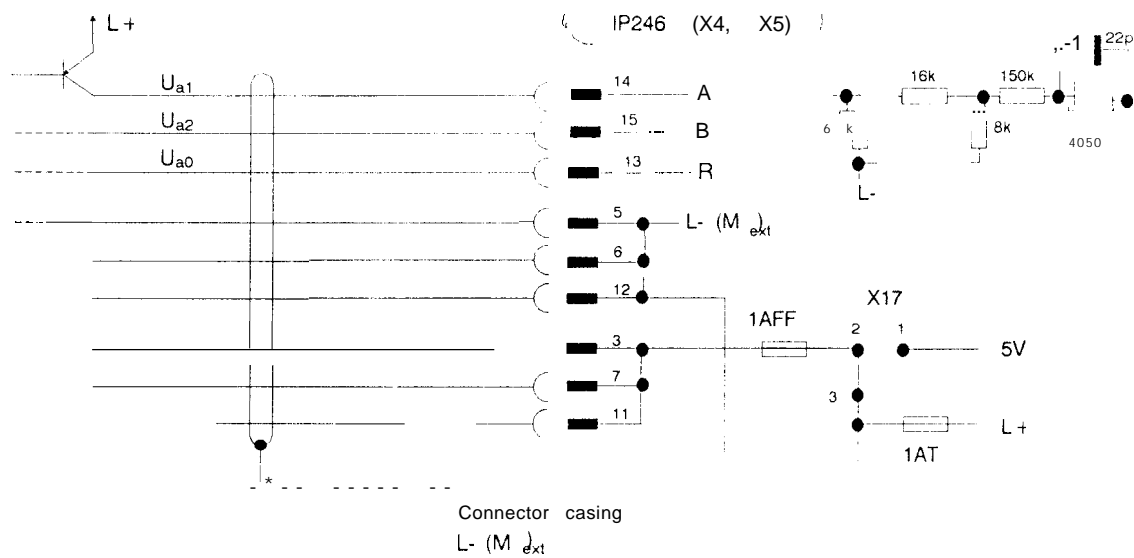


Fig. 3.3.2-1: Connection of 24 V position encoders to the connectors X4/X5 on modules 246-4UA

Note:

Depending on the plant, it may be necessary to swap A and B to obtain the suitable count and travel direction. (See “Planning, Installation and Service, Installation Guide”.)

3.3.3 Pin Assignment of the Connectors for Incremental Position Encoders (X4, X5)

The pin assignment of the two connectors for axis 1 (X4) and 2 (X5) is identical,

Pin	Connection for:
1	Square wave signal AI (A2)(TTL)
2	Reference signal RI (R2)(TTL)
3	Power supply (electronics and light source)
4	Square wave signal EtI (B2) (TTL)
5	Ground
6	Ground
7	Power supply (electronics and light source)
8	Square wave signal /A1 (/A2)(TTL)
9	Reference signal /R1(/R2)(TTL)
10	Square wave signal /B1(/B2)(TTL)
11	Power supply (electronics and light source)
12	Ground
13	Reference signal R1 (24 V)
14	Square wave signal AI (24 V)
15	Square wave signal B1 (24 V)

3.3.4 Connectable Position Encoders

Position encoders with open collector output stages cannot be connected to the incremental version of the IP246 owing to the input circuitry. Apart from this restriction, all position encoders which meet the signal and power supply requirements can be connected.

3.4 Connecting Absolute Position Encoders to the 246-4UB__

You can connect two absolute position encoders with 24 V signals to these modules. Per axis you can connect up to 20 inputs (bits). You can use either current sourcing or current sinking position encoders. A combination of both types is not possible. You can only use position encoders with Gray code or Gray excess X code (= > "Fundamentals of Positioning, Reference Manual"; Section 4.2.4 "Decoding and Evaluation of the Absolute Encoder Value").

The following jumpers must be inserted on the module:

To connect current sourcing encoders: jumper XI 7/2-3 inserted
 To connect current sinking encoders: jumper XI 7/1 -2 inserted

The position encoders must be connected as shown in Fig. 3.4-1

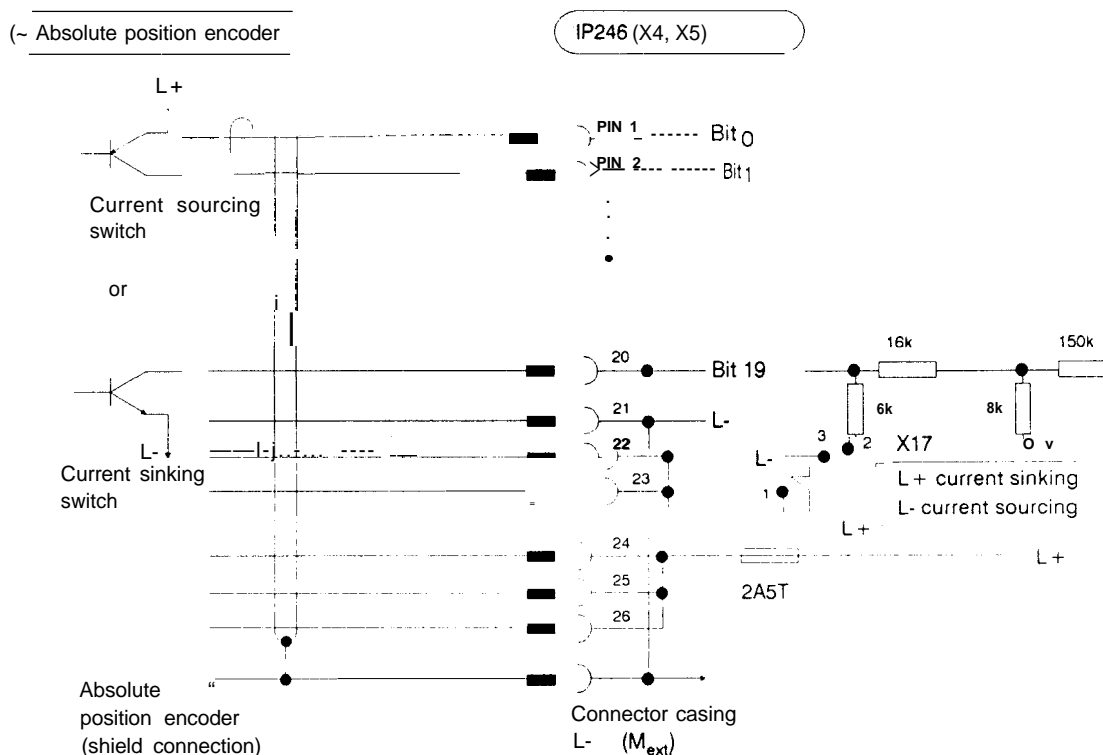


Fig. 3.4-1: Connecting absolute position encoders to the connectors X4/X5 on modules 246-4UB_

3.4.1 Pin Assignment of the Connectors for Absolute Position Encoders (X4, X5)

The pin assignment of the two connectors for axis 1 (X4) and 2 (X5) is identical.

Jack	Connection for:	Jack	Connection for:
1	bit 0	14	bit 13
2	bit 1	15	bit 14
3	bit 2	16	bit 15
4	bit 3	17	bit 16
5	bit 4	18	bit 17
6	bit 5	19	bit 18
7	bit 6	20	bit 19
8	bit 7	21	L-
9	bit 8	22	L-
10	bit 9	23	L-
11	bit 10	24	L+
12	bit 11	25	L+
13	bit 12	26	L+

3.4.2 Connectable Position Encoders

The position encoders which **can be connected to the module 246-4UB** must have the required logical levels and power supply (=> Section 1.4 "Technical Data").

3.5 Connecting Motor Power Units

Two **power** units for driving motors can be connected to the module, e.g. transistor DC chopper controllers for machine tool feed drives.

To achieve optimum adjustment, the drive voltage of the power unit for the rotational speed **setpoint** should be in the range from 0 V...+/- 10 V.

To ensure trouble-free operation, the manufacturer's guidelines for connecting and wiring the power units and the general guidelines for **SIMATIC S5** equipment should be adhered to.

For each axis, the rotational speed **setpoint** and ground must be output via a common connector (X6). The power units should be connected according to **Fig. 3.5-1**. The adjustment of the power unit (motor standstill, maximum **rpm**) **must** be carried out according to the manufacturers specifications, before connecting to the module.

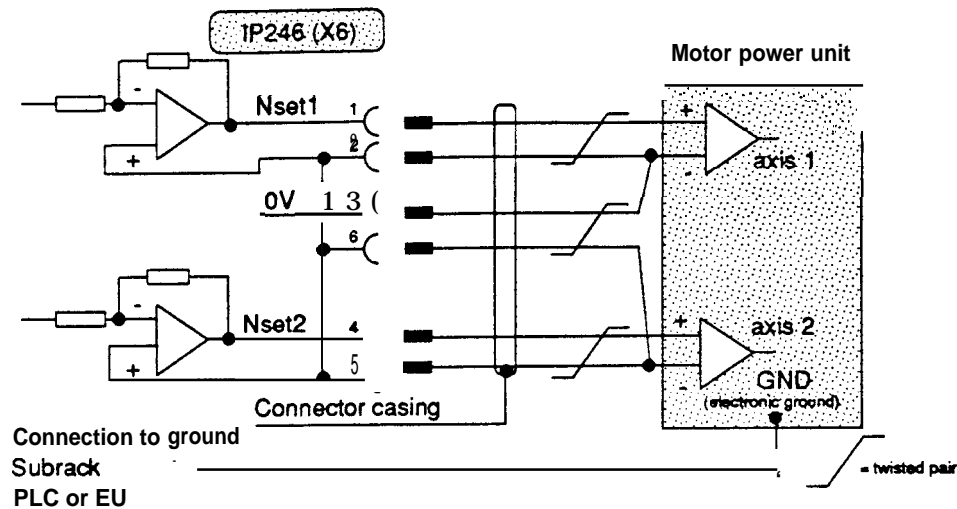


Fig. 3.5-I: Connection of motor power units to the 246-4UA__ or 246-4UB__

3.5.1 Pin Assignment of Connector X6 for connecting Motor Power Units

Jack	Connection for:	
1	Rotational speed setpoint	NSET1
2	Ground	
3	Ground	
4	Rotational speed setpoint	NSET2
5	Ground	
6	Ground	
7	---	
8	---	
9	---	

3.6 Digital Inputs/Digital Outputs

The digital inputs/outputs for both axes are located on one **common** 15-pin connector (X7). Current sourcing switches (contacts, two-wire **BEROs**) can be connected to the inputs.

Operational signals (controller enable signals and "position reached" messages) are output via **short-circuit-proof** digital outputs.

3.6.1 Pin Assignment of Connector X7 for Digital inputs/Digital Outputs

Jack	Connection for:		
1	Operational signal axis 1	Q	FUM 1
2	Limit switch axis 1	I	ANF 1
3	Reference point axis 1	I	BERO
4	Position reached axis 1	Q	PR 1
5	Limit switch axis 1	I	END 1
6	External start/stop axis 1	I	START/STOP 1
7	---		
8	Operational signal axis 2	Q	FUM 2
9	---		
10	Position reached axis 2	Q	PR 2
11	Limit switch axis 2	I	ANF 2
12	Reference point axis 2	I	BERO2
13	---		
14	Limit switch axis 2	I	END 2
15	External start/stop axis 2	I	START/STOP 2

I = input; Q = output

Note:

The limit switches can be specified as normally open (NO) or normally closed (NC). (See "Fundamentals of Positioning, Reference Manual").

Important safety note:

For safety reasons it is absolutely vital to interlock the enabling of the power unit with the "FUM" signal (operational signal) of the IP246! See Section 7.1 'The Operational Signal FUM' in "Fundamentals of Positioning".

3.7 PG Interface 20 mA

The programmers PG 635, PG 675, PG 685, PG 695 and PG 750 can be connected to the IP246 (X8) via suitable connecting cables (e.g. PG 685 S5 135).

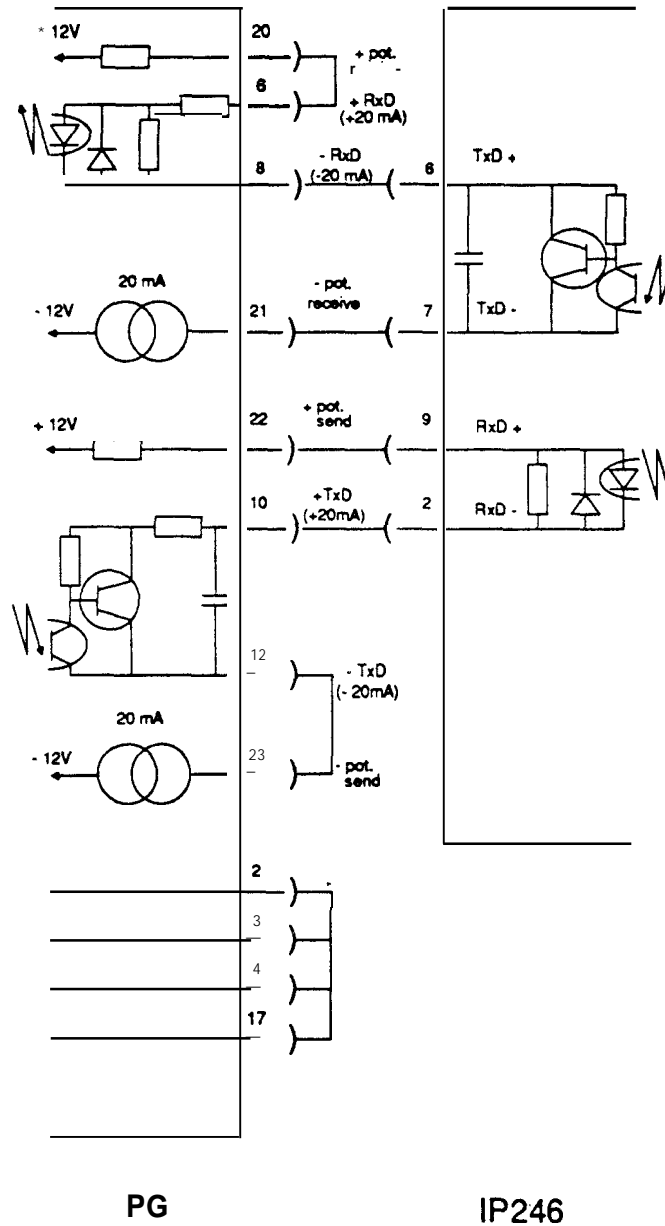


Fig. 3.7-1: Connecting the programmer to the IP246

To set the transmission rate of the programmer (PG), connections 2,3,4, 17 must be connected together in the connector on the PG side (transmission rate 9600 bps). When using standard cables, this speed is already set.

In the programmable controllers S5135U and S5 155U, the PG interface can also be used via the rear panel bus. To do **this**, the module must be inserted in a suitable slot. The module is then operated via the coordinator module (for details, refer to the coordinator instructions).

3.7.1 Pin Assignment of Connector X8 for the PG Interface

Jack Connection for:

1	Shield
2	RxD -
3	---
4	24 V
5	---
6	TxD +
7	TxD -
8	Shield
9	RxD +
10	Ground
11	-20 mA/transmitter
12	
13	-20 mA/receiver
14	---
15	---

3.8 Backplane Connector and Memory Cartridge Connector

3.8.1 Backplane Connector XI

	d	b	z
2		Ground	+5 V
4	UBATT		
6	ADB 12	ADB 0	/CPKL
8	ADB 13	ADB 1	/MEMR
10	ADB 14	ADB 2	/MEMW
12	ADB 15	ADB 3	/RDY
14		ADB 4	DB 0
16		ADB 5	DB 1
18		ADB 6	DB 2
20		ADB 7	DB 3
22		ADB 8	DB 4
24		ADB 9	DB 5
26		ADB 10	DB 6
28	/DSI	ADB 11	DB 7
30		BASP	
32		Ground	

3.8.2 Backplane Connector X2

	d	b	z
2		Ground	+5 V
4			
6			
8			
10			
12			
14			/NAU
16			
18			
20			
22	TxDsn		
24			
26		RxDsn	
28			
30			
32		Ground	

3.8.3 Memory Cartridge Connector X3

	cc	b	a
1	SADB 12	Ground	+ 5 V
2	SADB 1	SADB 1	SADB 2
3	SADB 3	SADB 4	SADB 5
4	SADB 6	SADB 7	SADB 8
5	SADB 9	SADB 10	SADB 11
6	SADB 13	SADB 14	/RD
7	+5 V	SDB 8	SDB 9
8	SDB 10	SDB 11	SDB 12
9	SDB 13	SDB 14	SDB 15
10	SDB 0	SDB 1	SDB 2
11	SDB 3	SDB 4	SDB 5
12	SDB 6	SDB 7	
13	/UCS	/UCS	
14			
15	SADB 15		
		Ground	

4 Connecting Cables and Spare Parts

Fuses: IAFF GWK-Nr. C72327-Z87-B12, Pico-Fuse e.g. from Wickmann
 I AT GWK-Nr. W79054-M1041-TIOO
 2A5T GWK-Nr. W79054-MI041-T250

For the connection of position encoders, power units and digital signals, standard prefabricated cables are available as follows:

... = length code for connecting cables:

5 m BFO
 10 m CBO
 20 m CC0
 32 m CDO

for ROD 220, 270, 420, 426 *) 6ES5 706-0...0

for ROD 320 6ES5 706-1 ...0
 (installed in 1HU3-, 1HU5- and 1FT motors)

For SIEMENS encoder & FC9320-3... (see SINUMERIC accessories catalog)
 6ES5 705-5...1

For encoders with 5 V differential signals 6ES5 706-2...0
 (encoder cable end open)

Signal assignment	Connector 5-p'n jack	Wire color	Wire ring
A ₁	1	bl	1x pi
\bar{A}_1	8	rd	
B ₁	4	gr	
\bar{B}_1	10	ye	
R ₁	2	gn	
\bar{R}_1	9	br	
0V	5	wt	2x pi
$\bar{0}V$	6	bk	
$\hat{0}V$	12	bl	
V ⁺⁺	3	rd	
V ⁺	7	gr	
V ⁺	11	ye	
Casing		Shield	

*) With a mating connector, manufacturer CONTACT GmbH (Order no. 201 O4OCB +4010 0212 + 1298 4400)

**For encoders with 24 V signals 6ES5 706-2...0
(encoder cable end open)**

Signal assignment	Connector 15-pin jack	Wire color	Wire ring
R _i	13	bl	
A _i	14	rd	
B _i	15	gr	
L+	3	ye	1x pi
L+	7	gn	
L+	11	br	
L-	5	wt	
L-	6	bk	
L-	12	bl	
--	--	rd	2x pi
--	--	gr	
--	--	ye	
Casing		Shield	

**For motor power unit
(cable end open)**

6ES5 706-4...0

Signal assignment	Connector 9-pin male	Wire color
N _{set1}	1	wt
GND	2	br
N _{set2}	4	gn
BS 2	5	ye
GND	3	gr
GND	6	pi
Casing		Shield

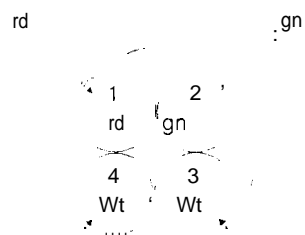
For digital input/outputs
(cable end open)

6ES5 706-5...0

Signal assignment	Connector		Wire color	Wire	ring
	15-pin male				
FUM1	1		bl		
ANF1	2		rd		
BERO1	3		gr		
PR1	4		ye		1x
END1	5		gn		pi
START/STOP1	6		br		
FUM2	8		wt		
PR2	10		bk		
ANF2	11		bl		
BERO2	12		rd		2x
END2	14		gr		pi
START/STOP2	15		ye		
	Casing				Shield

**For absolute position encoders 6ES5 706-6...0
(cable end open)**

Connector 26-pin male	Bundl	Sleeve color	Wire color
1	1	rd	wt
2			br
3			gn
4			ye
5			gr
6			pi
7			bl
8			rd
9	2	gn	wt
10			br
11			gn
12			ye
13			gr
14			pi
15			bl
16			rt
17	3	ye	ws
18			br
19			gn
20			ge
21			gr
22			pi
23			bl
24			rd
25	4	br	wt
26			br
--			gn
--			ye
--			gr
--			pi
--			bl
--			rd
--	Shield		



br ye

Cable construction with
color coding

SIEMENS

SIMATIC S5

IP246 Positioning Module

Incremental 6ES5246-4UA31/ -4UA41

Absolute 6ES5246-4UB11 / -4UB21

Functions

Reference Manual

C79000-B8576-C653 -02

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1 Principle of Operation

The module is operated by means of commands, regardless of whether these commands are sent to the IP246 by the CPU or by a programmer. Commands are divided into two basic groups:

instructions for “operating” and
commands for “monitoring”.

Operating instructions are used for the following:

- to set (change) modes,
- to start the execution of a mode,
- to input modifications during the execution of a mode and
- to abandon the execution of a mode

The reaction to an operating instruction depends on various factors.

- The instruction must be feasible.
- It must be feasible in the currently set mode and, if a change of mode is required, also in the new mode.
- It must not contradict the “axis attributes” which determine whether or not an operating mode is permissible at a given time (= > “Fundamentals of Positioning, Reference Manual”, Section 6 “Axis Attributes”).
- It must not contradict the mode of the other axis, if this has already been set by previous operating instructions (e.g. “teach-in” or “delete program”).

If all these conditions are fulfilled, the operating instruction will be processed, otherwise an error message is output and with a few exceptions processing is terminated.

Operating instructions are entered in the appropriate PC or PG job list on the IP246 in the order in which they are received. In each IP246 cycle (every 3,75 ins), an attempt is made to fetch and interpret the oldest valid job in this list. If the job is permitted in the current axis status, it is executed immediately. If it contradicts the current mode, the mode is terminated and an error message output.

Note:

An operating instruction which causes a mode to start should only be transferred to the module when the previous job is complete.

While an axis is braking, further jobs are accepted, however, not interpreted since they would trigger a stop and the module is already braking. If several jobs are sent to the IP246 during this phase, it is possible that an entry cannot be made in the job list. These jobs are then lost. The IP246, however, outputs the error message “PC (or PG) job list is full”.

With certain operating instructions (transferring a machining program to the IP246), data are also sent to the module along with the instruction, The reactions in this case are explained in the description of the modes.

Monitoring commands are used to fetch the axis attributes (checkback signals), the module errors and information about the actual value, distance to go or following error from the module cyclically. They are independent of the operating instructions and can be sent to the module at any time. They are processed immediately. The next monitoring command can only be input to an interface when the previous command has been processed. Monitoring commands can be sent to the positioning module simultaneously by both interfaces, without the commands interfering with each other.

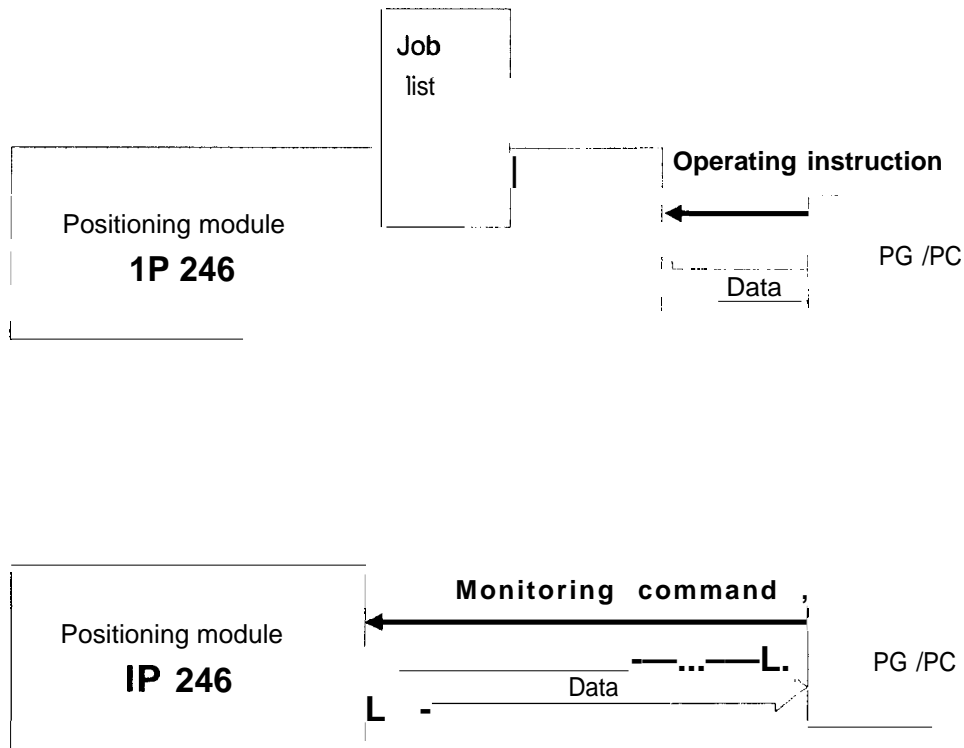


Fig. 1 -1: Operating instructions and monitoring commands

Error messages resulting from incorrect operation or an external event (e.g. limit switch responded) are not reset until they are acknowledged by the input of a new operating instruction at one of the two interfaces. Between the error message and the acknowledgement, any number of monitoring commands can be entered: the unacknowledged error will continue to be output along with the monitoring information.

Each of the axes is always in one of the operating modes. After power on, the following error mode (see below) is set. Within each mode, an axis can be active or idle. This is expressed by the "axis status" which can have the values "running" or "finished" (= > "Fundamentals of Positioning, Reference Manual", Section 6 "The Axis Attributes"). The axis status can be interrogated via both interfaces. The axis status appears in the operating modes mask on the PG; on the PC side it can be read in the checkback signals using FB164. (= > "Standard Function Blocks FB164 and FB165, User's Guide", Sections 2.4 and 2.7.1).

In the axis status "finished", an axis can be changed from one operating mode to any other operating mode, providing the restrictions mentioned above are not contradicted. The operating instruction includes the required operating mode number and a "command". The command can be "start", "stop", "forward", "reverse" or "enter". The axis then changes to the required mode. The mode is, however, only executed when the set mode and the command represent a feasible combination, i.e. "jog speed 1, forwards". The relationship between commands and individual modes is explained in more detail in the description of the modes.

If the input is correct, the axis begins to execute the mode. The axis status changes from "finished" to the status "running". Once the mode is completed, the axis once again assumes the status "finished" and can be started again.

If the execution of a mode is to be terminated, you once again send an operating instruction specifying a mode and the command "stop" to the module. The axis then changes to the "finished" status of the terminated mode. Modes used for data transfer or coordinate transformation cannot be terminated, since this could lead to inconsistencies.

In the "jog" and "incremental" modes (BA 1,2,3,6 and 7) it is also possible to change the speed during execution (override). This is achieved by once again selecting the mode along with the command "enter" and the percentage speed change as a parameter. Here, values of 1 % to 200% can be specified. The resulting speed must be in the valid range from 1 -65000 mm/min (or 1 - 650000.1 in/rein or 1-65000 deg/min) and must not result in the maximum speed programmed in the machine data record being exceeded. If the maximum speed would otherwise be exceeded, the speed is changed to the maximum upper or lower limit and the error message "speed range exceeded" is output.

2 Operating Instruction

An operating instruction consists of the following parts:

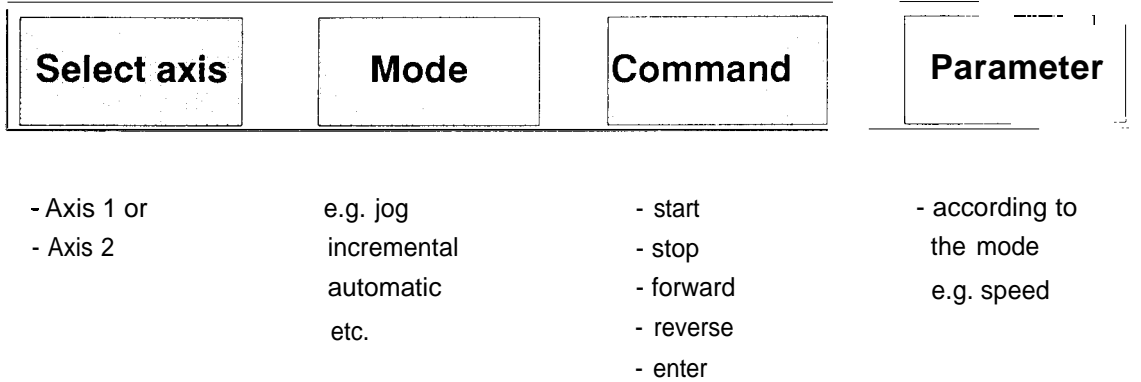


Fig. 2-1: Structure of an operating instruction

The relationship between modes, operating instructions and the axis status can be seen in the following diagram:

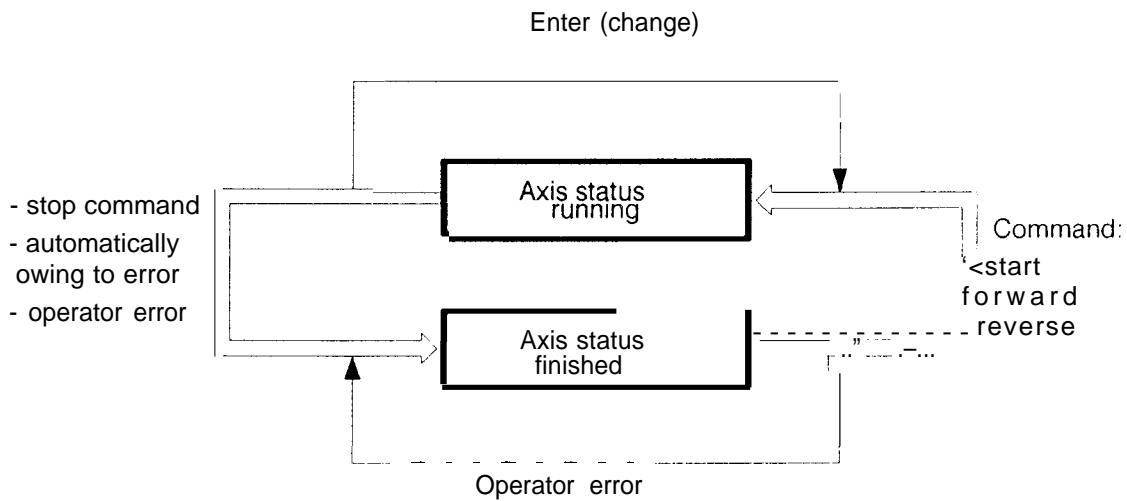


Fig. 2-2: Relationship between operating instruction and axis status

You can only change or start a mode in the axis status “finished”, This is achieved by the start, forward or reverse command in conjunction with the required mode, The module itself changes automatically to the following error mode (mode 4) and switches 0 V or a voltage adjusted by the drift compensation to the output when certain errors occur, even while a mode is running.

Such errors include the following:

- “position loop interrupted”

and with the absolute version the errors:

- “illegal absolute encoder reading”
- “illegal change of absolute encoder value”

If these errors occur, no closed-loop position control is possible.

Operating instructions entered while a mode is running and which do not contain an enter command, result in the error message “illegal job” and the current action is terminated. If an operating instruction is simply incorrect, the axis remains in the “finished” status. The axis can change from the “running” status to the “finished” status for a number of reasons. These include the following:

- a stop command in the particular mode,
- an operator error (e.g. “enter” command with a different mode),
- an error resulting from an external event (e.g. external stop command or a limit switch being tripped) or
- the correct completion of a job (e.g. approach to a particular target point or entry of machine data).

The enter command is required for the following tasks:

- for override changes during an active job,
- to trigger a single traversing movement in the “automatic single statement” mode,
- to acknowledge a “programmed halt” in the “automatic” or “automatic single statement” modes or
- to store statements in the teach-in mode,

When entering instructions at the PG, remember that everything you enter faster than can be processed by the PG or by the COM246 software is written to a keyboard buffer in the PG. If all the stored inputs are feasible and correct, they will be entered in the PG job list in the order in which they were input and then processed by the IP246. This can lead to a stop command being delayed.

The modes of the IP246 can be selected both by the PC and PG interfaces.

The operating modes of the IP246.

The following modes can be called directly by COM246 and by the PC via FB164:

- 1- Jog speed 1
- 2- Jog speed 2
- 3- Jog open loop (position controller off)
- 4- Following error
- 5- Reference/home point (approach or set)
- 6- Incremental (target approach) absolute
- 7- Incremental (target approach) relative
- 8- Automatic
- 9- Automatic single statement
- 10- Teach-in on
- 11 - Teach-in off
- 12- Zero offset absolute (set actual value)
- 13- Zero offset relative
- 14- Clear zero offset
- 15- Tool offset
- 16- Tool offset off
- 17- Clear error
- 18- Drift compensation
- 19- Drift compensation off

The following modes are used by the COM246 automatically in the test mode and can be called by the PC via FB164:

- Modes 71, 72, 73, 74: (for monitoring modes, see Section 4 “Description of the Individual Monitoring Commands”)

The following modes can be called indirectly by COM246 by means of function keys and by the PC via FB165:

- 20- Enter machine data
- 21 - Delete machine data
- 22- Enter machining program
- 23- Delete machining program
- 24- Enter **SYSID** (module identifier)
- 64- Read machine directory
- 65- Read machining program directory
- 66- Read actual values (monitoring mode)
- 67- Read machine data
- 68- Machine data overview
- 69- Read machining program
- 70- Read **SYSID** (module identifier)

3 Description of the Individual Operating Modes

In this description of the modes, it is assumed that you are familiar with the terms “machine data”, “machining program” and “axis attributes”. A detailed description of these terms can be found in “Fundamentals of Positioning, Reference Manual” in the Sections:

- 4 Machine Data and their Structure,
- 5 Machining Programs and their Structure and
- 6 Axis Attributes.

3.1 Jog Speeds 1 and 2 (Operating Modes 1,2)

In these two operating modes, it is possible to move an axis at a constant speed. The basic speeds themselves are contained in the machine data. There are two speeds for forwards movements and two for reverse movements which can be selected with the operating modes jog speed 1 and 2.

After selecting one of the two operating modes, you can start an axis moving in the required direction by setting the commands “forward” or “reverse”. By pressing the stop key on the PG you can stop the axis again. From the programmable controller’s side, FBI 64 provides a special feature. On the signal edge of the “forward” or “reverse” command from 0 to 1, the axis is moved in the selected direction and is stopped again when the signal changes from 1 to 0. The axis also stops if a stop command is entered (= > “Standard Function Blocks FBI 64 and FBI 65, User’s Guide”, Section 2.9.2 “Special Features of the Parameters VORW and RUCK”).

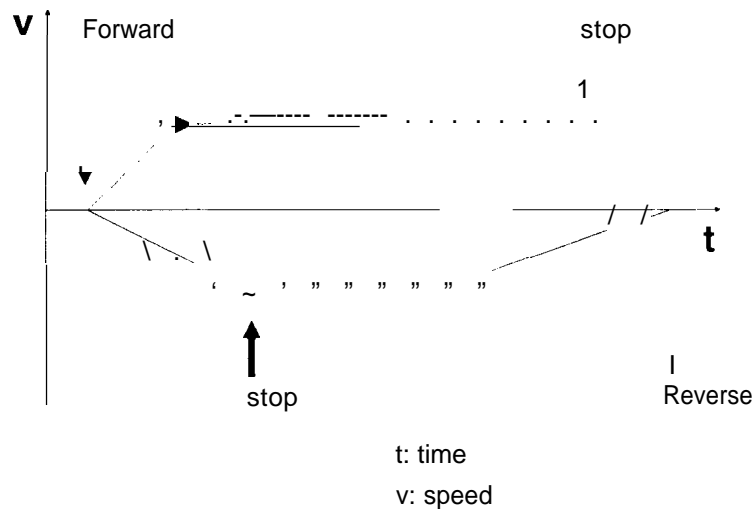


Fig. 3.1 -1: Traversing in the jog mode

You can also switch from one jog speed to the other while the axis is moving. The axis then stops and continues its movement in the new jog mode. This also applies to jog open loop (see below).

In the jog mode (BA 1 to 3) and in the incremental mode (BA 6 and 7), you can change the basic speeds stored in the machine data. To do this, you must enter a value between 1 % and 2000/0 in the “override” parameter. Values outside this range are restricted to the limit values. The traversing movement is then executed at the specified percentage of the speed programmed in the machine data. You can also change the speed while the axis is moving by changing the override parameter and entering the “enter” command.

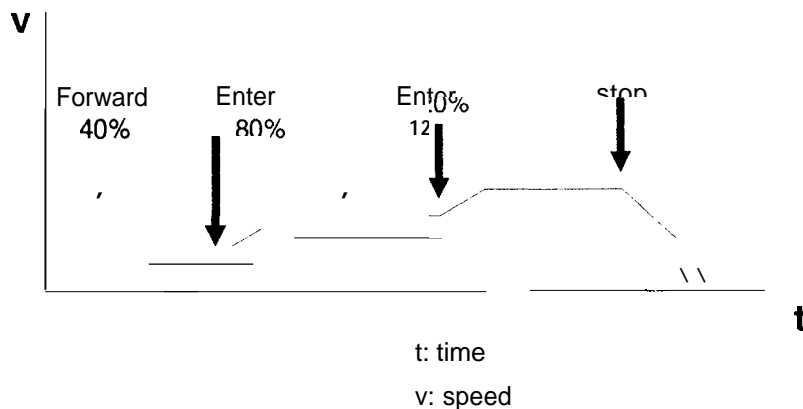


Fig. 3.1-2: Traversing in the jog mode with variable speeds

Note:

Traversing speeds resulting from an override change must not exceed the programmed maximum speed. The limits are 1 -65000 mm/min (or 1 -650000.1 in/rein or 1 -65000 deg/min). If this maximum speed would otherwise be exceeded, the speed is changed to the lower or upper limit and the error message “speed range exceeded” is output.

You can also specify override in steps of 1%. This accuracy of speed change is also taken into account internally.

3.2 Jog Open Loop (Operating Mode 3)

The open-loop jog mode corresponds to “jog speed 2” except that the closed-loop position controller is switched off. Instead of the following error, the programmer now displays the speed calculated from the signals of the position encoder. Accurate display of the speed is only possible if the position encoder has correct parameters and the resolution is correctly assigned. The accuracy of the display is reduced the lower the speed and the less accurate the resolution.

Using the open-loop jog mode you can check the adjustment of the power unit or the assignment of parameters to the drive. The speed displayed on the programmer in the open-loop mode should roughly correspond to jog speed 2 in the machine data. If this is not the case, the power unit of the drive should be readjusted or the machine data corrected.

The setpoint of the position controller is updated in the open-loop jog mode to avoid jolting the axis when the closed-loop position controller is re-enabled. This allows you to switch between closed and open-loop modes as required.

Using the absolute version of the IP246 you can only traverse in the open loop jog mode without a position encoder connected if you have assigned parameters for an absolute position encoder which does **not** output Gray excess X code.

3.3 Following Error Mode (Operating Mode 4)

During normal IP246 operation the closed-loop position controller is always enabled, i.e. as soon as the axis deviates from the **setpoint** position the controller attempts to correct the deviation. By starting the following error mode, the position controller is switched off. This is always necessary when the IP246 is to evaluate the signals of the position encoder but

- the power unit is switched off for some reason and the drive can no longer follow the manipulated variable, e.g. when the axis is moved manually or if it becomes jammed
- when the power unit is controlled by an external analog voltage.

If the position controller is switched on, a following error would accumulate. If this remains in the permitted range, the axis would jerk suddenly to the original setpoint position when the power unit is switched on again or when the IP246 is switched back to closed-loop operation.

When the following error mode is active:

- the position controller is switched off,
- the **setpoint** output is set to 0 V, or to a value adjusted by the drift compensation,
- the following error is cancelled,
- the movements of the axis are measured as speed and displayed as in mode 3 instead of the following error,
- the position **setpoint** follows the position actual value. This means that when the following error mode is deactivated, the current actual position value is accepted as the set point for the controller, avoiding jerky movements.

The reference or home point and therefore also the stipulated coordinate system remain unchanged. A selected backlash value is also taken into account in the following error mode, You can, for example, move the axis within the range of the backlash manually without changing the actual position value. If, however, you move the axis so that there is "play" in the drive (less than the backlash compensation value) the backlash is not taken into account with the next traversing job when the following error mode is switched off. The backlash is only taken into account by the IP246, i.e. compensated, when a traversing distance greater than the backlash compensation value in the machine data is travelled. Only then can you assume that there is no play in the drive (= > "Fundamentals of Positioning, Reference Manual", Section 4.7 "Correction Parameters"). If the rotational speed control loop remains switched on in the following error mode, the axis must not move or at most very slightly, If the axis does however move, the power unit has a drift and must be readjusted. If the movement is only very slight, the deviation may be corrected in the "drift compensation" (BA 18) mode.

The following error mode can be disabled by the operating instruction

- Following error, stop 1 or by
- "external stop".

The position controller is then reactivated. The stop command, in conjunction with a different mode sent from the PC, does not terminate the following error mode, but simply leads to the error message "illegal job".

With the absolute version of the IP246, if the following error mode was switched on automatically owing to the error "illegal absolute encoder reading" or "illegal change of absolute encoder value", then the machine data can also be changed while the following error mode is active. The following error mode is then terminated. If one of these errors occurs again after the machine data have been changed, the module once again switches to the following error mode.

3.4 Reference/Home Point (Mode 5)

Operating mode 5 is used to calibrate the axis. This means the following for incremental position encoders:

- Reference point approach: the reference point is located by a calibration run. The reference point precontact (e.g. BERO) and the zero marker of the position encoder are evaluated.
- Set reference point: the current position of the axis (at rest) is assigned the coordinate of the reference point stored in the machine data. A precontact and the zero marker of the encoder are ignored.

For absolute position encoders this means the following:

- Set home point: the position signal currently being supplied by the position encoder at rest is assigned the coordinate of the home point. From the information about the encoder resolution and the travel resolution from the machine data, an absolute position coordinate is calculated for all other position encoder signals.

In each case, an error-free machine data record is required on the module. The coordinate of the reference or home point is stored in the machine data. With the incremental version, the direction of approach to the reference point and the speeds for approaching the reference point are also contained in the machine data record.

Note:

On correct completion of mode 5, the checkback signal "reference/home point set" is sent. (= > "Fundamentals of Positioning, Reference Manual", Section 6 "Axis Attributes").

If the reference/home point is not set, the software limit switches stipulated in the machine data are not evaluated and the following operating modes are blocked:

- "incremental absolute" (mode 6),
- "automatic" (mode 8),
- "automatic single statement" (mode 9) and
- "teach-in on" (mode 10).

Zero offsets and tool offsets which were active before the calibration of the axis (= > Section 3.10 or Section 3.11 "Absolute/Relative Zero Offset" and Section 3.1.3 "Tool Offset") are retained and are included in the calculation of the reference/home coordinate.

Example:

A zero offset of 100 mm in the reverse direction was executed.

The mode “set reference point” was executed. The coordinate of the reference point in the machine data is 0 mm.

The actual value following “set reference point” is indicated as 100 mm.

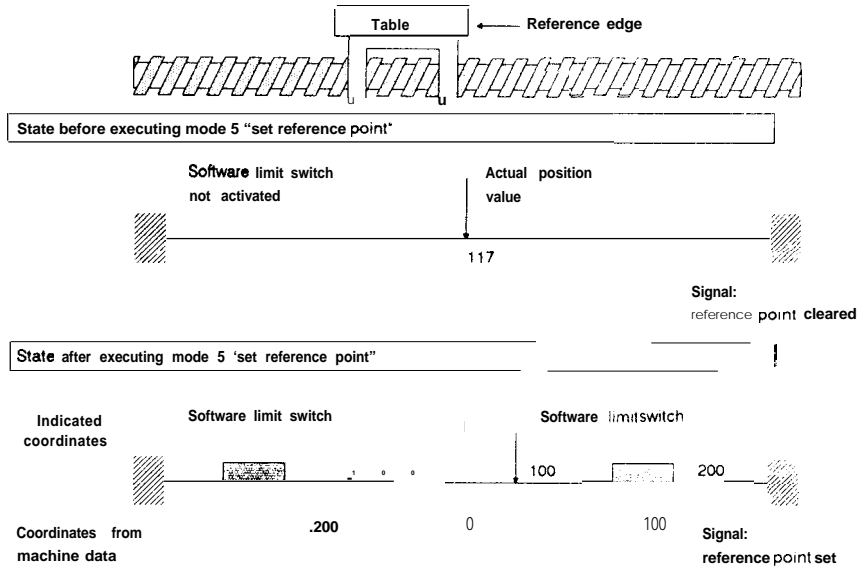


Fig. 3.4-1: Mode 5 with a zero offset

The reference point of the incremental version is always lost when the positioning module is switched on and must be calculated again. The reference point in the absolute version is only lost after the module is removed from the PC frame or if the PC battery back-up fails. You can, however, save the relationship between the reference point specified in the machine data record and the coordinate system of the absolute position encoder on diskette, hard disk or in the PC and recreate it on the module at any time. (= > Section 3.4.2 “Set Home Point” and 3.1.7 “Machine Data Processing”).

The calibration of the axis is triggered by specifying operating mode 5 and the command “start’. With the incremental version, it must also be stipulated whether the reference point is to be calculated using a reference point approach or by setting the reference point.

By starting mode 5, an existing reference/home point is cleared or overwritten,

3.4.1 Reference Point Approach (only for the Incremental Version)

Hardware requirements:

- A reference signal whose positive-going edge is evaluated. This is normally the zero marker of the incremental position encoder (zero pulse), which is output once per encoder revolution.
- A precontact (usually **BERO**) which has its falling edge in the “reference point direction” before the reference signal. The contact must be NO.

- Possibly hardware limit switches, which restrict the traversing range and trigger the reversal of direction during the reference point approach.

Sequence of the reference point approach

A reference point approach goes through the following steps: (see Fig. 3.4.1 -1: "Reference point approach" with reversal at the limit switch.)

- 1) Select "reference/home point" (mode 5) with the parameter "run".
- 2) Send the start command.
- 3) The drive traverses in the opposite direction from the reference direction at "reference speed 1".
- 4) The direction is reversed at the hardware limit switch.
- 5) On the rising signal edge of the **precontact**, the speed changes to reference speed 2.
- 6) Once the falling signal edge of the **precontact** is recognized, the evaluation of the zero marker is activated.
- 7) With the rising edge of the zero marker, an interrupt is executed internally and the inordinate of the reference point from the machine data is taken immediately as the actual value.
- 8) The drive brakes.

Since the drive only brakes after the reference point is recognized, it cannot remain exactly on the reference point. If the drive must be located exactly on the reference point after the reference point approach, then you must follow the reference point approach with mode 6 "incremental absolute" specifying the appropriate target point.

In the following diagram please note the different directions of the time axis for positive and negative velocity. (A certain distance on the d-axis does **not** correspond to the respective surface below the velocity curve.)

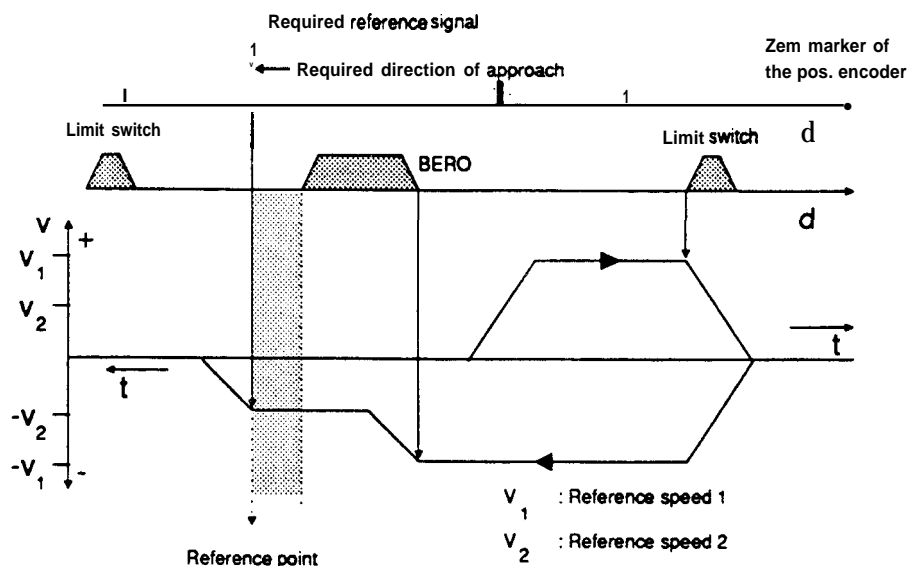


Fig. 3.4.1 -1: Reference point approach with reversal at the limit switch

Special cases with reference point approach

Depending on the position of the drive before the reference point approach is executed, there are three **special situations** which affect the sequence of **movement**. These can be seen in the following diagrams. In the opposite approach direction, these movements are reversed.

- **Special case 1**

If the IP246 detects the precontact before reaching the hardware limit switch, the direction is reversed at the end of the precontact.

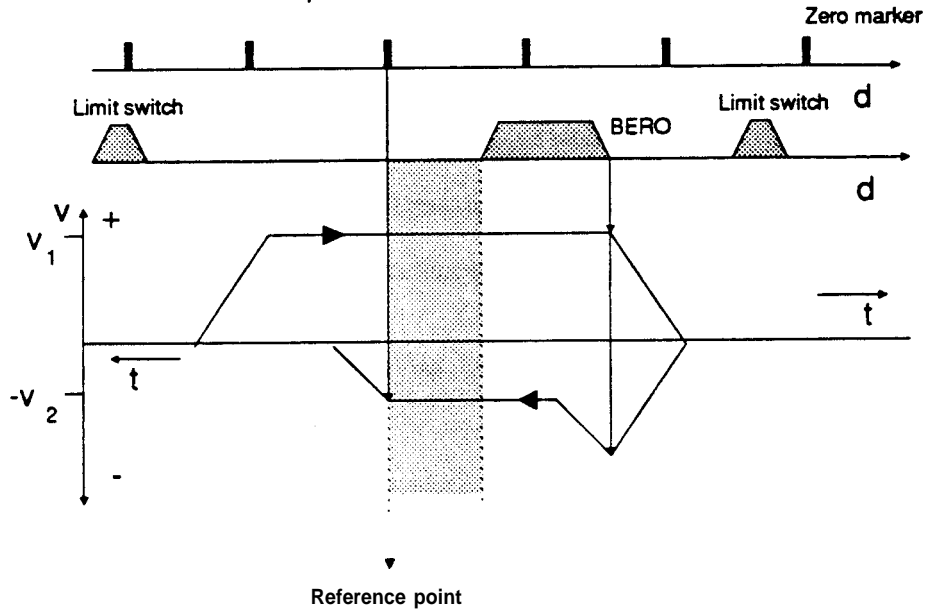


Fig. 3.4.1-2: Reference point approach with reversal at the BERO

- **Special case 2**

If the appropriate limit switch is activated when the approach is started, the drive starts immediately in the reference point direction.

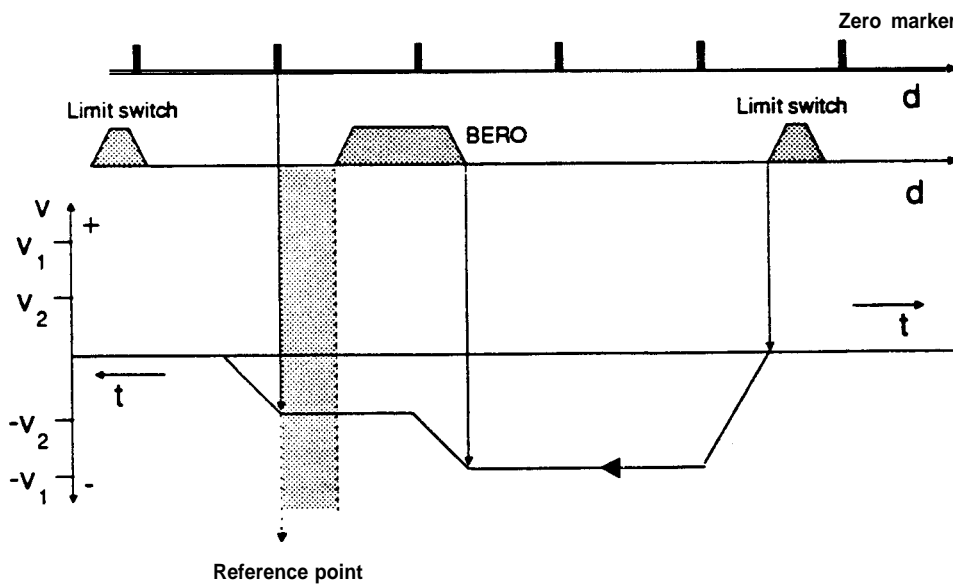


Fig. 3.4.1 -3: Reference point approach with start at the reversal limit switch

- **Special case 3**

If the **precontact** is activated when the reference point approach starts, the drive moves immediately in the reference point direction at reference speed 2.

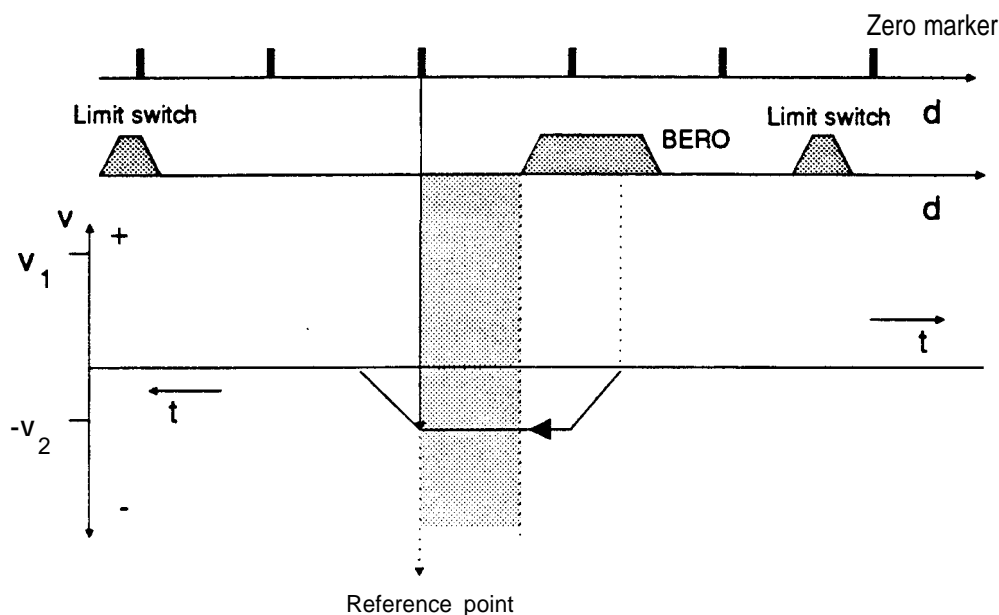


Fig. 3.4.1-4: Reference point approach with start at the BERO

If one of the two limit switches is “out of bounds”, i.e. must not be reached, the reference direction in the machine data must be specified so that the reversal of direction only occurs at the other limit switch. If both limit switches are prohibited, the axis must be positioned in front of or on the **precontact** (BERO) before the reference point approach is started, so that special case 1 or 3 comes into effect.

If the axis is already on the BERO at the beginning of the reference point approach, you can be sure that no limit switch will be tripped. There is also no reversal of direction in the reference point approach. If there is backlash outside the closed control loop, you must, however, remember that the reference signal can occur within the backlash. The reference point can then no longer be reproduced and there may be play in the drive after the reference point approach.

If the reference point approach is abandoned, there is no reference point present, even if there had been one previously. The mode must be **restarted** and carried out completely.

3.4.2 Set Reference Point; **Set Home Point**

With the “set reference/home point” function, the axis is calibrated without movement. No hardware limit switches and no **precontact** are required. The point at which the axis is **located** (actual position) at the start of “set reference/home point” is assigned the reference/home point coordinate programmed in the machine data record. Tool length and zero offsets are taken into account.

A reference or home point can be set at any axis position, even outside the hardware limit switches. You must, therefore, make sure that your axis is in a permissible position within the hardware limit switches before executing the “set **reference/home** point” mode. Remember that the programmed software limit switches may, under certain circumstances, be outside the hardware limit switches mounted on the axis and therefore have no effect.

If a backlash compensation value is assigned other than 0, the **reference/home** point must only be set when there is no play in the drive. The first traversing movement (traversing distance greater **than/equal** to the assigned backlash) must be in the direction in which there is no play, since the backlash is not taken into account with this traversing **movement** (=> Part 2, “**Fundamentals of Positioning**”; Section 4.7.1 “Backlash Compensation”).

3.4.3 **Special** Features **when using Absolute** Position Encoders

In the “set home point” mode, the bit pattern of the Gray code currently being transmitted by the encoder is assigned the coordinate of the reference point from the machine data. Only after this is the module capable of recognizing the actual position of the axis from every bit pattern of the absolute encoder. Zero point adjustment of the position encoder is not required!

Since the module loses this assignment without data back-up, e.g. when the module is removed, the current code from the position encoder is entered in the machine data record on the module and identified as valid when a reference point is set. This identification cannot be read or influenced directly via **COM246**. The entry is overwritten the next time a reference point is set.

Save the machine data record with the valid home point, both in the CPU and on diskette. If this data record is once again loaded on the module after a module has been exchanged, a “set reference point” is not required again, providing the mechanical coupling between the position encoder and axis is not changed. The module then once again outputs the actual position of the axis.

As soon as the following are changed in the machine data, the allocation is invalid:

- the encoder data,
- the travel resolution,
- the module number or
- the axis number.

When working with **COM246**, this occurs automatically. If the data manipulation is in the CPU or external, you must make sure that the “valid bit” is reset (=> Part 6 “Standard Function Blocks **FB164** and **FB165**”; Section 3.8.1 “Structure of a Machine Data **DB** in the PC Memory”).

Changing the home point coordinate in the machine data record leads to a physical displacement of the traversing range, and does not clear the home point.

Proceed as follows after replacing the position encoder:

- position the axis on the physical home point in the “jog” or “incremental relative” mode,
- execute** the mode “set reference/home point”,
- save the** machine data again.

With the IP246, the zero of the position encoder does not require adjustment!

If the position encoder does have a zero adjustment **and** this was carried out correctly for both position encoders, so that both encoders supply the same bit pattern at the same axis position, then “set home point” does not need to be repeated.

Response of the module when the PC is switched on:

- If there are no machine data on the module, the actual value remains constant zero. Checkback signal (axis attribute): “machine data not present”, “home point **missing**”.
- If machine data are present, but there is no home point, then the actual value is the same as the coordinate of the home point from the machine data after the machine data are entered without zero offsets or tool length offsets. If the axis moves, the actual value is updated.
Signal: “home point missing”.
- If machine data exist with a valid home point, the actual value is correctly indicated and updated.
Signal: “**home point set**”.

During operation any number of absolute position encoder overflows may occur. The module still calculates the correct absolute values. When stipulating the coordinate system, you must make sure that an absolute encoder position is read, which can be assigned to a coordinate within the limits resulting from the coordinates of the software limit switches and the deceleration ramps. This range is known as the “usable range” (= > “Fundamentals of Positioning, Reference Manual”; Section 4.3 “Traversing Range”).

3.5 incremental Approach Absolute (Mode 6)

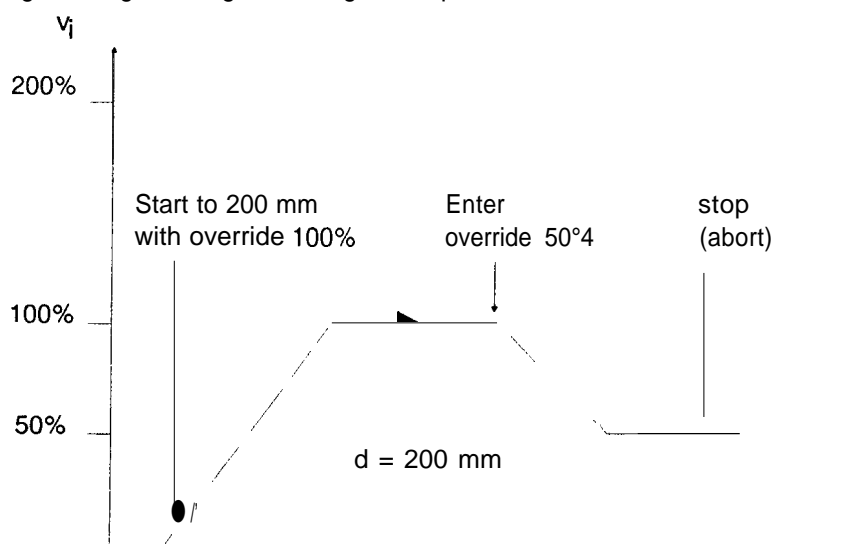
In this mode, a target specified in absolute coordinates is approached. The speed of the approach is the basic speed (1 OYO) specified in the machine data “incremental speed”, You can vary this speed with override between 1 % and 200%. The resulting speed must, however, not exceed the maximum speed. See “jog” modes 1..3, The target position must be within the software limit switches or range limits. The mode can only be executed when there is a reference/home point.

With a **linear axis** the movement is triggered by the start command.

When operating a **rotary axis** the terms below have the following meaning:

- “Start” = approach the target by the shortest route, If the distance is the same in both directions, the direction forwards (clockwise) has priority. Reversal backlash is in this case not taken into consideration. If the axis is already on the target position, no movement is executed (=> “Fundamentals of Positioning, Reference Manual”, Section 5.6.5 “Direction of Approach to the Target Point with a Rotary Axis”).
- “Forwards” = approaching the target in a forwards direction (clockwise direction). If the axis is already on the target position, the total traversing range is covered once.
- “Reverse” = approaching the target in a reverse direction (anti-clockwise direction). If the axis is already on the target position, the total traversing range is covered once.

Changing the target during traversing is not possible.



d: distance t: time v: speed

vi: incremental speed

Fig. 3.5-I: Traversing in incremental absolute

3.6 Incremental Approach Relative (Mode 7)

In this mode, a preset distance forwards or backwards is travelled from the current actual position. The speed used is the basic speed (100%) stipulated in the machine data “incremental speed”. You can vary this speed with an override between 1% and 200%. The resulting speed must not, however, exceed the maximum speed (=> Section 3.1 “JOG Speeds 1 and 2”),

This mode can also be executed when the reference or home point is deleted. The travel direction is determined by the operating instruction "forwards" or "reverse".

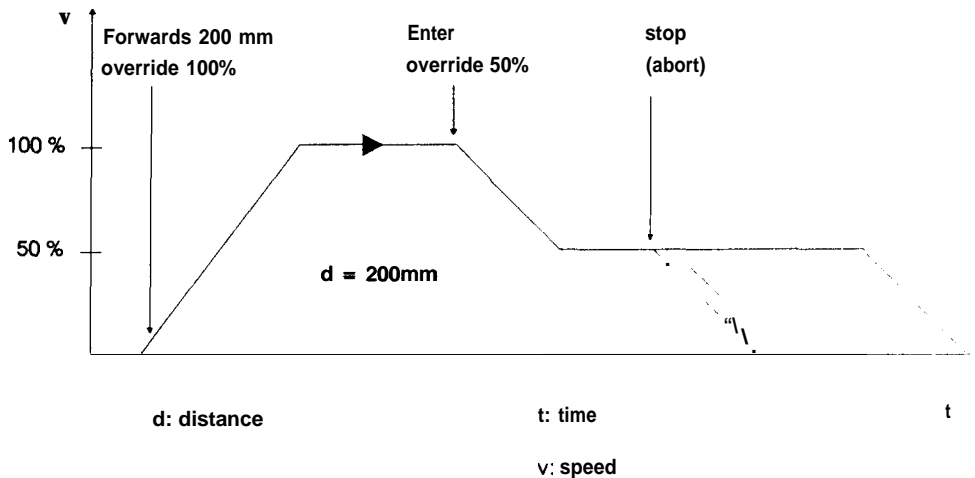


Fig. 3.6-1: Traversing in "incremental approach relative"

With a linear axis, the distance to be travelled must be such that the resulting target position with a reference or home point set remains within the traversing range between the two software limit switches (also taking into account zero point offsets). If this is not the case, the job is aborted and the error 'traversing range exceeded' is displayed. With a rotary axis, the distance travelled is limited to +/-40 m (+/-4000 inches, +/-40000 degrees). If this limit is not adhered to, the job is also aborted and the error message "illegal dist. spec." is generated.

3.7 Automatic (Mode 8)

A series of traversing movements, dwell times and loops can be stored on the module as a machining program. The structure and effects of machining programs or of functions in machining programs is discussed in "Fundamentals of Positioning, Reference Manual", Section 5 "Machining Programs and their Structure". To execute a machining program, you must specify the parameter "program number" in the operating instruction. The machining program is executed with the "start" command. You can abandon the program at any time with the "stop" command. The distance to go then remains unchanged until the next traversing movement. The program is terminated after a stop command. You can only start again from the first statement, and not from the point at which the program was interrupted. For the automatic mode, the reference or home point must be set. While a machining program is being executed you can not change or delete this program.

Machining programs stored on the module are not assigned to a particular axis. They can be used by both axes simultaneously. If the machine data or your plant contradict the requirements of the machining program, the **IP246** recognizes the error while executing the machining program. The machining program is then terminated for the corresponding axis and an error message is displayed.

On the module, a machining program interpreter evaluates the individual statements of the machining program. This interpreter is normally several statements ahead of the statement currently being executed. This means that an error such as “statement not allowed after flying change” may be signalled before the illegal statement in the machining program has been executed.

Zero offsets can be programmed in machining programs, which are then automatically cancelled again after the program is completed. If the program is aborted before it is completed, these offsets are not automatically cleared. They must be eliminated with BA14 “clear zero offset” (= > Section 3.12 “Clear Zero Offset”).

Tool length offsets activated in the automatic mode are retained after the machining program is completed or aborted.

If a machining program is executed on a rotary axis, the approach to the target by the shortest route is the default. Since the IP246 calculates the shortest route itself and therefore determines the direction, you must make sure when programming a flying change that the flying change is permitted and does not lead to an error.

Note:

- With a programmed halt (MOO) and a flying change (G10) in one statement, the programmed halt has priority.
- In mode 8 (“automatic”) an enter command is required for each “programmed halt”
- The point at which the program is halted is always immediately before the next traversing movement or dwell time.

In the following example, a number of unnecessary MOO functions have been used. Before approaching target 200, the enter command must be given three times although the interrupt point is directly before the movement.

```
N10 X100 F1000 MOO
N15 ! MOO
N20 G56 ! MOO
N25 G43 ! X200 F1000 M02    (! = halt point)
```

3.8 Automatic Single Statement (Mode 9)

This mode runs, in principle, in exactly the same as automatic. However, you must supply the “enter” command before a traversing movement or dwell time is executed. Only one traversing movement or one dwell time in the machining program is executed, any further movement or dwell time must be triggered separately. The halt point is always immediately before the next traversing movement or dwell time.

The command sequence with “automatic signal statement” is as follows:

!“Automatic single statement”; program number; start.

- The axis changes to the “automatic single statement” mode.
- The axis searches for the machining program with the specified program number,
- Within the machining program the statements are executed until the first dwell time or first traversing movement.
- The axis then waits for the enter command.
- When the enter command is received, all functions are executed until the next traversing movement or dwell time.

etc.

“Automatic single statement”, stop

With this command, the “automatic single statement” mode is terminated, This can occur both between the execution of two statements or during a traversing movement or dwell time.

Special features

- Statements connected with a flying change are treated as one statement

```
N10 G10 X1000 F100 M10
N20 X2000 F500          . > treated as one statement
```

Exception

- If “flying change” and “programmed halt” are used in one statement, “programmed halt” has priority.

```
N10 G10 X1000 F100 MOO
N20 ! X2000 F500          => separated owing to MOO
```

- Offsets or switchovers are executed following the program start, following the previous traversing movement or dwell time and following the programmed halt.

```
N10 X100 F1000 M10
N11 G56! X200 F1000 M1 1  => The execution of the program is only interrupted
                           after G56
                           (! = halt point)
```

- A “programmed halt” is suppressed in conjunction with a traversing movement and dwell times to avoid two enter commands being required.

- ```
N10 X100 F1000 MOO
N11 G56 ! X200 F1000
```

 => Despite “programmed halt” and single statement execution, only one enter command is required (! = halt point)

```

N10 G74 M10
N15 G90! X100 F1000 M00
N20 G56! X200 F1000 M20

```

= > Only one enter command is required at both halt points

In the following cases, the “enter” command must be sent twice:

- Apart from the statement number, only MOO was programmed (N10 MOO)
- In the statement with MOO, only an offset or switchover was programmed.

### 3.9 Teach-in On/Off (Modes 10/1 1)

In the “teach-in” mode, only the JOG modes and modes “incremental approach absolute or relative” are permitted, other entries are not executed, If no position was stored in “teach-in”, the positioning module will have generated an empty machining program.

The following procedure must be followed to generate machining programs in “teach-in”:

- the mode BA10 must be activated and the required program number specified,
- the required target points must be approached in “JOG” or in the mode “incremental approach absolute or relative”,
- with the axis at a standstill (axis status = “finished”), the current actual position must be stored in the selected program with the enter command. The storing of the statement is signalled with the message “statement stored. It is possible to transfer the position several times. In this case, several identical machining program statements with a consecutive N function are stored in the machining program,
- after storing all target positions, switch off the “teach-in” mode with BA11 (“teach-in off”) The program is then completed with M02 and entered in the program directory of the module.

A program generated in this way can be used in both automatic modes by both axes.

In the “teach-in” mode, all statements

- are stored one after the other,
- begin with NO1 and have a consecutive N function,
- are assigned “incremental speed” 100% and
- are stored without M functions

When “teach-in” is switched on

- the machine data record must be valid,
- the reference/home point must be available,

- there must be sufficient space in the program memory of the IP246,
- a machining program number must be specified which has not yet been used on the IP246,
- the other axis of the IP246 must **not** be in the “teach- in” mode and
- machining program input must **not** be active on the other axis.

Note:

If the power supply to the positioning module is switched off during “teach-in” and if statements have already been recorded, this machining program is lost. The “teach-in” mode is no longer active. If the limit of maximum 10000 machining program characters is exceeded in “teach-in”, the mode is automatically terminated, the last stored statement is taken as the final statement.

The following command sequence is for example possible: (in the example, the incremental speed in the machine data is 2500 mm/s)

- “Teach-in on” (mode 10), program 7, start  
“Teach-in” is switched on and machining program 7 is set up.
- “JOG speed 1” (mode 1), 20%, forwards  
The axis moves forward at 20% of JOG speed 1.
- “JOG speed 1” (mode 1), 50%, enter  
The axis continues in a forwards direction at half JOG speed 1.
- “JOG speed 1” (mode 1), stop  
The axis stops (e.g. at 1258,250 mm). After the “finished” message, the enter command can be used to enter the machining program statement. (= > “Fundamentals of Positioning, Reference Manual”, Section 6 “Axis Attributes”).
- “JOG speed 1” (mode 1), enter  
The axis is now stopped. With the enter command, the first statement NO1 X1258,25 F2500 of machining program 7 is generated.
- “incremental approach absolute” (mode 6), 3000 mm, start  
The axis travels to the absolute position 3000 mm and stops. The “finished” message is set
- “Incremental approach absolute” (mode 6), enter  
N02 X3000 F2500 is entered in the second statement (N2).
- “Teach-in off” (mode 11), start  
Machining program 7 is completed and the teach-in mode switched off. The statement N3 M02 is appended to machining program 7 to indicate the end of the program.

The complete example appears as follows:

```

%07
N1 X1258.250 F2500 : approach position 1258.250 at speed 2500 mm/min
N2 X3000.000 F2500 : approach position 3000.000 at speed 2500 mm/min
N3 M02 : final statement, program end

```

In the machining program, there are preset absolute coordinates, For a rotary axis these are approached via the shortest route when executing a machining program generated in this way. If you wish to change these presets or speeds or add further G or M functions, you can do this easily with COM246. Output the generated machining program from the module, edit the program and then store it again on the IP246.

### 3.10 Zero Offset Absolute (Mode 12)

When you start the mode “zero offset absolute”, the current actual position of the axis is assigned a new coordinate. This means that the whole coordinate system including the reference/home point coordinate and the software limit switches or traversing range limits are transferred. A traversing movement does not take place, The new coordinate for the current position must be transferred with the start of the mode, It is then displayed as the actual value

The coordinate required as the transfer parameter for the mode must not exceed the maximum range ( +/-40 m; +/-4000 inches; +/-40000 degrees). Greater values cause the mode to be terminated and the error message “illegal dist. spec.”. The displacement of the coordinate system must be such that all the new coordinates still lie within the permitted range. This is checked by the module, and if the coordinates are outside the range, the mode is terminated and the error message “traversing range exceeded” is displayed,

Zero offsets can be stored in the machine data (zero offset 1..,4) and called in the machining programs (= > “Fundamentals of Positioning, Reference Manual”, Section 4,7.3 “Zero Point Offset”). These bring about an additional displacement of the coordinates. At the end of a machining program, the offsets executed during the program are cancelled, not however those generated by the modes “zero offset absolute” and “zero offset relative”.



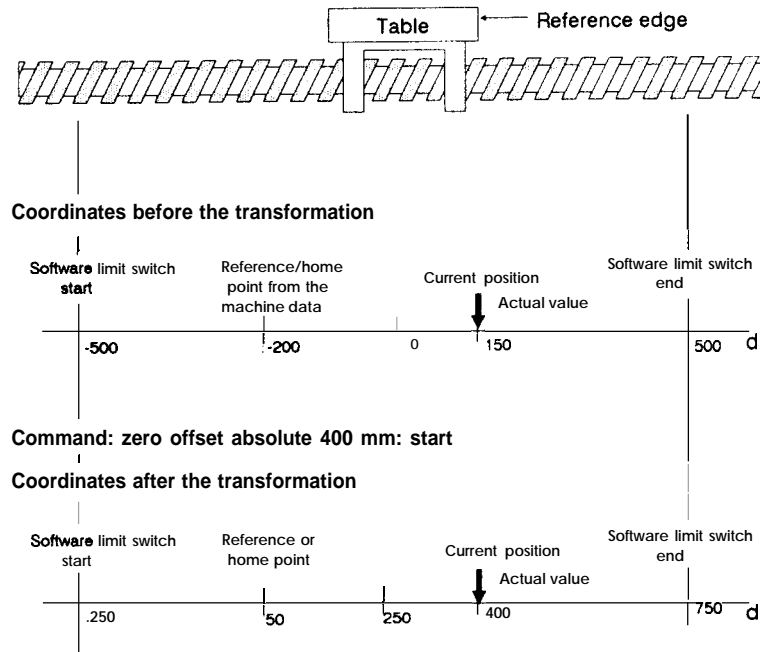


Fig. 3.10-1: Zero offset absolute with a linear axis

The coordinate of the current position is transformed from 150 mm to 400 mm. All other position coordinates (software limit switches, reference/home point) are 250 mm more positive.

Effect of zero offset for a rotary axis

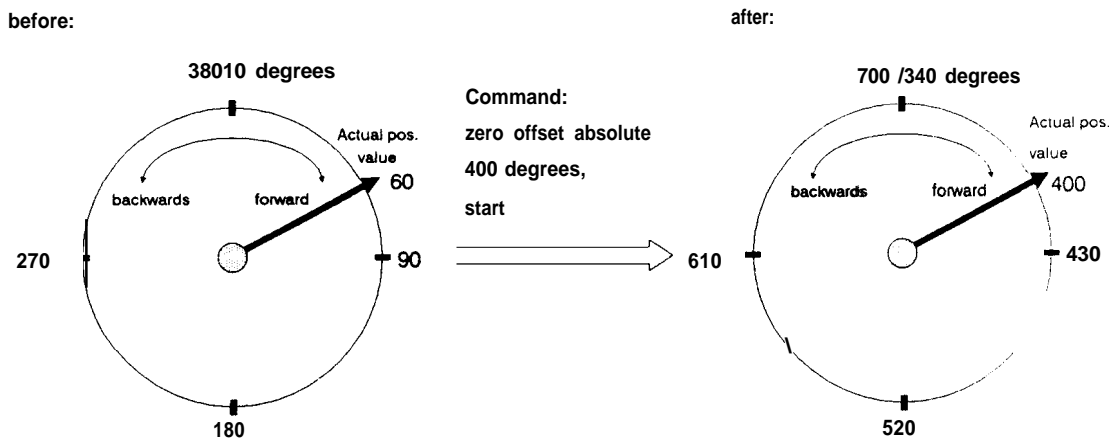


Fig. 3.10-2: Zero offset absolute with a rotary axis

The current position of 60 degrees is assigned the coordinate 400 degrees. All other position coordinates become more positive by the difference of 400 degrees -60 degrees i.e. 340 degrees. The range limits are then no longer at 0/360 degrees but at 340/700 degrees.

Absolute target specifications must have values within this range following the coordinate transformation. The coordinate 0 degrees, for example, no longer exists after the zero offset

You can execute any number of zero offsets one after the other, A zero offset is only possible with valid machine data but can be executed without a reference/home point. When the axis is calibrated (BA5) a zero offset is taken into account. (See Section 3.4 “Example of Reference Point Approach or Set Reference/Home Point”,)

After switching on the incremental version of the IP246 again, the reference point is lost, however, not the zero offset.

**If new machine data are entered to the IP246 or if existing machine data are modified, zero offsets are cleared.**

### 3.11 Zero Offset Relative (Mode 13)

In this mode, the coordinate system is displaced by a value specified in the input parameter. An offset “forwards” means that the coordinates of the software limit switches or range limits and the reference/home point coordinate as well as the current actual value become more negative by the value specified. An offset “backwards” has the opposite effect, A sign entered with the parameter is also taken into account. The command zero offset relative -50 mm backwards causes a zero offset of 50 mm forwards.

The same requirements, conditions and limits apply as for mode 12.

Relative zero offsets are added to zero point offsets set with “zero offset absolute”

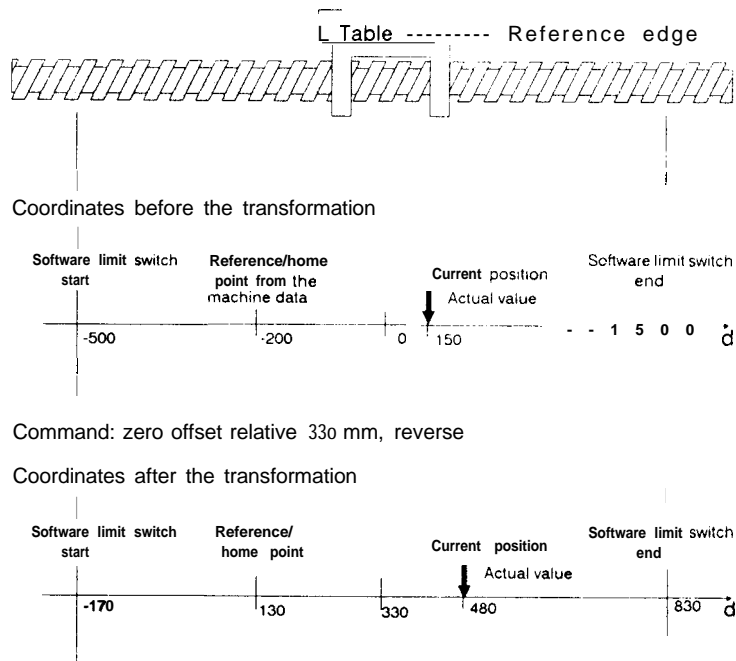


Fig. 3,1 1-1: Zero offset relative

### 3.12 Clear Zero Offset (Mode 14)

When this mode is started, all zero offsets, established by

- “zero offset absolute”, BA12 or
- “zero offset relative” , 6A 13

or zero offsets which were not **cancelled** because a machining program was aborted are cleared. (= > Section 3.7 “Automatic”).

If several zero offsets have been performed, it is not possible to clear individual offsets, only the total offset can be cleared. The coordinate system is then once again as it was with mode 5.

### 3.13 Tool Offset (Mode 15)

The “tool offset” mode allows user programs and machining programs to be used when the tool length changes without having to change the program.

In the operating instruction of mode 15, you enter the value and direction of the tool length offset. The direction is stipulated with the commands “forwards” or “backwards”. Remember that the sign before the offset value is taken into account. The command “tool offset -80 mm, backwards” corresponds to a tool length offset of 80 mm forwards.

When any positioning movement is carried out, the **new** tool tip is brought to the specified target position. This also applies to the execution of machining programs, If mode 15 is called again, the offset is replaced by a new value.

The mode “tool offset” requires valid machine data. A reference/home point is not necessary. A value within the limits of +/-40 m (+/- 4000 inches or +/-40000 degrees) can be entered for the tool length. Values outside these limits lead to termination of the program and to the error message “illegal **dist. spec.**”.

The value displayed as the actual position following a tool offset is the position at which the tip of the tool is located. Following a tool offset, even if a software limit switch is tripped, the actual value (tool tip) must not exceed the limits of +/-40 m (+/-4000 inches, +/-40000 degrees). This is checked when the tool offset is executed. If this condition is not met, the tool offset is not accepted and the error message “traversing range exceeded” is set.

#### Example:

A drilling program was written assuming that the drill is 100 mm long. The reference edge of the chuck is position 50 when retracted. Enabling conditions were generated at this position for the equipment, i.e. the chuck must always return to this retracted position. The target position of the drill tip when operating is 200.

## Implementation

|                |          |                                            |
|----------------|----------|--------------------------------------------|
| BA6 ; 50 mm ;  | Start    | ;"incremental approach absolute" to 50 mm  |
| BA15; 100 mm ; | forwards | ;"tool length offset"                      |
| BA6; 200 mm ;  | start    | ;"incremental approach absolute" to 200 mm |
| BA16;          | start    | ;"tool offset" off                         |
| BA6; 50 mm ;   | start    | ;"incremental approach absolute" to 50 mm  |

In the parameter for mode 15, only the actual length of the drill is entered. This means that the required depth is always achieved.

Before the drill is retracted, the offset is cancelled so that the chuck returns to the basic position.

In the program, you must of course make sure that the individual jobs are sent when the axis status is "finished".

### Note:

The detection of the software limit switch depends on the internal position setpoint. The axis begins to brake when the reference edge of the tool holder passes a software limit switch. Depending on the tool offset, the tip of the tool may be well outside the selected traversing range.

You can also specify a tool offset in the machine data which can be switched on within machining programs by G43 or G44. (= > "Fundamentals of Positioning, Reference Manual", Section 5.6 "The G Functions". This offset is added to the offset specified with mode 15 and can be called repeatedly. This allows, for example, the estimated wear on a tool to be taken into account within the machining program by setting the tool length with mode 15 and then calling the tool offset from the machine data in the machining program to make up for the tool wear.

The tool offsets executed in a machining program are not cancelled at the end of the program. They are retained just as the tool offset set with mode 15, even after the IP246 is switched off. If however new machine data are entered or the existing machine data are modified, the existing tool offset is cleared.

Each new tool offset set with BA15 overwrites the previously effective tool offset. This applies to offsets set with BA15 or switched on during a machining program.

### Special features for a rotary axis

If a tool offset of 30 degrees forwards (clockwise) is executed at position 60 degrees for a rotary axis, the actual position is then signalled as 90 degrees (tool tip), The actual traversing range is, however, still between 0 degrees and 360 degrees. The coordinate system is therefore turned. On the other hand, with a zero offset the coordinate system is transformed to a different numerical range.

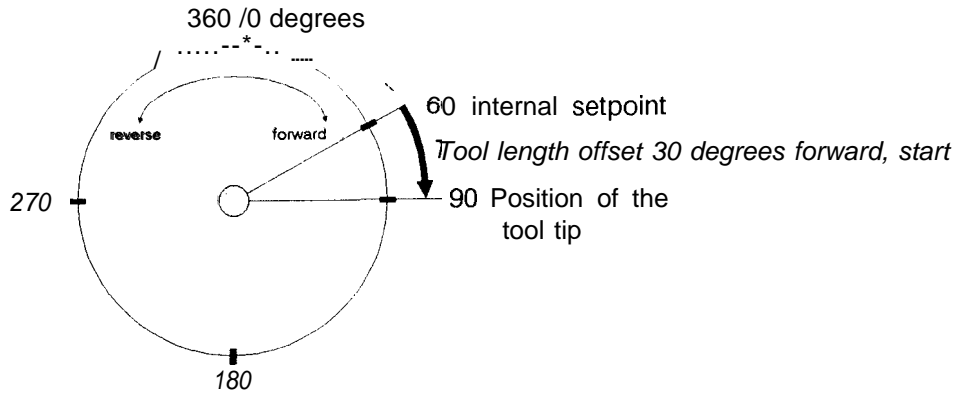


Fig. 3.13-2: Tool offset with a rotary axis

The calculation of the shortest route in the incremental approach mode is always calculated from the tool tip when a tool offset is set with a rotary axis.

#### Restrictions on tool offsets with a rotary axis

The value of the tool offset or value of the offset resulting from mode 15 and G43/G44 in a machining program must be less than the traversing range, i.e. less than the difference between

range end - range start.

If this condition is not met, either the tool offset set with mode 15 is not accepted and the error message "illegal tool offset" is signalled or the machining program is aborted with this error message.

### 3.14 Tool Offset Off (Mode 16)

When this mode is started, all tool offsets are cancelled. If you cancel tool offsets set with mode 15 using "tool offset off", you also cancel the tool offsets set in a machining program (= > "Fundamentals of Positioning, Reference Manual", Section 5.6.6 "Tool Length Offset").

### 3.15 Clear Error (Mode 17)

Error messages resulting from incorrect operation or an external event (e.g. tripping a limit switch or receiving an external stop command) remain active until they are acknowledged by entering a new operating instruction to one of the interfaces. While the error message is active, any number of monitoring commands can be sent to the module and the error will be output along with the response from the module. In the axis status "finished" you can reset the error message with the command "clear error". Only the module errors are reset (= > "Planning, Installation and Service", Section 2 "Troubleshooting").

### 3.16 Drift Compensation On/Off (Modes 18, 19)

With the “drift compensation” mode, it is possible to compensate a slight drift in the power electronics of the drive.

#### **Drift compensation is not a substitute for correct adjustment of the power unit**

The power unit must be adjusted according to the manufacturers' instructions, i.e.:

- the motor must be at a standstill when the rotary speed setpoint of 0 V is applied to the input of the power unit
- at a rotary speed setpoint of + 10 V the motor must rotate in a “forwards” direction at the rated speed
- at a rotary speed setpoint of -10 V the motor must rotate “backwards” at the rated speed.

Various influences, e.g. component tolerances or fluctuations in temperature may cause a drift even with a well adjusted power unit.

At the start of the mode, the axis must be in the “finished” status and the position control loop must be closed. After the command

“Drift compensation”; start, = > checkback signal: axis status: “running”

the following error is monitored for 4 seconds while the axis is at a standstill. The axis then changes to the “finished” status again.

The following error is proportional to the output voltage (rotational speed setpoint) and corresponds at a standstill to the drift of the power electronics. This voltage constant is permanently superimposed on the rotary speed setpoint of the position controller on completion of the “drift compensation” mode.

If the drift changes, you can correct the existing compensation value by restarting the drift compensation mode. The compensation value should never be greater than 1 V (a tenth of the maximum speed). You can compare this before executing the drift compensation. The following should be the case:

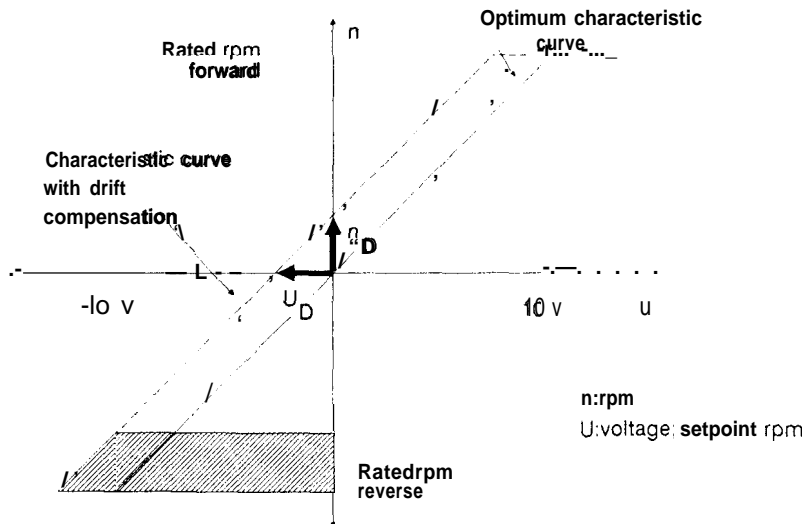
following error at standstill [mm] . gain factor [l/see]  $\leq v_{\max}[\text{mm/min}] / (60 \cdot 10)$

#### **Example:**

Drive with rated speed  $v_{\max} = 10000 \text{ mm/min}$  at +10 V input signal.  
 Displayed following error at standstill = 1 mm; at a gain (kV) factor of 16,6 l/see  
 This corresponds to a drift of approximately -1 V.

Note:

Owing to the drift, the full speed range of the drive is not longer available. In the example, a speed of only approximately -9000 rpm is achieved at an input signal of -10 V. If a traversing movement is programmed in the reverse direction at maximum speed, the following error would continually increase and the movement could be stopped by the error message "maximum following error exceeded".



The shaded area of the speed range is not available owing to the drift of the drive

Fig. 3.15-1: Drift compensation

The "drift compensation off" mode (BA19) sets the compensation voltage to 0 volts again. The command is as follows:

"Drift compensation off" ; - ; start

When setting the reference/home point, the reference/home point coordinate is assigned to the current actual position. A possible following error resulting for example from power unit drift, is not taken into account.

### 3.17 Machine Data Processing (Modes 20,21,64,67 and 68)

The concept of the IP246 is that machine data records are generated initially using the communications software COM246 at the PG. These data records are then stored as required on the IP246, in the programmer memory or on diskette/hard disk. COM246 automatically uses the modes for machine data processing and ensures that the data records are correctly edited and transferred. Working with the COM246 software is described in detail in "COM246 Communications Software, User's Guide".

Via the PC interface, you can exchange this data between the CPU and IP246 and process it in the CPU using FBI 65, The procedure is as follows:

- generate the machine data records with COM246, transfer them to the IP246, test and optimize the machine data
- save the data on diskette or hard disk using COM246
- if necessary, save the data with FBI 65 in a data block in the CPU
- if required, store the data block from the CPU in an EPROM
- if required, modify individual data for particular applications in the CPU and transfer the data record again to the IP246.

Remember that the same machine data record which you fetched from the CPU to diskette with STEP 5 is not identical to the machine data record which you transfer to diskette using the software package COM246.

The modes for machine data processing are as follows:

- BA 20 "enter machine data"
- BA 21 "delete machine data"
- BA 64 "read machine data directory"
- BA 67 "read machine data"
- BA 68 "**read machine data** overview"

### 3.17.1 Enter Machine Data (Mode 20)

Using this mode a complete machine data record is transferred via the PG interface or PC interface to the IP246. COM246 uses mode 20 indirectly when the appropriate function key is pressed. If you transfer a machine data record from the CPU to the IP246, you must assign parameters to FB165 as described in "Standard Function Blocks FB164 and FB165, User's Guide", Section 3 "Standard Function Block FB165".

You can only enter machine data when

- the machine data record to be entered has the same module number as the SYSID (module identifier). Otherwise you must first run through mode 24 "enter SYSID" (=> Section 3.19 "Enter SYSID")
- the axis for which the data are to be transferred is in the "finished" status,

A machine data record can only be transferred via the corresponding interface (axis) to the IP246.

After the transfer, the IP246 checks the consistency of the machine data. If the machine data are correct, they are indicated as "existing" in the checkback signals and the digital output "FUM" is set.



If an error is detected in the machine data, the data record is marked by the IP246 by entering an error number. The functional signal is then reset and 0 V or a previously calculated compensation voltage is output at the analog output,

The error number and corresponding error text are displayed in the error message line of COM246 on the PG. Via the PC interface the error number can be evaluated by reading the machine data (BA67) or by reading the machine data overview (BA68).

If the machine data are changed, the position setpoint is set to the actual position value to allow a bumpless transition.

Note:

If the positioning module is removed from the programmable controller, the machine data stored on it are lost (battery back-up via the programmable controller). A reference/home point is also lost.

Each time machine data are entered, zero offsets and tool offsets are reset.

If a machine data record is deleted, the reference/home point remains set in the checkback signals. After entering a machine data record, the reference/home point is not lost if the machine data listed below have not changed from those of the old data record. The following data are relevant:

- number of encoder revolutions (only with the absolute version),
- steps or pulses per encoder revolution,
- distance per encoder revolution,
- reference direction (only with incremental version) and
- the pulse evaluation (only with incremental version).

### **Additional information about the absolute version of the IP246**

With the absolute version of the IP246, the position encoder signal belonging to the home point is automatically entered in the machine data record on the module following each "set home point". If you save this machine data record on diskette, hard disk or in the PC, you can re-establish the calibration of the axis by transferring the machine data record to the module. Note the conditions explained in Section 3.4.3 "Special Features when using Absolute Position Encoders".

If you change machine data, you must make sure that the actual position of the axis remains within the traversing range between the software end limit switch and software start limit switch or at least within the usable range (= > "Fundamentals of Positioning, Reference Manual", Section 4.3 "Traversing Range").

If the position of the axis is outside the usable range after changing the machine data

- software start limit switch,
- software end limit switch or
- reference/home point

then this point cannot be assigned a unique absolute coordinate, The module reacts with the error message “actual value not clear” and deletes the home point on the module (checkback signal “reference point missing”). The home point remains entered in the machine data record.

If the absolute position encoder is exchanged for a position encoder with the same “number of revolutions” and the same “number of steps per encoder revolution”, you must recalibrate the axis using mode 5 “set home point” or adjust the position encoder exactly as the first one. If the axis is started up without recalibrating it or without adjusting the zero point, no correct actual positions will be detected. A stored machine data record containing the home point must not then be used, since the relationship between the coordinate of the home point and the encoder reading at the home point as contained in the data record is incorrect, You can only delete a valid home point in the machine data record using COM246 by outputting the machine data record from the IP246 and changing one of the machine data:

- “number of encoder revolutions”
- “steps per encoder revolutions” or
- “distance per encoder revolution”

and writing the modified data record back to the IP246.

### 3.17.2 Delete Machine **Data (Mode 21)**

This mode is used to delete a machine data record on the IP246. The axis involved must be in the “finished” status. COM246 uses this mode when the appropriate function key is pressed. Using FB165 via the PC interface you can also delete a machine data record. To do this, the mode must be triggered by FB165 via the axis interface.

For more detailed information, refer to the description of FB165 in “Standard Function Blocks FB164 and FB165, User’s Guide”, Section 3 “Standard Function Block FB 165”.

### 3.17.3 Read Machine Data Directory (**Mode 64**)

In this mode, you obtain information from the IP246 about

- the machine data records stored on the IP246 and
- the axis for which the records are valid.

The information for both axes is made available simultaneously. COM246 uses this mode with the “information function”. If a destination data block is set up in the PC in which the information can be entered, you can read the machine data directory using FBI 65 via the PC interface.

For more detailed information, refer to the description of FB165 in “Standard Function Blocks FB164 and FB165, User’s Guide”, Section 3 “Standard Function Block FB165”.

#### 3.17.4 Read Machine Data (Mode 67)

With the “read machine data” mode, a machine data record is transferred from the IP246 either to the CPU or using COM246 to the PC or to diskette/hard disk. COM246 uses this mode when the appropriate function key is pressed. With FBI 65, you can transfer a machine data record via the PC interface to the CPU. When doing this, you must remember that the machine data record

- must be transferred via the axis interface and
- must be entered in an adequately long destination data block set up in the CPU

You should use this mode to save machine data in the CPU. Only in this way can you exchange a module without using the PG.

For more detailed information about mode 67 refer to “Standard Function Blocks FB164 and FB165, User’s Guide”, Section 3 “Standard Function Block FB165”.

#### 3.17.5 Machine Data Overview (Mode 68)

Using this mode you can read the following information about the machine data on the IP246 from the PC side:

- the machine data number of the data record,
- the module number for which the data record is intended,
- the axis number for which the data record is intended,
- the length of the data record in words and
- the machine data errors.

The overview is transferred simultaneously for both module axes. You must first set up an adequately long destination data block in the CPU.

For more detailed information, refer to “Standard Function Blocks FB164 and FB165, User’s Guide”, Section 3 “Standard Function Block FB165”.

### 3.18 Executing Machining Programs (Modes 22,23,65 and 69)

The concept of the IP246 allows machining programs to be created easily using the communications software COM246 on the PG. These data records are then stored as required

- on the IP246,
- in the programmer memory or
- on diskette/hard disk.

COM246 automatically uses the modes for executing machining programs and makes sure that the data records are correctly edited and transferred. Working with COM246 is described in "Communications Software COM246, User's Guide".

You can also exchange and process data with FB165 between the CPU and IP246. To do this, proceed as follows:

- create a machining program with COM246, transfer it to the IP246 and test it,
- save the data on diskette or hard disk using COM246,
- if necessary, save the data in a data block in the CPU using FBI 65,
- if required, store the data block from the CPU in an EPROM,
- if necessary, change the individual data in the CPU for the particular application and transfer the data record to the IP246 again.

Remember that a machine data record written to diskette from the CPU using STEP 5 is not identical to the machine data record transferred from the IP246 to diskette using COM246.

The modes for executing machining programs are as follows:

- BA 22 "enter machining program"
- BA 23 "delete machining program"
- BA 65 "read machining program directory"
- BA 69 "read machining program"

#### 3.18.1 Enter Machining Program (Mode 22)

In this mode, a complete machining program is transferred to the IP246 via the PG or PC interface. COM246 uses mode 22 indirectly if the corresponding function key is pressed. If you transfer a machining program from the CPU to the IP246, FB165 must be assigned parameters as described in "Standard Function Blocks FB164 and FBI 65, User's Guide", Section 3 "Standard Function Block FB164".

The structure of machining programs is described in “Fundamentals of Positioning, Reference Manual”, Section 5 “Machining Programs and their Structure”.

Since machining programs are not axis related, it does not matter which interface (axis) is used to transfer the program to the module.

Machining programs are stored one after the other in the memory of the IP246 in the order in which they are entered. A maximum of 255 machining programs can be stored on the module. The total number of characters is limited to 10000.

Requirements for the transfer of machining programs areas follows:

- the axis whose interface is to be used to transfer the program must be in the “finished” status,
- the machining program number must not exist on the IP246. It is not possible to overwrite a program from the PC side. The old program must be deleted first with BA23 (“delete machining program”),
- there must be adequate space in the machining program memory of the IP246. (See note in Section 3,18.2, “Delete Machining Program”).

If you wish to execute a machining program after it has been created in the CPU, proceed as follows:

- create a machining program in DIN representation with COM246. Fill in the input values with blanks up to the maximum number of input characters (token characters). Having done this, it is easy to change the machining program in the CPU at a later time,
- transfer the machining program to the IP246,
- read the machining program with mode 69 using FBI 65.

The program structure is now set in the CPU data block. You can modify individual parameters in the ASCII format.

- delete the machining program on the IP246 with FB165,
- enter the machining program to the IP246 using FBI 65 with mode 22.

**Note:**

If the program is extended during the modification, you must update the program length in the header information, otherwise the entry of the program is aborted with an error!

If a machining program is created with COM246, the machining program can only be transferred to the module if it is syntactically correct. The syntax check is made by COM246. If, however, the machining program is transferred from the CPU to the IP246, the program is checked for syntactical errors by the firmware on the IP246. If an error occurs, the module error “machining program error” is set. The machining program error itself is written in the machining program header in DW n +3 ( = > “Standard Function Blocks FB164 and FB165, User’s Guide”, Section 3.8.2 “Structure of the Machining Program DB in the PC Memory”). A machining program marked as containing errors is not listed in the machining program directory. It cannot be edited using the software package COM246.

If an error is detected, you must proceed as follows:

- read the machining program with mode 69 (“read machining program”) from the IP246 to the PC memory,
- locate the machining program error in the program and correct it,
- delete the program on the IP246 with mode 23(“delete machining program”),
- transfer the program to the IP246 again using mode 22 (“enter machining program”)

When a machining program is created using the software package COM246, a syntax check is carried out. Whether or not the program is consistent with the machine data can however only be determined when the program is executed.

### 3.18.2 Delete Machining Program (Mode 23)

Using this mode, a machining program is deleted from the IP246 memory, The job is either triggered using FB165 via one of the two interfaces or by the software package COM246 by pressing the delete key < F5 > ( => “Communications Software COM246, User’s Guide”, Section 10 “Delete”). The following requirements must be met:

- the axis of the selected interface is in the “finished” status,
- the program to be deleted is not currently being executed.

If a program is deleted from the program memory of the IP246 while the IP246 is operating (“automatic” or “automatic single statement”) a gap may result in the memory area of the IP246 You will then receive the error message “machining program only cleared from directory”. This gap can be closed both with COM246 or by the PC as follows:

- read the machining program directory (BA65) from the IP246,
- save the first program on diskette, hard disk or using mode 69 (“read machining program”) in the CPU,
- delete this program on the IP246 with mode 23, The memory of the IP246 is then compressed,
- transfer the saved program to the IP246 again using mode 22 (“enter machining program”). The program now appears last in the machining program directory,

While the memory is being compressed make sure that neither of the axes is executing a machining program (“automatic”, “automatic single statement” or “teach-in”). If one of these modes is being executed, only the memory area after the program currently being executed will be compressed and no new memory space will be made available.

### 3.18.3 Machining Program Information (Mode 65)

With this mode, using **FB165**, you obtain a listing of all the machining programs contained on the **IP246**. The machining program number and length of the programs in words is output. **COM246** also uses this mode in the "information function" (= > "Communications Software **COM246**, User's Guide", Section 11 "Information"). Here, however, the length of the machining programs is shown in bytes.

Since machining programs are not axis related, the machining program directory can be read out by the PC interface via either of the axes. The only condition is that the destination data block is sufficiently long.

The programs are

- listed in the order in which they are entered and
- entered without gaps in the destination data block.

For more detailed information, refer to the description of **FB165** in "Standard Function Blocks **FB164** and **FB165**, User's Guide", Section 3,8.5 "Structure of the Machining Program Directory")

### 3.18.4 Read Machining Program (Mode 69)

With the mode "read machining program", a complete machining program is transferred from the **IP246** to the CPU. **COM246** uses this mode indirectly if the appropriate function key is pressed. Via the PC interface, the transfer is made with **FB165**. The transfer can be made via either of the interfaces. The only condition is that the destination data block in the CPU is of adequate length.

When outputting a machining program, the **IP246** adds information in the header. This includes the following:

- the length of the program in words,
- the data block number of the machining program on the **IP246** (identical to the machining program number),
- if applicable, the machining program error number and
- if applicable, the number of the statement in which the error was recognized

Following this, the machining program is output in **ASCII** characters.

### 3.19 Enter SYSID (Mode 24)

With mode 24 (SYSID input), a module identifier (SYSID) is entered on the IP246. This is necessary when a module has been exchanged before transferring machine data.

When operating the IP246 using COM246, the SYSID input does not appear directly, It is triggered when you press < F1 > (begin) in the presetting mask (= > "Communications Software COM246, User's Guide", Section 4 "Start COM246"). The data entered and displayed in the presetting mask are then written to the module.

From the PC side you can execute this mode with FBI 65 via both interfaces,

The module identifier consists of the following elements:

- Module type:

The type consists of the characters "IP246I" to indicate the incremental version of the IP246 or the characters "IP246A" for the absolute version. The module type cannot be changed.

- Version:

This indicates the firmware version. For example, A02.I for firmware version 2.1. It consists of five characters and cannot be changed,

- Module number:

This is a number between 0 and 99 which you assign to differentiate between positioning modules. The same number must also be entered in the machine data of the axes,

**Note:**

The module number can no longer be changed once a correct machine data record (MD) exists on the module. If you attempt to change this number, the error "correct MD module number cannot be changed" is output.

- Slot number:

This number can be selected between 0 and 255. It is only used for documentation.

- Page number:

The page number can be selected between 0 and 255 and is simply used for documentation. The page address set on the module can be entered here (= > "Hardware, Instructions", Section 3.2 "Setting the Module Address"). The number can then be read at the programmer without having to remove the positioning module from the PC. No check is made as to whether the page address on the module is the same.



### 3.20 Read **SYSID** (Mode 70)

Using mode 70 (read **SYSID**), you can read the module identifier of the IP246 using FB165. This is possible via both interfaces. The parameters are explained in the previous section.

For more detailed information about calling mode 70 refer to the description of FB165 in "Standard Function Blocks FB164 and **FB165**, User's Guide", Section 3.8.3.1 "Read **SYSID**".

**COM246** starts "read **SYSID**" when you press c F2 > (ONLINE-OFFLINE) in the presetting mask. The data read are then displayed in the appropriate fields (= > "Communications Software **COM246**, User's Guide", Section 4 "Start **COM246**").

## 4 Description of the Individual Monitoring Modes

Using the monitoring modes, you can call current information from the module. The monitoring modes are as follows:

| Mode number | Type                  | Execution with |
|-------------|-----------------------|----------------|
| 66          | Read actual values    | FB165          |
| 71          | Actual position value | FB164          |
| 72          | Following error       | FB164          |
| 73          | Distance to go        | FB164          |
| 74          | Monitoring off        | FBI 64         |

The monitoring modes do not appear directly on the PG interface. They are used internally by the COM246 software package.

Monitoring modes do not influence the operating mode and can be executed at any time regardless of the axis status,

On the PC interface, the monitoring modes 71, 72 and 73 are started with FB164, the monitoring mode 66 is started with FB165.

Function block FB164 continues an activated monitoring function (71, 72, 73) periodically. You can stop these monitoring functions with mode 74,

In contrast, mode 66 "read actual values" supplies all three actual values simultaneously using FB165. These are stored in the destination data block (= > "Standard Function Blocks FB164 and FB 165, User's Guide", Section 3.8,6 "Occupation of the Data Area when reading Actual Values").

For more detailed information about the monitoring modes, refer to the description of function blocks FB164 and FB165 in the above publication.

# SIEMENS

## SIMATIC S5

IP246 Positioning Module

Incremental 6ES5246-4UA31 / -4UA41

Absolute 6ES5246-4UB11 / -4UB21

Communications Software COM 246

User's Guide

C79000-B8576-C654 -02

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## 1 Introduction

The programming package COM246 which runs on the PG, provides you with user-friendly support for programming and starting up the IP246. All the functions are executed by means of dialog displays (input fields) and function keys.

If machine data or machining programs are created for the IP246, the data can be stored on the programmer (PG), on the module (IP246) or on a floppy or hard disk (FD).

The COM246 software package is started by selecting the package from the Komi (command interpreter). At the Komi level, a brief description of COM246 can be displayed by pressing function key < F3 >. By pressing < F1 >, COM246 is loaded and the first mask, the configuration mask, is displayed. This displays the logo of COM246. The module version must be entered in an input field. The two possibilities (absolute or incremental version) can be selected using the help key < F7 >. The COM246 version and the serial number are displayed, From this mask you branch to the presetting mask with < F1 > (START),

In the presetting mask, you must select the drive on which the data blocks are to be read and saved. The drive can be selected using the help key < F7 >. Again using < F7 >, you can select files on the previously selected drive. If there is no file on the selected drive, the name of a new file must be entered here. In addition to the file name, the fields "plant designation" and "generated by" must be completed. After entering this data, you can change to the next mask with function key < F1 > (BEGIN), On the selected drive, a file with the required file name is then generated. The documentary information "plant designation" and "generated by" are saved in the file. If the specified file does not, however, exist, the fields are completed with the stored information.

Using < F2 > (ONLINE-OFFLINE) you can set the operating mode. The two possible modes are online and offline. Online, the mode "SYSID output" (BA 70) is executed and the fields with the module data of the IP246 are completed. The date and time are read from the hardware clock in the PG and entered in the fields "date-time". The date and time can still be manipulated. Changes are, however, not transferred to the hardware clock of the PG. If the hardware clock is wrong, it must be set with the PCP/M-86 program "date" at the operating system level.

By pressing < F1 > (BEGIN) you branch to the basic mask. This mask always indicates the version of the module (absolute or incremental). In the online mode, the operating mode "SYSID input" (BA 24) is executed when you change to the basic mask. The module data, module number, slot number and page address are transferred to the IP246. The slot number and page address are only used for documentation. The module number, on the other hand, can only be changed when there are no machine data on the IP246. If there are machine data on the IP246, whose module number is not identical with the entry "module no.", the error message "wrong module number" is displayed in the error line.

Using the function keys, machine data and machining programs can now be entered, output, modified, deleted or transferred. Test functions can be executed with the function key < F3 > (TEST).

Remember that the following limits apply to files:

maximum number of machining programs per file: 250

maximum number of machine data per axis and file: 16

maximum number of files which can be selected in the presetting mask with < F7 > : 32

The interactive dialog masks of COM246 include the following elements:

- . fixed texts,
- input fields and
- . output fields.

The masks are largely self-explanatory. It is, however, advisable to have the User's Guide at hand until you are completely familiar with them. The User's Guide contains descriptions of the masks and explains the significance of the input and output fields. The function keys for each mask are explained.

Entries are made in the input fields of the masks via the alphanumeric keyboard or using function keys (help function). These fields are displayed on the screen inversely, in this description they have a grey shaded background. The menu line of each mask is also on a grey shaded background, however, there are no input fields.

Output fields in the masks are used to display COM246 statuses and parameters. Outputs appear on the screen as fixed text. In the following description, they are shown in boxes with a broken line.

In all the masks explained in the following sections, the input fields are already completed with typical values. The output fields also have values entered. These are in some cases fixed for the particular mask (operating status) or may change according to the previous entries (parameters).

By pressing the RETURN key, you jump to the next input field. To edit within the input fields, use the arrow keys.

Error messages from the IP246 and from COM246 are always displayed in the last line (error message line). In column 1, the identifier for the current axis is displayed, followed by the character | and a blank. A O in column 1 stands for a general message. The error message is then output preceded by the error code. From column 60 onwards the error codes of the two axes are once again displayed (axis 1, axis 2).

Example:

```
1 |F8A reference point missing F8A FOO
```

The message has the following significance

**1|**: the current axis is axis 1,

**F8A** reference point missing: axis 1 is not calibrated,

**F8A-FOO**: axis 1 is signaling the module error 8A, axis 2 is not signaling a module error,

|                      |               |                        |              |                     |          |            |        |
|----------------------|---------------|------------------------|--------------|---------------------|----------|------------|--------|
| INPUT                |               | MOOUL                  | INCR         | SIMATIC S5 / COM246 |          |            |        |
| MACHINE DATA         |               | DEVICE                 | IP246        | BLOCK               | DB       | 1 2 3      |        |
| Module :             | 11            | Axis :                 | 1            | Meas. system :      | mm       | Axistype : | LINEAR |
| Maximum deceleration | 9 0 0 0       | [mm/sec <sup>2</sup> ] |              | (10...9999)         |          |            |        |
| Acceleration fwd.    | 1000          | [mm/sec <sup>2</sup> ] |              | (10...9999)         |          |            |        |
| Deceleration fwd.    | 1000          | [mm/sec <sup>2</sup> ] |              | (10...9999)         |          |            |        |
| Acceleration rev.    | 1500          | [mm/sec <sup>2</sup> ] |              | (10...9999)         |          |            |        |
| Deceleration rev.    | 1500          | [mm/sec <sup>2</sup> ] |              | (10...9999)         |          |            |        |
| F1                   | F2            | F3                     | F4           | F5                  | F6       | F7         | F8     |
| NEXT PAGE            | PREVIOUS PAGE |                        | PRINT M.DATA |                     | TRANSFER |            | EXIT   |

1 = header  
2 = softkeys

= input field

[ ] = output field

Fig. 1-1: Mask for entering machine data

The masks are structured so that you can always recognize the current operating status. At the top left INPUT and below this MACHINE DATA may be displayed. This shows that the current function involves input of machine data. In the output field MODUL the previously selected version of the module (incremental or absolute) is displayed, the DEVICE output field displays the target device and the BLOCK field displays the DB no. for these machine data. The output fields module, axis, meas. system and axis type indicate the values from the previous mask.

The actual machine data can now be input in the five input fields (shown on a grey background)

Travel data, speeds and rates of acceleration always refer to the measuring system selected in the machine data record. The appropriate dimension is therefore always displayed following input fields (e.g. for machine data input) and output fields (e.g. actual position value of the axis),

Using the function keys <F1> and <F2> further machine data pages can be called. With function key <F4> the machine data can be printed out on a connected printer. By pressing function key <F6> the machine data are transferred to the selected device. <F8> brings you back to the basic menu without transferring the machine data.

## 2 Definition of Terms

|                   |                                                                                                                                                                                                                                                                                                                                     |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pc :              | programmable controller for SIMATIC S5                                                                                                                                                                                                                                                                                              |
| Operating system: | COM246 runs under the operating system S5-DOS. Remember that S5-DOS itself consists of the operating system PCP/M-86 and the additional functions provided by the ZEFU diskettes. These functions are activated with "S5" The operating system is not supplied with COM246 and must be ordered separately if not already available. |
| CO M246:          | programming package for user-friendly operation of the intelligent I/O module IP246.                                                                                                                                                                                                                                                |
| Function key:     | in the programming package COM246, function keys are the eight keys immediately below the screen indicated by < F1 >... < F8 > .                                                                                                                                                                                                    |
| IP246:            | intelligent I/O module of the SIMATIC S5 range. With this module, you can operate two independent axes.                                                                                                                                                                                                                             |
| Mask:             | the display used for input and output of data on the monitor.                                                                                                                                                                                                                                                                       |
| Menu:             | inverse display of function keys < F1 >... < F8 > and a text to indicate the function currently assigned to this key.                                                                                                                                                                                                               |
| PG:               | programmer for SIMATIC S5 (e.g. PG635, PG675, PG685, PG695 and PG750).                                                                                                                                                                                                                                                              |

In this User's Guide, the following conventions have been used for all commands entered at the programmer:

- The equality sign ( = ) at the start of a line indicates the beginning of a new activity
- The greater than character ( > ) at the start of a line indicates a keyboard input.
- Keyboard inputs start with the character displayed by the currently active program as a system prompt. This is followed by the characters to be input shown in bold upper case characters.
- < CR > stands for carriage return.
- < F1 > < F8 > stand for the function keys F1 F8



## 3 Getting Started

### 3.1 Consignment

Under the order number 6ES5 895-5 SA22, the manual includes, among other things, this User's Guide, a 5 1/4 inch diskette and a 3 1/2 inch diskette with the file:

S5PDC09X.CMD

The software package COM246 runs under the operating system S5- DOS, which is not part of the consignment.

### 3.2 Setting the Configuration Register

If the operating system S5-DOS has never run on your PG, you must set the configuration register of the PG using the test diskette. You must enter the memory capacity, the drive configuration and other important PG characteristics in the configuration register to be able to inform various programs (e.g. S5-DOS) of the hardware configuration. To set the configuration register, you must insert the test diskette supplied with the PG in drive A: and start the PG either by turning on the power or by using the key switch. Answer the prompt "CHANGE CONFIGURATION?" with "Y" and then mark the appropriate information with "+" and the incorrect information with

"-". Once you have answered all the questions, you can remove the test diskette and continue with PCP/M after a cold restart. The content of the configuration register is retained even when power is switched off.

### 3.3 Working Copy of the COM246 Diskette

Before you use the COM246 diskette, you should make a working copy and put the original away for safekeeping. To make a copy, use the PCP/M utility "DSKMAINT", with which you can check, format and copy diskettes.

#### 3.3.1 Programmers with one Floppy Disk Drive (PG685)

- = PCP/M system diskette"1 of n" in drive A:
- = Start the PG by turning on the power or using the keyswitch
- > A > **DSKMAINT** <CR >
- = New diskette in drive A:
- > < F5 > < F1 > **Y** < **F8** >
- = COM246 diskette in drive A:
- > < F3 > < F1 >

- = Formatted diskette in drive A:
- > < F1 > Y
- = Insert the diskettes required by DSKMAINT in drive A; the COM246 diskette is the source diskette and the newly formatted diskette is the target diskette.
- > < F8 > < F8 >

### 3.3,2 Programmers with two Floppy Disk Drives (PG675, PG635)

- = PCP/M system diskette"1 of n" in drive A:
- = Start the PG by turning on the power or using the keyswitch
- > A> **DSKMAINT** <CR >
- = New diskette in drive A:
- > < F5 >< F1 > Y < F8 >
- = COM246 diskette in drive B:
- > < F3 > < F3> < F1 > Y
- > < F8 > < F8 >

## 3.4 System Configuration

### 3.4.1 Programmers without a Hard Disk (PG675, PG635)

To work with COM246 effectively, it is advisable to create a system diskette on which all the required programs are available, i.e. programs from the software package "PCP/M" should be copied to one diskette:

- = PCP/M system diskette"1 of n" in drive A:
- = Start the PG by turning on the power or using the keyswitch
- > A > **DSKMAINT** <CR >
- = New diskette in drive B:
- > < F5 > < F3 > Y < F8 > < F8 >
- > A> **PIP** <CR>
- > **\*B: = PCPM.SYS[RV]** <CR>
- > **\*B: = CCP.CMD[RV]** <CR >
- = ZEFU diskette"3 of n" in drive A:
- > **\*B: = S5WX200X.CMD[RV]** c CR >
- > **\*B: = S5WX201X.CMD[RV]** <CR >
- > **\*B: = S5WX202X.CMD[RV]** < CR >
- > **\*B: = S5WX204X.CMD[RV]** < **CR** >
- > **\*B: = S5WX000H.CMD[RV]** <CR >
- > **\*B: = S5WX100X.CMD[RV]** <CR >
- > **\*B: = S5KDS02X.CMD[RV]** <CR >
- > **\*B: = S5.CMD[RV]** <CR >
- > \* < CR >

This diskette now contains the operating system "PCP/M" and all the S5-DOS programs you require to work with COM246. If this system diskette is correct, you should make it read-only by

placing a tab over the notch, since you should only read from this diskette when working with COM246. To avoid having to repeat this operation if the diskette is damaged or lost, you should make a copy of this diskette and keep it in a safe place.

Apart from the system diskette, you also require the COM diskette with the COM package which will later also contain the machine data and machining programs in the form of data blocks. You create this diskette by formatting a new diskette (DSKMAINT). Following this, the COM package can be copied to this diskette.

```

= PCP/M system diskette"1 of n" in drive A:
> A> PIP <CR>
= Newly formatted diskette in drive B:
= COM246 diskette in drive A:
> *B: =S5PDC09X.CMD <CR>
> * < CR >

```

With the PG635, the procedure is analogous depending on the S5- DOS release.

### 3.4.2 Programmers with a Hard Disk (e.g. PG685)

Programmers with a hard disk have the advantage that almost all programs and data can be accessed directly owing to the high capacity of the hard disk. This means that several SIMATIC program packages can be located simultaneously on the same data medium.

#### 3.4.2.1 Installing PCP/M

If your programmer is new and PCP/M is not yet installed, you must first format the hard disk with the PCP/M utility "HDFORM6" (see PCP/M User's Guide, page 6-29).

#### Note:

From issue 1.0/5 (1.0/6 for PG695)HDFORM6 has been replaced by HDPARTY. Please refer to the manual for further information.

#### Caution!

When formatting the hard disk, all programs and data already on the disk are lost!!

```

= PCP/M system diskette"1 of n" in drive A:
= Start the PG by turning on the power or using the keyswitch
> A> HDFORM6 <CR >
= Enter the disk capacity, e.g. 12 MBytes
> 12
> Y

```

**Note:**

If your programmer has one floppy disk drive, the hard disk has the logical name "B". The operating system displays the prompt "B >".

Next, the programs on the PCP/M diskette must be copied to the hard disk, as follows:

```
= PCP/M system diskette"1 of n" in drive A:
= Start the PG by turning on the power or using the keyswitch
> A> PIP <CR>
> *B: = *.* < CR >
```

If PCP/M was supplied on more than one diskette, the programs from the other diskette should also be copied to the hard disk:

```
= Next PCP/M diskette in drive A:
> *B: = *.* < CR >
```

After copying the last diskette, press < CR >, to complete the copying program "PIP", Now that all the PCP/M system programs are on the hard disk, this can be selected as the default drive:

```
> A>B: < CR>
```

The operating system now searches for all programs on the hard disk, unless a floppy disk is specified explicitly.

To avoid the programs being deleted accidentally, and to make them accessible from all user areas, assign the "read-only" (RO) and "system" (SYS) attributes using the "SET" utility as follows:

```
> B > SET B:*.*V[RO SYS] <CR>
```

### 3.4.2.2 Installing COM246

The following description assumes that S5-DOS is installed on your PG. If this is not the case, please read the section "installing PCP/M".

To install COM246 on the hard disk, you simply copy the file S5PDC09X.CMD on the supplied COM246 diskette to the hard disk and assign the attributes "RO" and "SYS" to it,

```
= Start the PG by turning on the power or using the keyswitch without a diskette in the drive
= COM246 diskette in drive A:
> B > PIP B: =A:S5PDC09X.CMD <CR >
> B > SET B: S5PDC09X.CMD [RO SYS] <CR >
```

## 4 Starting COM246

The following description assumes that you have made the preparations described in "System configuration" (you have created a system diskette or installed COM246 on the hard disk).

With PGs without a hard disk, the prepared system diskette is inserted in drive A and the data diskette in drive B

With PGs with a hard disk, drive A: must not have a diskette inserted

Start the PG by turning on the power or using the keyswitch

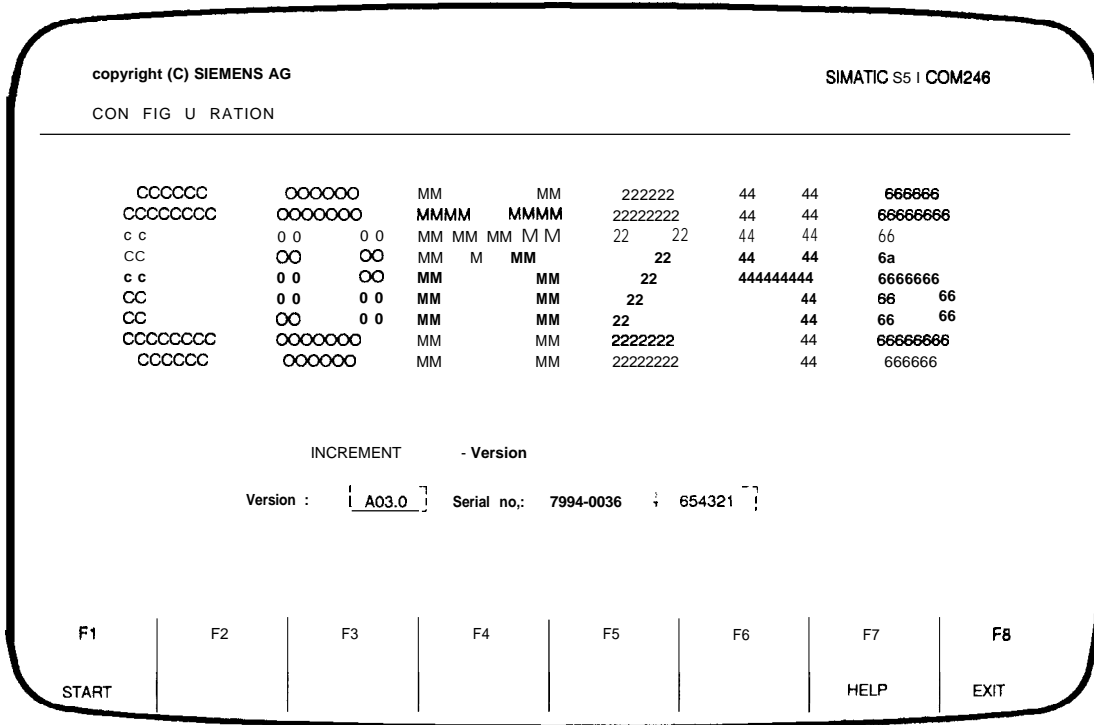
The S5 call loads the KOMI in the working memory of the PG. While this is being loaded, the KOMI mask appears as shown below:

```

.....
SIMATIC S5 S5 - Komi
Serial-No.: xxx-yyy-zzzzzz All rights reserved
Copyright (c) 1986 SI EM ENS AG
.....

```

In the "PACKAGE SELECTION" menu, you can now select the required program, in this case COM246, by moving the cursor with the arrow keys. If you then press < F1 > (PACKAGE) this program is loaded from mass memory. Once the package is loaded, the first COM246 mask, the configuration mask, appears.



= input field      = output field

Fig. 4-1: Configuration mask

This mask displays the COM246 logo and the version and serial number of COM246. You must now decide whether you wish to operate an incremental or an absolute version of the IP246.

**Description of the input fields**

Version:

Using the help key, you must select the module version, i.e. ABSOLUTE or INCREMENT. This selection is then valid for all following operations.

Description of the output fields

Version:

This field displays the version of COM246

Serial number:

Each diskette has a serial number which is displayed in this field.

**Significance of the function keys**

< F1 > : With function key < F1 > (START) you branch to the next mask, the presetting mask.

< F8 > : With this key you exit COM. You will be prompted to confirm that this is your real intention.

| PRESETTING        |                | MODUL | INCRE | SIMATIC S5 / COM246 |                |      |      |
|-------------------|----------------|-------|-------|---------------------|----------------|------|------|
| Drive             | A              |       |       |                     |                |      |      |
| Filename          | EXAMPLE        |       |       |                     |                |      |      |
| Plant designation | LINEAR AXIS    |       |       |                     |                |      |      |
| Generated by      | SMITH          |       |       |                     |                |      |      |
| Generated on      | 12.06.89       |       |       |                     |                |      |      |
| Mode              | ONUNE          |       |       |                     |                |      |      |
| Module no.        | 11             |       |       |                     |                |      |      |
| Slot no.          | 001            |       |       |                     |                |      |      |
| Page address      | 000            |       |       |                     |                |      |      |
| Firmware          | IP246I         | A02.1 |       |                     |                |      |      |
| PG date - time    | 15             | 09    | 89    | 12:23               |                |      |      |
| F1                | F2             | F3    | F4    | F5                  | F6             | F7   | F8   |
| BEGIN             | ONLINE-OFFLINE |       |       |                     | PRINTER PARAM. | HELP | EXIT |

= input field      = output field

Fig. 4-2: Presetting mask

### Description of the output fields

PRESETTING is displayed in the header and the version of the module ("INCRE" or "ABSOL") is displayed in the output field MODUL.

Generated on:

This field displays the date on which the selected file was created, if it already exists. If you create a new file, the current date from the internal PG clock will be used as the generation date.

Mode:

The mode selected with < F2 > ONLINE or OFFLINE is displayed here.

Firmware:

Immediately after "Firmware", the version of the module is displayed. "IP246I" stands for the incremental version and "IP246A" for the absolute version". The next output field displays the version of the firmware.

## Description of the input fields

Each module has several characteristics (SYSID), some of which cannot be changed and some of which can be selected. There are other characteristics which must be set, such as the module number, and some which can be set. The latter are mainly of a documentary nature and are not checked.

### Drive:

Here, you specify the drive in which the user data diskette is to be inserted. With the PG685, the data can, of course, be stored on the hard disk. In this case "B" must then be selected.

### File name:

The file name identifies the file in which the data blocks are stored (here, EXAMPLE), This allows you to assign different files to different projects or plant sections. Using the help key, it is possible to display all the files on a current drive with the file type .246 for the incremental version or .A46 for the absolute version. As you page through the file names, the "plant designation", "generated by" and "generated on" are updated.

### Plant designation:

In this field you can select a brief designation for the plant for which the data blocks are intended (here, LINEAR AXIS). This designation is written into the file header. This field must be completed, otherwise the error message "inadmissible input" is displayed.

### Generated by:

As in the plant designation field, the name of the operator (here, SMITH) can be saved in the file. Once again this field must also be completed,

### Module no.:

This is a number between 0 and 99 which you can specify to distinguish between various positioning modules. A module number is also entered in the machine data records. If there are already machine data on the module, the module number entered here must be identical to that contained in the machine data records. This means that the module number can no longer be changed if one correct machine data record already exists on the module. (Only possible online.)

### Slot no.:

You can also assign this number as required, between 0 and 255. The number is simply for documentation. (Only possible online.)

### Page address:

The conditions for this are the same as for the slot number. The page address set on the module can be read more easily at the PG than by reading the switch on the positioning module itself (only possible online). Differences between the switch setting and the entry made here are not checked.

### Date - time:

The internal PG date and time are displayed here. if you modify anything in these fields, this is taken as a date and time change and the software clock of the PG is set to these values.



**Note:**

After switching off the PG, this setting is lost. The hardware clock can only be set at the system level.

**Significance of the function keys**

- < F1 > : With BEGIN, you branch to FUNCTION SELECTION and providing ONLINE is set, the presets (module number, slot number, page address) are written to the module. These values **are**, however, only accepted by the module when either no correct machine data are stored on the module or the module number is identical to the module number in the machine data (= > "Functions, Reference Manual", Section 3.19 "SYSID Input").
- < F2 > : This key switches from OFFLINE to ONLINE and vice-versa. If you switch to ONLINE, the values on the module "module number", "slot number", "page number" and "firmware release" are read ( = > "Functions, Reference Manual", Section 3.20 "Read SYSID") and displayed in the mask. OFFLINE, these fields are deleted. With the incremental version of the IP246 a correct actual value display in "test" is only guaranteed when the module does not start up again after selecting "online" (power off/on). Following a warm restart of the module <F1> (BEGIN) must be pressed again.
- < F6 > : Branch to the printer parameter mask. Declaration of control character sequences
- < F7 > : Help key to select possible drives and file names contained in them.
- < F8 > : With the EXIT key you return to the configuration mask,

## 5 Function Selection

By pressing <F1> (BEGIN) in the presetting mask, you branch to "function selection".

The presets are displayed once again. The fields are, however, no longer output fields, i.e. you cannot change the displayed values. From this mask you branch to the individual functions. If you terminate a function with the EXIT key you always jump back to this mask.

The screenshot shows a terminal window titled "FCT SELECTION". At the top right, it displays "MODUL : INCRE" and "SIMATIC S5 / COM246". The main area contains several data fields with their values: Drive (A), Filename (EXAMPLE), Plant designation (LINEAR AXIS), Generated by (SMITH), Generated on (15 09 89), Module no. (11), Slot no. (001), Page address (000), Firmware (IP246I), and PG date time (15 09 89 - 12:23). At the bottom, there is a row of function keys: F1 (INPUT), F2 (OUTPUT), F3 (TEST), F4 (TRANSFER), F5 (DELETE), F6, F7 (INFORMATION), and F8 (EXIT). Below the screenshot, a legend indicates that a solid box represents an input field and a dashed box represents an output field.

| Field             | Value            | Type   |
|-------------------|------------------|--------|
| Drive             | A                | Input  |
| Filename          | EXAMPLE          | Output |
| Plant designation | LINEAR AXIS      | Output |
| Generated by      | SMITH            | Output |
| Generated on      | 15 09 89         | Output |
| Module no.        | 11               | Input  |
| Slot no.          | 001              | Input  |
| Page address      | 000              | Input  |
| Firmware          | IP246I           | Input  |
| PG date time      | 15 09 89 - 12:23 | Output |

Legend:  
  = input field  
  = output field

Fig. 5-1: Basic mask

### Significance of the function keys

<F1>: Branch to input of machine data/machining programs.

<F2>: Branch to output of machine data/machining programs.

<F3>: Branch to test mode.

<F4>: Branch to transfer of machine data/machining programs on the individual media.

< F5 >: Branch to deleting machine data/machining programs on the individual media

< F7 >: Branch to information (overview) of machine data/machining **programs as** they exist on the individual media.

< F8 >: Return to the presetting mask.

## 6 Input

If you press < F1 > (**INPUT**) in the basic mask (function selection) you branch to data input.

Here, you can generate machine data or machining programs and store them on the module, the PG or a data drive. You stipulate the destination device in this mask (function keys < F1 >... < F3 > ).

MODUL  SIMATIC S5 / COM246  
 DEVICE   LOCK : DB

---

DATA BLOCK MACHINE DATA  
 BLOCK NO. DB

|                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| <input type="text" value="F1"/> | <input type="text" value="F2"/> | <input type="text" value="F3"/> | <input type="text" value="F4"/> | <input type="text" value="F5"/> | <input type="text" value="F6"/> | <input type="text" value="F7"/> | <input type="text" value="F8"/> |
| MODULE                          | PG                              | FD                              |                                 |                                 |                                 | HELP                            | EXIT                            |

= input field       = output field

Fig. 6-1: Block selection

### Description of the output fields

INPUT is displayed in the header. The version of the module ("INCRE" or "ABSOL") is displayed in the output field **MODUL**. The other fields are still blank.

### Description of the input fields

Data block:

Select machine data or machining program. This field can be manipulated with the function key <F7> (HELP).

Block no.:

You select the data block number under which the generated data are to be stored.  
The DB number can be a value between 0 and 255.

### Description of the function keys

- <F1>: The destination device is the IP246 module. You branch immediately to the next mask, either to the first machine data or the first machining program mask.
- <F2>: The destination device is the programmer. You branch immediately to the next mask, either to the first machine data or the first machining program mask.
- <F3>: The destination device is the data drive entered in the configuration mask. You branch immediately to the next mask, either to the first machine data or the first machining program mask.
- <F7>: With the help key you can select the text "machine data" or "machining program" in the "data block" input field.
- <F8>: If you press the EXIT key you return to the basic menu (function selection).

## 6.1 Entering Machine Data

### 6.1.1 General Information about Machine Data

Before traversing movements can be executed, each axis requires the technical data of the drive. This information is known as machine data (= > "Fundamentals of Positioning, Reference Manual", Section 4 "Machine Data and their Structure"),

When you input the machine data, the module checks that the data is consistent, If you make an error, an error message is output and the program branches to the mask in which the incorrect value might be located. After correcting the value, the data record can once again be transferred to the module.

The data block numbers of the machine data for the two axes can be identical.

When deleting and entering a machine data record for the first time, the reference point of the incremental version and the home point of the absolute version need not necessarily be lost; this depends on the machine data in the new data record which have changed compared with the old record (= > "Functions, Reference Manual", Section 3.17 "Machine Data Processing"). Zero offsets and tool length offsets are, however, reset each time new machine data are input to the module.

The individual machine data are only explained briefly here. For more detailed information about machine data, refer to "Fundamentals of Positioning, Reference Manual", Section 4 "Machine Data and their Structure".

## 6.1.2 Compiling Machine Data

If you selected “machine data” in the data block selection mask, specified the block number and pressed one of the function keys < F1 > ... < F3 >, the axis selection mask is displayed. The destination device (I P246, PG, FD) is now fixed and can no longer be changed for this input.

As an example in this section, a machine data record (data block number 123) will be generated for an incremental module. The destination device on which the data will be stored is the IP246 module, module number 11. The data record refers to a linear axis, axis 1, with metric dimensions.

The mask for machine data compilation, page 2 and page 6 are different for the absolute version and the incremental version. In these masks, data specifically required by the absolute version are entered as examples in the input and output fields.

The screenshot shows a terminal window with the following content:

```

INPUT
MACHINE DATA
MODUL : INCRE SIMATIC S5 / COM246
DEVE : IP 246 BLOCK : DB 123

Axis : 1 (1..2) ?
Module : 11 (0..99)
Meas system : mm (mm, in, deg)
Axis type : LINEAR

F1 F2 F3 F4 F5 F6 F7 F8
NEXT PREVIOUS PRINT TRANSFER HELP EXIT
PAGE PAGE M.DATA

```

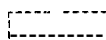
 = input field       = output field

Fig. 6.1 .2-1: Axis selection

### Description of the output fields

INPUT and M A C H I N E D A T A are displayed in the header. The module version ("INCRE" or "ABSOL") is displayed in the MODUL field, the previously selected destination device is displayed in the DEVICE field and the previously selected DB no, in the BLOCK field,

### Description of the input fields

Axis:

In this field, you enter the number of the axis for which the machine data record is to be created. The number can be either 1 or 2.

Module:

In this field, you can enter the number of the module for which the machine data record is to be created. This is necessary, since several IP246 modules can be installed in a plant.

Meas. system:

Here, you enter the required measuring system. mm stands for millimetres (basic unit urn), in for inches (basic unit 0.0001 in) and deg for degrees (basic unit 0,001 degrees).

Axis type:

Using the help key < F7 > you can select either a rotary axis "ROUND" or linear axis "LINEAR".

These values are used as output values for all machine data pages,

### Significance of the function keys

- <F1> : With function key < F1 > (NEXT PAGE) you branch to the first mask for machine data compilation. This is distributed over six different pages.
- < F2 > : Select the previous machine data page. From this mask, you return to the last machine data page if you press < F2 > ,
- < F4 > : Output all the machine data on the printer.
- < F6 > : **Store all** the machine data on the selected destination device. This is, however, only possible when all the input fields of all the pages have had values entered.
- < F7 > : **Switchover** the measuring system or axis type, providing the cursor is located in the appropriate input field.
- < F8 > : Return to the basic mask (function selection) after confirmation.

## 6.1.2.1 Machine Data Page 1

|                      |               |                |                     |                   |
|----------------------|---------------|----------------|---------------------|-------------------|
| INVT                 |               | MODUL : INCRE  | SIMATIC S5   COM246 |                   |
| MACHINE DATA         |               | DEVICE : IP246 | BLOCK : DB          | 123               |
| Module :             | 11            | Axis :         | 1                   | Meas. system : mm |
|                      |               |                |                     | Axistype : LINEAR |
| Maximum deceleration | 9000          | [mm/sec~]      |                     | (10...9999)       |
| Acceleration fwd.    | 1000          | [mm/sec~]      |                     | (10...9999)       |
| Deceleration fwd.    | 1000          | [mm/sec~]      |                     | (10...9999)       |
| Acceleration rev.    | 1500          | [mm/sec~]      |                     | (10...9999)       |
| Deceleration rev.    | 1500          | [mm/sec~]      |                     | (10...9999)       |
| F1                   | F2            | F3             | F4                  | F5                |
| NEXT PAGE            | PREVIOUS PAGE |                | PRINT M.DATA        | TRANSFER          |
|                      |               |                |                     | F6                |
|                      |               |                |                     | F7                |
|                      |               |                |                     | F8                |
|                      |               |                |                     | Exit              |

= input field

= output field

Fig. 6.1.2.1-1: Machine data page

## Description of the output fields

The header remains the same as described in the section "Machine Data Compilation".

## Module:

The previously entered module number is displayed here.

## Axis:

The previously selected axis number is displayed here.

## Meas. system:

The previously selected dimension is displayed here.

## Axis type:

The previously selected axis type ("LINEAR" or "ROUND") is displayed here.



### **Description of the input fields**

Maximum deceleration:

The maximum deceleration when hardware limit switches are tripped or when an external STOP is received, can be selected between 10...9999.

Acceleration fwd.:

Acceleration values between 10..9999 for any acceleration in a forward direction

Deceleration fwd.:

Deceleration values between 10...9999 for any deceleration in a forward direction

Acceleration rev.:

Acceleration values between 10...9999 for any acceleration in the reverse direction

Deceleration rev.:

Deceleration values between 10...9999 for any deceleration in the reverse direction

### **Significance of the function keys**

< F1 > : Select the next machine data page.

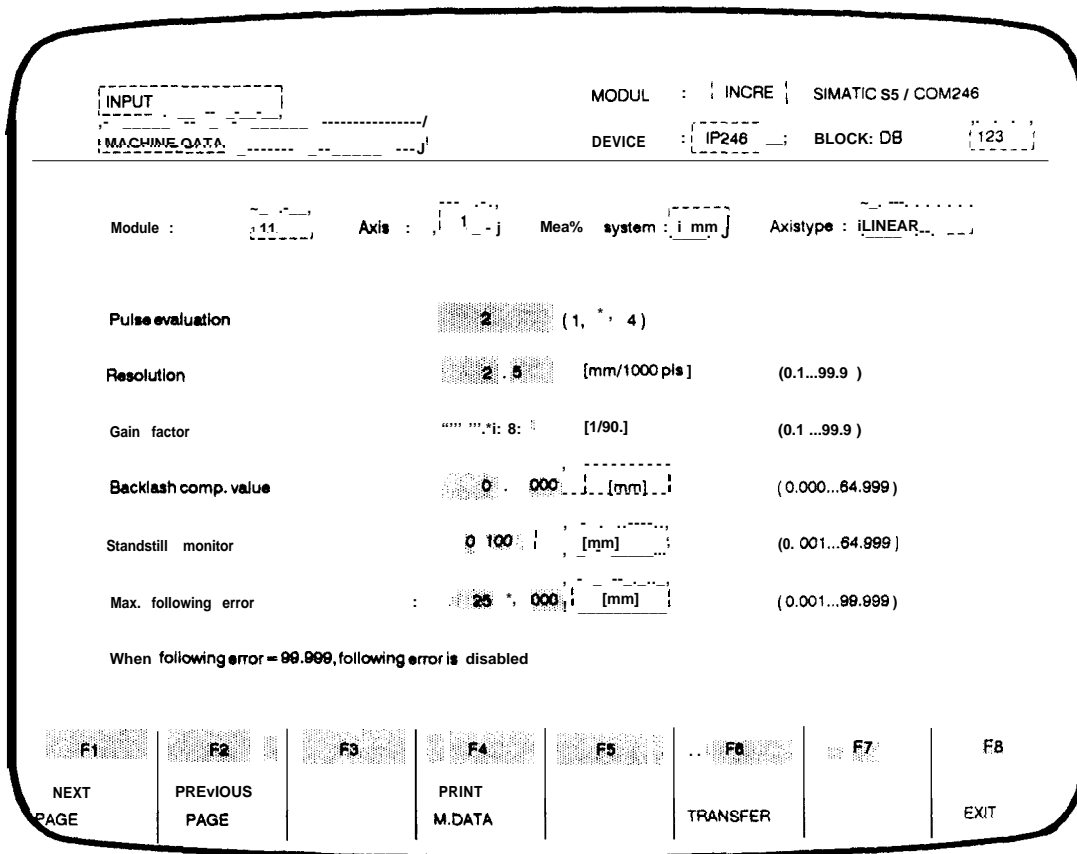
< F2 > : Select the previous machine data page,

< F4 > : Print out all machine data,

< F6 > : Store all machine data on the destination device.

< F8 > : Return to the basic mask without storing the data.

6.1.2. Machine Data Page 2 (Incremental Version)



= input field I [ ]; = output field

Fig. 6.1 .2.2-1: Machine data page 2

**Description of the output fields**

The header remains as described in the section “Machine Data Compilation”.

Module, axis, meas. system, axis type: see machine data page 1.

**Description of the input fields**

**Pulse evaluation:**

Single, double or quadruple evaluation of the pulses from the incremental position encoder can be selected.

**Resolution:**

Travel distance related to 1000 pulses from the position encoder. The value entered here has no significance. A value within the specified limits must, however, be entered. The actual resolution is assigned using the values “pulses/revolution” and “distance/revolution”. COM changes this input field automatically when you page through the individual machine data pages.

**Note:**

With the incremental version, from firmware version 2, 1, the values pulse/revolution and distance/revolution are taken from page 6 of the machine data. If these values result in, for example, a resolution of 100.0, then the value 00,0 will be entered in the resolution field of the machine data. This is, however, an illegal value, and it would be impossible to exit the mask. **For this reason**, COM246 enters a value within the permitted limits, The calculated value is then supplied by the firmware.

**Gain factor:**

Gain factor ( $k_v$ ) of the position controller in units l/see, The permitted limits are 0.1...99.9. Depending on the plant and the other machine data (e.g. resolution or maximum speed) not all of these values are generally permitted,

**Backlash comp. value:**

This value is added to the distance to be travelled whenever the axis changes direction. This allows backlash outside the control loop (play in the drive) to be compensated, The backlash compensation is only effective when it is certain that there is no longer play between the drive and the carriage, With a reference point approach, this may be the case immediately following the reference point approach. Otherwise you must make sure this play is taken up yourself,

**Standstill monitor:**

The maximum difference between the setpoint and actual position value when the axis is at rest and the position controller is active. This value must be greater than 0 and less than the maximum following error,

**Max. following error:**

The maximum difference between the setpoint and actual position value when closed loop control is active. The maximum following error must be greater than or equal to the standstill monitor value. Monitoring of the following error can be suppressed by entering the maximum value (99,999) in the field,

**Significance of the function keys**

- < F1 > : Select the next machine data page,
- < F2 > : Select the previous machine data page.
- < F4 > : Print out all machine data.
- < F6 > : Store all machine data on the destination device,
- < F8 > : Return to the basic mask without storing the data,

### 6.1.2.3 Machine Data Page 2 (Absolute Version)

This machine data page for the absolute version differs from the page for the incremental version.

|                                                            |               |            |                       |
|------------------------------------------------------------|---------------|------------|-----------------------|
| INPUT                                                      | MODUL         | ABSOL      | SIMATIC S5 I COM246   |
| MACHINE DATA                                               | DEVICE        | IP246      | BLOCK : DB @          |
| Module :                                                   | 22            | Axis :     | 1                     |
| Meas. system :                                             | mm.           | Axistype : | LINEAR                |
| Gain factor                                                | :             | 10 . 0     | [1/sec] (0.1...99.9)  |
| Backlash comp. value                                       | :             | 0 . 000    | [mm] (0.000...64.999) |
| standstill monitor                                         | :             | 0 100      | [mm] (0.001...64.999) |
| Max. following error                                       | :             | 25 . 000   | [mm] (0.001...99.999) |
| When following error = 99.999, following error is disabled |               |            |                       |
| F1                                                         | F2            | F3         | F4                    |
| NEXT PAGE                                                  | PREVIOUS PAGE |            | PRINT M-DATA          |
|                                                            |               |            | F5                    |
|                                                            |               |            | F6                    |
|                                                            |               |            | TRANSFER              |
|                                                            |               |            | F7                    |
|                                                            |               |            | F8                    |
|                                                            |               |            | EXIT                  |

= input field [-----] = output field

Fig. 6.1 .2.3-1: Machine data page 2

#### Description of the output fields

The header remains as described in section "Machine Data Compilation".

Module, axis, meas. system, axis type: see Machine Data Page 1.

#### Description of the input fields

##### Gain factor:

Gain ( $k_v$ ) factor of the position controller in units l/sec. The permitted limits are 0.1...99.9. Depending on the plant and the other machine data (e.g. resolution or maximum speed) not all of these values are generally permitted.

**Backlash comp. value:**

This value is added to the distance to be travel led whenever the axis changes direction. This allows backlash outside the control loop (play in the drive) to be compensated, The backlash compensation is only effective when it is certain that there is no longer play between the drive and the carriage. You must make sure this play is taken up yourself.

**Standstill monitor:**

The maximum difference between the setpoint and actual position value when the axis is at rest and the position controller is active. This value must be greater than 0 and less than the maximum following error.

**Max. following error:**

The maximum difference between the setpoint and actual position value when closed loop control is active. The maximum following error must be greater than or equal to the standstill monitor value. Monitoring of the following error can be suppressed by entering the maximum value (99,999) in the field,

**Significance of the function keys**

- < F1 > : Select the next machine data page.
- < F2 > : Select the previous machine data page.
- < F4 > : Print out all machine data.
- < F6 > : Store all machine data on the destination device.
- < F8 > : Return to the basic mask without storing the data

## 6.1.2.4 Machine Data Page 3

|                       |               |                |                                       |    |          |    |      |
|-----------------------|---------------|----------------|---------------------------------------|----|----------|----|------|
| INPUT                 |               | MODUL : INCRE  | SIMATIC S5   COM246                   |    |          |    |      |
| MACHINE_DATA          |               | DEVICE : IP246 | BLOCK: 06 1 2 3                       |    |          |    |      |
| Module:               | 11            | Axis : 1       | Meas. system : mm   Axistype : LINEAR |    |          |    |      |
| Ref. point/home point | 0 000         | [mm]           | (+ 400(X3,000))                       |    |          |    |      |
| SW limit switch start | 400 000       | [mm]           | (+ - 40000.000)                       |    |          |    |      |
| SW limit switch end   | 500 000       | [mm]           | (+ - 40000.000)                       |    |          |    |      |
| Tool length offset    | 2 S00         | [mm]           | (+ - 40000.000)                       |    |          |    |      |
| F1                    | F2            | F3             | F4                                    | F5 | F6       | F7 | F8   |
| NEXT PAGE             | PREVIOUS PAGE |                | PRINT M.DATA                          |    | TRANSFER |    | EXIT |

= input field      = output field

Fig. 6.1 .2.4-1: Machine data page 3

#### Description of the output fields

The header remains as described in section "Machine Data Compilation".

Module, axis, meas. system, axis type: see Machine Data Page 1.

The terms entered in the 2nd and 3rd fields depend on the axis type selected in the axis selection mask. For a linear axis, these are the software limit switches (SW limit switch start and SW limit switch end). For a rotary axis, they are the traversing range limits (traversing range start and traversing range end).

#### Description of the input fields

Ref. point/home point:

The reference point coordinate (incremental version) or the home point coordinate (absolute version) must be located between or at most **exactly** on the coordinates of the software limit switches or traversing range limits. With a rotary axis, remember that the start of the traversing range is physically the same point as the end of the traversing range.

SW limit switch start.:

(For a linear axis). This value indicates the coordinate of the start software limit switch. It must be less than the end software limit switch and be positioned so that the axis does not reach the hardware limit switch during deceleration.

Traversing range start:

(For a rotary axis). This value indicates the start of the traversing range of the rotary axis. It must be less than the value of the traversing range end.

SW limit switch end:

(For a linear axis). This value indicates the coordinate of the end software limit switch. It must be greater than the start software limit switch and be located so that the axis does not reach the hardware limit switch during deceleration.

Traversing range end:

(For rotary axis). This value indicates the coordinate of the end of the traversing range of the rotary axis. It must be greater than the value of the traversing range start.

Tool length offset:

The value specified here can be selected in machining programs (G43, G44) to correct changes in the tool length (usually wear and tear on the tool). Each specified target is corrected by this value. The correction is added to a tool length offset previously selected with mode 15 and can be called repeatedly in machining programs. The following restrictions apply to the tool length offset:

the tool length offset must be less than 40 m,  
the coordinates of the software limit switches or traversing range limits plus the tool length offset must be less than or equal to +/-40 m,  
with a rotary axis, the tool length offset must be less than the selected traversing range (traversing range end - traversing range start).

**Significance of the function keys**

- < F1 > : Select the next machine data page.
- < F2 > : Select the previous machine data page.
- < F4 > : Print out all machine data.
- < F6 > : Store all machine data on the destination device.
- < F8 > : Return to the basic mask without storing the data.

## 6.1.2.5 Machine Data Page 4

|                     |               |                    |               |                     |          |    |      |
|---------------------|---------------|--------------------|---------------|---------------------|----------|----|------|
| INPUT               |               | MODUL              | INCRE         | SIMATIC S5 / COM246 |          |    |      |
| MACHINE DATA        |               | DEVICE             | IP246         | BLOCK: DB           | 123      |    |      |
| Module :            | 11            | Axis :             | 1             | Meas. system:       | mm       |    |      |
|                     |               | Axistype :         | LINEAR        |                     |          |    |      |
| Zero point offset 1 | 10.000        | [mm]               | (+ 40000.000) |                     |          |    |      |
| Zero point offset 2 | 25.000        | [mm]               | (+ 40000.000) |                     |          |    |      |
| Zero point offset 3 | 3250          | [mm]               | (+ 40000.000) |                     |          |    |      |
| Zero point offset 4 | 75.000        | [mm] <sup>-7</sup> | (+ 40000.000) |                     |          |    |      |
| F1                  | F2            | F3                 | F4            | F5                  | F6       | F7 | F8   |
| NEXT PAGE           | PREVIOUS PAGE |                    | PRINT M-DATA  |                     | TRANSFER |    | EXIT |

= input field  = output field

Fig. 6.1.2.5-1: Machine data page 4

**Description of the output fields**

The header remains as described in section "Machine Data Compilation".

Module, axis, meas. system, axis type: see Machine Data Page 1.

**Description of the input fields**

Zero point offsets 1...4:

The values of the four zero point offsets are independent from each other and can be called alternatively in machining programs using G54...G57. They are added to offsets executed with the modes "zero point offset absolute/relative" (BA 12, BA 13). The range of values of the four offsets is +/-40 m. In addition to this, the coordinates of the software limit switches or traversing range limits must not exceed +/- 40 m following the zero point offset.



### Significance of the function keys

- < F1 >: Select the next machine data page.
- < F2 >: Select the previous machine data page.
- < F4 >: Print out all machine data.
- < F6 >: Store all machine data on the destination device.
- < F8 >: Return to the basic mask without storing the data.

#### 6.1.2.6 Machine Data Page 5

|                   |               |          |               |                     |          |            |        |
|-------------------|---------------|----------|---------------|---------------------|----------|------------|--------|
| INPUT             |               | MODUL    | INCRE         | SIMATIC S5 / COM246 |          |            |        |
| MACHINE DATA      |               | DEVICE   | IP246         | BLOCK : DB          | 1 2 3    |            |        |
| Module :          | 11            | Axis :   | 1             | Meas. system :      | mm       | Axistype : | LINEAR |
| Maximum speed     | 20000         | [mm/min] | (1 ... 65000) |                     |          |            |        |
| JOG speed 1 fwd.  | 18000         | [mm/min] | (1 ... 65000) |                     |          |            |        |
| JOG speed 1 rev.  | 17000         | [mm/min] | (1 65000)     |                     |          |            |        |
| JOG speed 2 fwd.  | 10000         | [mm/min] | (1 65000)     |                     |          |            |        |
| JOG speed 2 rev.  | 10000         | [mm/min] | (1 ... 65000) |                     |          |            |        |
| Incremental speed | 17500         | [mm/min] | (1 65000)     |                     |          |            |        |
| F1                | F2            | F3       | F4            | F5                  | F6       | F7         | F8     |
| NEXT PAGE         | PREVIOUS PAGE |          | PRINT M.DATA  |                     | TRANSFER | HELP       | EXIT   |

 = input field     
  = output field

Fig. 6.1 .2.6-1: Machine data page 5

#### Description of the output fields

The header remains as described in section “Machine Data Compilation”.

Module, axis, meas. system, axis type: see Machine Data Page 1.

## Description of the input fields

### Maximum speed:

This value specifies the speed with which the axis traverses when 10 V are output at the power unit.

### Example

Rated **rpm** of the motor:  $N = 2000$  rpm; "distance per encoder revolution" : 10 mm/rev

This results in a maximum speed as follows:

$$V_{\max} = 2000 \text{ rpm } 10 \text{ mm/rev} = 20000 \text{ mm/min}$$

The value "distance per encoder revolution" includes all transmissions (gearing) between the position encoder and the axis.

### JOG speed 1 fwd.:

Value for JOG speed 1 in the forward direction. This value must be less than or equal to the maximum speed and greater than 1.

### JOG speed 1 rev.:

Value for JOG speed 1 in the reverse direction. This value must be less than or equal to the maximum speed and greater than 1.

### JOG speed 2 fwd.:

Value for JOG speed 2 in the forward direction. This value must be less than or equal to the maximum speed and greater than 1.

### JOG speed 2 rev.:

Value for JOG speed 2 in the reverse direction. This value must be less than or equal to the maximum speed and greater than 1.

### Incremental speed:

Value for the speed for incremental approach (BA 6 and BA 7). This value must be less than or equal to the maximum speed and greater than 1.

## Significance of the function keys

<F1> : Select the next machine data page.

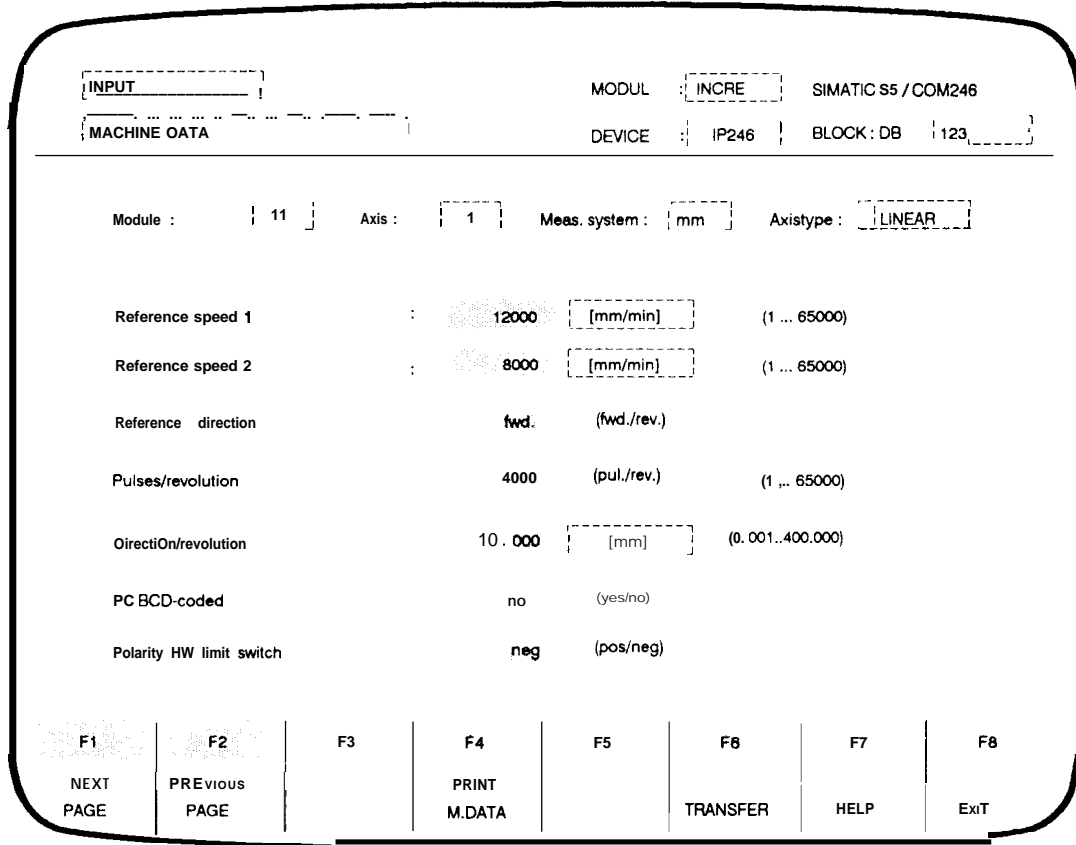
<F2> : Select the previous machine data page.

<F4> : Print out all machine data.

<F6> : Store all machine data on the destination device,

<F8> : Return to the basic mask without storing the data,

6.1.2.7 Machine Data Page 6 (Incremental Version)



= input field [-----] = output field

Fig. 6.1 .2.7-1: Machine data page 6

Description of the output fields

The header remains as described in section “Machine Data Compilation”.

Module, axis, meas. system, axis type: see Machine Data Page 1,

Description of the input fields

Reference speed 1:

Speed during a reference point approach. The axis travels at this speed in the opposite direction from the reference direction as far as the reversal point and then travels in the reference direction until the precontact is reached. This value must be less than or equal to the maximum speed and greater than 1.

**Reference speed 2:**

Speed during the reference point approach. After reaching the precontact in the reference direction, the axis travels at this speed as far as the reference point (zero marker of the encoder). It must be:

less than or equal to the reference point speed 1,  
less than or equal to the maximum speed and  
greater than 1.

**Reference direction:**

Direction (forward, reverse), in which the axis moves from the precontact to the zero marker during reference point approach.

**Pulses/revolution:**

This field specifies how many signal edges of the two position encoder signals (A and B) are evaluated. In single evaluation, the number of signal edges to be evaluated is the same as the number of pulses per encoder revolution. In double evaluation, this is twice the number and in quadruple evaluation four times the number of pulses per encoder revolution. The possible range is from 1 to 65000.

**Distance/revolution:**

(Note: "direction" is an error in the software which will be corrected in the next version). In these two fields (numbers and decimal places) the distance per encoder revolution is specified. The range of values is from 0,001 to 400.000. This value includes all transmissions (gearing) between the position encoder and the axis.

The two values "pulses/revolution" and "distance/revolution" produce the resolution (distance/pulses).

**PC BCD-coded:**

If you enter "yes" in this field (help key < F7 > ), all coordinates (targets, travel increments, zero point offsets and tool length offsets) transferred from the PC are interpreted by the IP246 in BCD format. The range of values in BCD format is limited to +/- 9999999.

**Polarity HW limit switch:**

In this field you specify the polarity of the hardware limit switch. "Pos." means positive edge when the limit switch is triggered (normally open contact) and "[neg. " means negative edge when the limit switch is triggered (normally closed contact).

**Significance of the function keys**

- <F1> : Select the next machine data page.
- < F2 > : Select the previous machine data page.
- < F4 > : Print out all machine data.
- < F6 > : Store all machine data on the destination device.
- < F8 > : Return to the basic mask without storing the data.

### 6.1.2.8 Machine Data Page 6 (Absolute Version)

This page of machine data for the absolute version differs from the page for the incremental version.

|                         |               |                   |               |                     |                   |            |        |
|-------------------------|---------------|-------------------|---------------|---------------------|-------------------|------------|--------|
| INPOT                   |               | M O O U L : ABSOL |               | SIMATIC S5 / COM246 |                   |            |        |
| MACHINE DATA            |               | DEVICE : IP246    |               | BLOCK : DB 123      |                   |            |        |
| Module :                | 22            | Axis :            | 1             | Meas. system :      | mm                | Axistype : | LINEAR |
| Encoder:                |               |                   |               |                     |                   |            |        |
| Number of revolutions   | 512           | (rev.)            | (1 ... 65000) |                     |                   |            |        |
| Number of steps/rev.    | 1024          | (step/rev.)       | (2... 65000)  |                     |                   |            |        |
| Direction/revolution    | 2             | 560               | [mm]          | 1                   | (0.001...400.000) |            |        |
| PCBCD-coded             | no            | (yes/no)          |               |                     |                   |            |        |
| Polarity HW limit witch | neg           | (pos/neg)         |               |                     |                   |            |        |
| F1                      | F2            | F3                | F4            | F5                  | F6                | F7         | F8     |
| NEXT PAGE               | PREVIOUS PAGE |                   | PRINT M.DATA  |                     | TRANSFER          | HELP       | EXIT   |

= input field  = output field

Fig. 6.1 .2.8-1: Machine data page 6 (abs)

#### Description of the output fields

The header remains as described in section “Machine Data Compilation”.

Module, axis, meas. system, axis type: see Machine Data Page 1.

#### Description of the input fields

##### Number of revolutions:

This field specifies how many revolutions the absolute position encoder requires to exceed its total range once. The range of values is from 1 (single turn) to 65000 (multi-turn).

**Number of steps/rev.:**

This field specifies how many steps the position encoder has per revolution. The range of values is from 2 to 65000. If values are specified which are not equal to a power of 2, it is assumed that you are using an absolute position encoder with the Gray excess X code.

The product of the number of revolutions and the number of steps/revolution is the total number of steps of the absolute position encoder. The total number of steps is limited to  $2^{20}$ .

**Distance/revolution:**

(Note: "direction" is an error in the software which will be corrected in the next version). In these two fields (numbers and decimal places) the distance per encoder revolution is specified. The range of values is from 0.001 to 400,000, This value includes all transmissions (gearing) between the position encoder and the axis.

The two values "pulses/revolution" and "distance/revolution" produce the resolution (distance/pulses).

**PC BCD-coded:**

If you enter "yes" in this field (help key <F7> ), all coordinates (targets, travel increments, zero point offsets and tool length offsets) transferred from the PC are interpreted by the IP246 in BCD format, The range of values in BCD format is limited to 1;-9999999.

**Polarity HW limit switch:**

In this field you specify the polarity of the hardware limit switch. "Pos." means positive edge when the limit switch is triggered (normally open contact) and "neg. " means negative edge when the limit switch is triggered (normally closed contact).

**Significance of the function keys**

- <F1>: Select the next machine data page.
- <F2>: Select the previous machine data page.
- <F4>: Print out all machine data.
- <F6>: Store all machine data on the destination device,
- <F8>: Return to the basic mask without storing the data.

**6.1.3 Print Machine Data**

The data (DB number) selected using the functions "input" or "output" of machine data can be printed out using function key <F4> (PRINT M. DATA). The data are formatted in a fixed framework.

A header is printed out at the start of each machine data page and a title block (footer) at the end

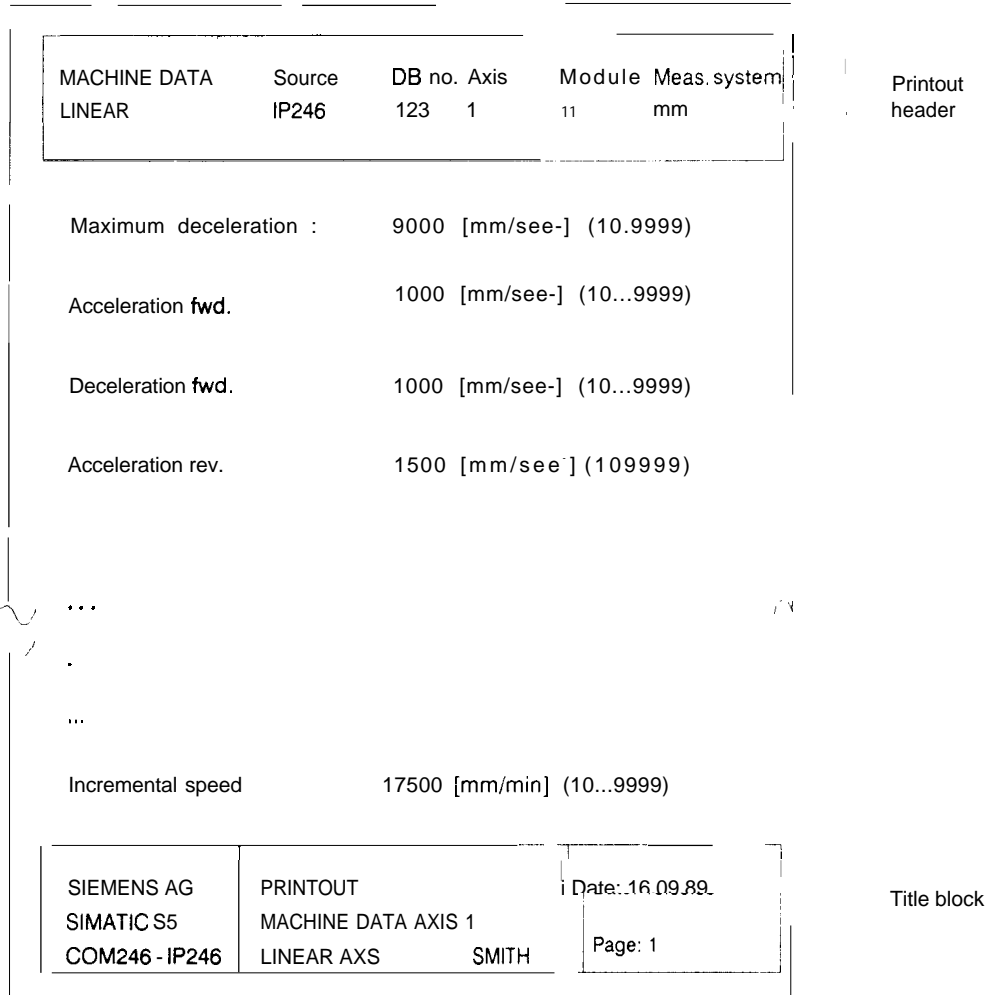


Fig. 6.1 .3-1: Machine data printout

The following information is supplied in the header:  
 the machine data are for a linear axis,  
 the source device (FD, PG or IP246) from which they were read,  
 the DB number under which they are stored,  
 the axis and module for which they are intended and  
 the measuring system (mm, in or deg.) of the machine data.

The title block is explained in the machine data printout mask,

|                           |                     |        |        |                     |                      |      |      |
|---------------------------|---------------------|--------|--------|---------------------|----------------------|------|------|
| OUTPUT                    |                     | MODUL  | INCRE  | SIMATIC S5 / COM246 |                      |      |      |
| MACHINE DATA              |                     | DEVICE | IP 246 | BLOCK :             | DB 123               |      |      |
| SIEMENS AG                | PRINTOUT            | Date:  | 1 5 0s | 89                  |                      |      |      |
| SIMATIC S5                | MACHINE DATA AXIS 1 | Page:  | 1      |                     |                      |      |      |
| COM 246 — IP 246          | LINEAR AXIS SMITH   |        |        |                     |                      |      |      |
| Printer type              |                     | PT80   |        |                     |                      |      |      |
| Lines per page (40-95)    |                     | 68     |        |                     |                      |      |      |
| Columns per line (80-132) |                     | 60     |        |                     |                      |      |      |
| F1                        | F2                  | F3     | F4     | F5                  | F6                   | F7   | F8   |
|                           |                     |        | PRINT  |                     | PRINTER<br>PARAMETER | HELP | EXIT |

= input field ~- [ ] = output field

**Fig. 6.1.3-2: Machine data printout mask**

In this mask there are two lines available to enter information about the machine data, e.g. the plant for which they are intended etc. This information is only used for documentation (here, PRINTOUT MACHINE DATA AXIS 1). The fields in the third line, "plant designation" and "generated by" are completed automatically from the information in the presetting mask. The date can also be entered. The page number is incremented automatically following each form feed.

#### Description of the output fields

In output field 1 in the header either INPUT or OUTPUT is displayed. MACHINE DATA is displayed in output field 3. Output field MODUL contains the version of the module ("INCRE" or "ABSOL"), DEVICE indicates the previously selected destination or source device and BLOCK shows the DB number.

Page:

The numbers of the pages are displayed here during the printing. The page number is incremented by 1 at each form feed.

Third comment line:

The fields "plant designation" and "generated by" from the presetting mask are entered in this line (here, LINEAR AXIS, SMITH).



Printer type:

This field displays the printer selected in the printer parameter mask, The default is the Siemens PT88 printer,

Lines per page:

**The number of** lines per page selected in the printer parameter mask is displayed. The default is 68 lines per page.

Columns per line:

The number of columns per line selected in the printer parameter mask is displayed here. The default is 80 columns per line.

If you have not yet printed out or not yet set the printer parameters, branch to the “printer parameter mask” with < F6 > (PRINTER PARAMETER). Refer also to Section 6,1,4 “Assigning Printer Parameters”.

### Description of the input fields

Comment:

In two lines of the title block you can enter a comment about the machine data to be printed out. This comment is then printed out as a title block on each page.

Date:

In these three input fields you can enter the date on which the machine data were created, This date is also printed out on each page.

### Significance of the function keys

< F4 > : The printout is started with this function key.

< F6 > : This function key branches to the printer parameter mask,

< F7 > : Help key: no function.

< F8 > : Exit the print option without printing out,

## 6.1.4 Assigning Printer Parameters

From the presetting mask and from the mask for printing machine data, you can branch to the printer parameter mask by pressing <F6> (PRINTER PARAMETER). Here, you can select the Siemens printers PT80 and PT88 or other printers using the IBM or EPSON mode. The values for the number of lines per page (default 68) and the number of columns per line (default 80) can be changed. You can also adapt the control characters for print type and character set to any printer. The control characters must be entered in ASCII code without gaps or separators. A maximum of 5 ASCII characters can be entered. If a control character sequence is less than 5 characters, the sequence must be completed with ASCII NIL characters,

At present, only the parameters for print type 2 can be used,

| OUTPUT                        |              | MODUL        | INCRE        | SIMATIC S5 / COM246 |     |      |      |
|-------------------------------|--------------|--------------|--------------|---------------------|-----|------|------|
| MACHINE DATA                  |              | DEVICE       | IP246        | BLOCK: DB           | 123 |      |      |
| Printer type :                |              | PT88         |              |                     |     |      |      |
| Lines per page (40 - 95) :    |              | 68           |              |                     |     |      |      |
| Columns per page (80 - 132) : |              | 80           |              |                     |     |      |      |
| Print type 1 :                | 0D1B5B317717 | ASCII        | 1B2842170000 |                     |     |      |      |
| Print type 2 :                | 001B5B327717 | Expanded on  | 1B3817000000 |                     |     |      |      |
| Print type 3 :                | 0D1B5B347717 | Expanded off | 1B3C17000000 |                     |     |      |      |
| F1                            | F2           | F3           | F4           | F5                  | F6  | F7   | F8   |
|                               |              |              | TRANSFER     |                     |     | HELP | EXIT |

= input field    = output field

Fig. 6.1 .4-I: Printer parameter mask

#### Description of the output fields

The header is the same as described in Section "Machine Data Compilation".

#### Printertype:

Using the help key, you can select one of the four printers PT80, PT88, IBM and EPSON. The fields print type 1 to 3 "ASCII", "expanded on" and "expanded off" are then completed accordingly; they can, however, still be adapted to your particular requirements.

#### Lines per page:

Here, you specify the number of lines per page

#### Columns per page:

In this field you specify the number of columns per page,

#### Print type 1:

For the PT88 printer, the sequential control characters (0DH), ESC (1BH), '[I w' (5BH, 31H, 77H) and the sequential end character 17H are defaults. This printer then prints normal print with 17 characters per inch.

Print type 2:

For the PT88 printer, the sequential control characters (0DH), ESC (1 BH), '[2w' (5BH, 32H, 77H) and the sequential end character 17H are defaults. This printer then prints condensed print with 12 characters per inch.

Print type 3:

For the PT88 printer, the sequential control characters (0DH), ESC (1 BH), '[4w' (5BH, 34H, 77H) and the sequential end character 17H are defaults, This printer then prints super-condensed print with 10 characters per inch.

ASCII:

For the PT88 printer, the sequential control characters ESC (1 BH), '(B' (28H, 42H) and the sequential end character 17H are defaults, This printer then prints with the ASCII character set.

Expanded on:

For the PT88 printer, the sequential control characters ESC (1 BH), '8' (38H) and the sequential end character 17H are defaults, Expanded print is then set on this printer. Each character is then printed in double width.

Expanded off:

For the PT88 printer, the sequential control characters ESC (1 BH), '<' (3CH) and the sequential end character 17H are defaults, This switches off expanded print on this printer. Each character is then once again printed in normal width.

For IBM or EPSON printers please refer to the control characters in the appropriate manual

## 6.2 Entering Machining Programs

### 6.2.1 General Information about Machining Programs

The structure of the machining program generally corresponds to a subset of the representation described in DIN 66025. The programs consist of a sequence of ASCII characters with a maximum length of 1023 characters.

Machining programs are packaged by COM246 in data blocks in keeping with the STEP 5 representation. The blocks are distinguished by their data block number. A data block generated by COM246 contains exactly one machining program. The data block number is entered in the machining program header by COM246 as the machining program number, Numbers 0.,.,255 are possible.

For more information about machining programs, refer to "Fundamentals of Positioning, Reference Manual", Section 5 "Machining Programs and their Structure".

Machining programs can be generated in two methods of representation:

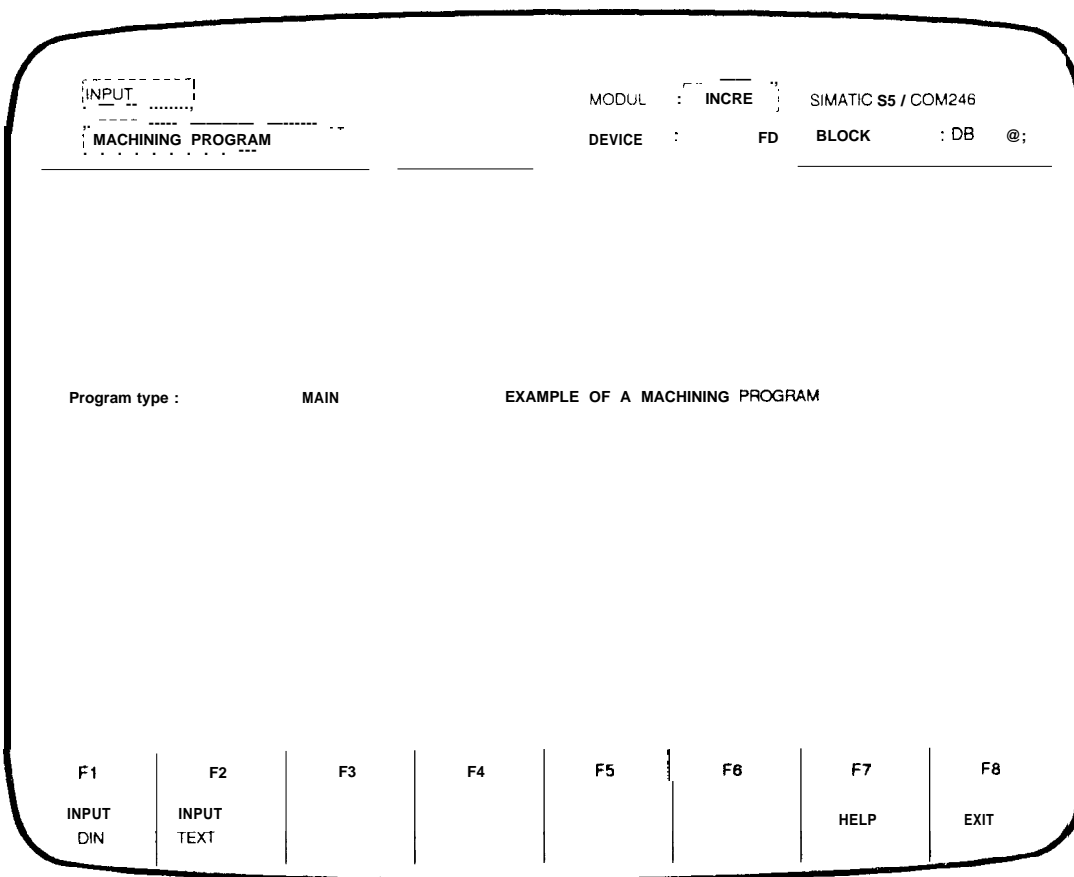
- representation according to DIN 66025
- representation in text mode

It is also possible to generate machining programs using TEACH-IN. The test mode of COM246 provides the necessary support. (See also Section 8 "Test" or "Functions, Reference Manual", Section 3.9 "Teach-in On/Off").

**6.2.2 Generating Machining Programs**

If you select "MACHINING PROGRAM" in the data block selection mask, specify the block number and press one of the function keys < F1 >... < F3 >, the first mask for machining programs is output. The destination device (I P246, PG, FD) is now fixed and cannot be changed for this input.

In the following machining program masks examples of data for machining programs have been entered. The destination device is the drive (FD) selected in the presetting mask. The data is stored in the set file as DB1 55. An incremental version has been selected.



= input field -----j = output field

Fig. 6,2.2-1: Machining program mask

**Description of the output fields**

INPUT is displayed in the header and M A C H I N I N G P R O G R A M is displayed in output field 2. The output field MODUL displays the version of the module ("INCRE" or "ABSOL"), DEVICE displays the previously selected target device and BLOCK the previously selected DB no.

### Description of the input fields

In the first input field "program type" you can select between a main program ("P") and a subroutine ("L"). The permitted entries are MAIN and SUB,

In the next input field, you can enter a comment, e.g. to provide information about the machining program.

### Significance of the function keys

< F1 > : With this function key you branch to input of machining programs according to DIN.

< F2 > : With this function key you branch to input of machining programs in the TEXT mode.

< F7 > : With the help key you can select the type of program (MAIN or SUB).

< F8 > : If you press the exit key, you will be prompted to confirm abandoning the machining program, if you answer with YES you return to the basic mask (function selection) and if you answer NO you continue with machining program input.

### 6.2.3 Entering Machining Programs according to DIN

In the DIN representation, only one statement of a traversing program can be written per line. Each statement must begin with the statement type and statement number.

The IP246 processes all statements as "normal statements". Normal statements are identified by "N". The statement identifiers "N" for "suppressible statements" and "N" for "main statement" are permitted, however, they have no significance.

The statement number comprises a maximum three digit number. The range of values is 0...999. Apart from the N function (statement type and statement number) the following functions are permitted:

- L function (subroutine call)
- G function (preparatory positioning condition)
- X function (target function)
- F function (speed, time loop repetitions)
- M function (auxiliary function)

|                       |                 |                     |
|-----------------------|-----------------|---------------------|
| INPUT                 | MODUL : L INCRE | SIMATIC S5 / COM246 |
| MACHINING PROGRAM OIN | DEVICE : L FD   | BLOCK : DB 155      |

---

Prog. header : %155 EXAMPLE OF A MACHINING PROGRAM

```

N10 G74 M10
N11 G04 F50 M1 1
N20 G00 X1 10.WJ M20

N25 G24 F7
N30 X-200.000 F4500 M30
N35 G10 X - 50.000 F400 M35
N40 X150.000 F2000 M40
N45 G20
N99 M02

```

|           |               |                    |        |        |           |                      |
|-----------|---------------|--------------------|--------|--------|-----------|----------------------|
| F1        | F2            | F3                 | F4     | F5     | F6        | F7                   |
| NEXT PAGE | PREVIOUS PAGE | DIN --><br>T E X T | INSERT | DELETE | s T O R E | PRINT M.PROG<br>EXIT |

= input field                      .....! = output field

Fig. 6.2.3-1: Machining program mask according to DIN

#### Description of the output fields

The header is as described in the section "Generating Machining Programs."

The program type ("% for main program or "L" for subroutine), the program number and any comment are output in the output field **PROG HEADER**.

#### Description of the input fields

The statements of the machining program are entered in the individual lines. Once the last line is reached, the machining program is scrolled one line upwards, i.e. a new page is begun. The previous page can be displayed again by pressing < F2 > .

#### Significance of the function keys

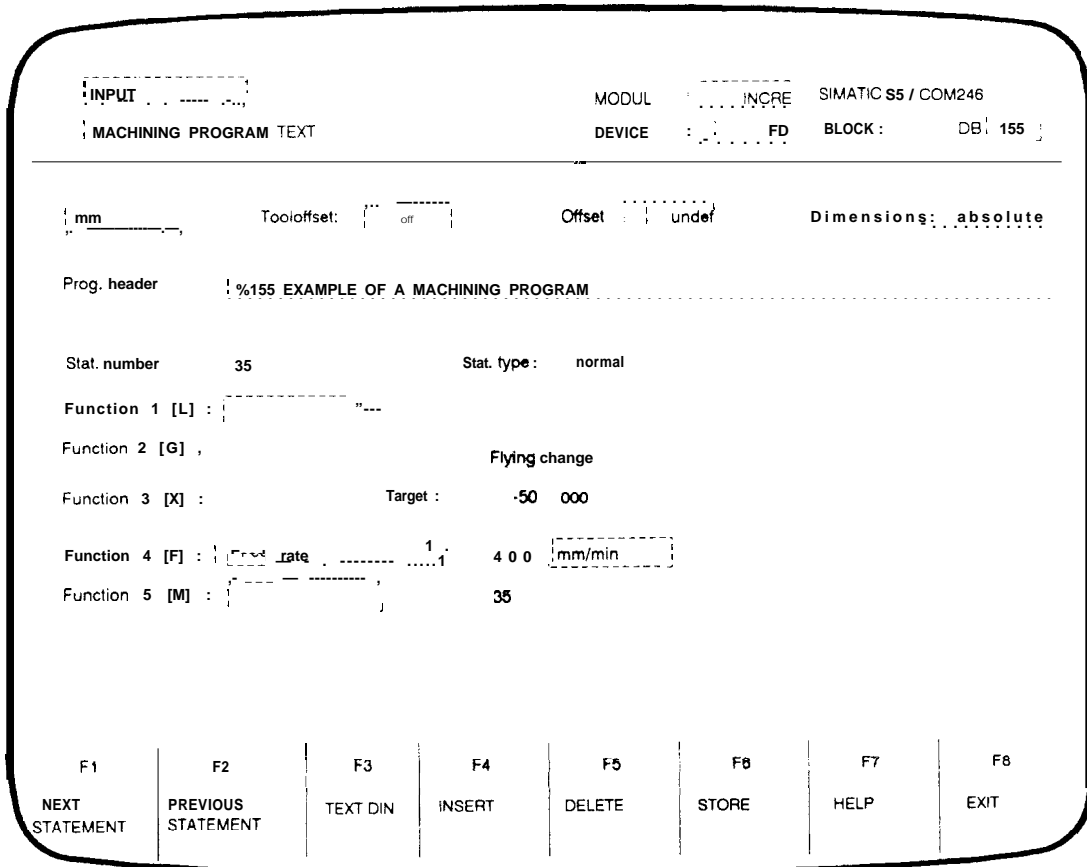
< F1 > : This function key is used to page forwards when the machining program is longer than one page and when you are not on the last page.

< F2 > : Analogous to < F1 > , this function key is used to page backwards.

- < F3 > : With this key, you can switch to text representation.
- < F4 > : Function key < F4 > inserts a line in front of the current cursor position.
- < F5 > : Function key < F5 > deletes the line marked by the cursor.
- < F6 > : If the machining program is syntactically correct, this key stores the program on the previously selected device under the specified DB number. If the program already exists on this device and with this DB number, you will be asked whether or not to overwrite the data block.
- < F7 > : The machining program can be printed out by pressing this key. The masks are the same as those for printing machine data (cf. Section 6.1.3 "Print Machine Data"). When machining programs are being printed out, "MACHINING PROGRAM DIN" is displayed in the third output field of the header.
- < F8 > : With the exit key, the input function can be exited without saving the data.

6.2.4 Entering Machining Programs **in the Text Mode**

In the text mode, only one statement is displayed in a screen mask, The type of statement and the G function can be selected using the help key < F7 >. With the other functions, the appropriate numerical values must be entered.



= input field |-----| = output field

Fig. 6.2.4-1: Machining program mask in the text mode

## Description of the output fields

The header is as described in section "Generating Machining Programs"

### Meas. system:

The measuring system in which the displayed statement is to be interpreted can be seen in the first output field after the header. The default unit is mm. Alternatively, "O. 1 in" will be displayed (G70 or G71).

### Tool offset:

The current tool length offset is displayed here. Possible displays are "off" (G40), "negative" (G44) and "positive" (G43). "Off" is the default. Only the last selected G function (G40, G43 or G44) is displayed, not the resulting tool length offset, A change of sign for example, G44 with -10 mm is not taken into account.

### Offset:

The last selected offset is displayed. Possible displays are "undef" (G53), "1 on" (G54), "2 on" (G55), "3 on" (G56) and "4 on" (G57). "Undef" is the default.

### Dimensions:

The numerical values of the target functions (X functions) can be specified in "absolute" (G90) form or in "incremental" (G91) form, "Absolute" is the default,

## Description of the input fields

### Stat. number:

The statement number is entered here as a numerical value, The statement number can be up to three digits long. It is not necessary to enter statements in ascending order. The individual statements are processed in the order in which they are entered regardless of the statement number.

### Stat. type:

Using the help key, you can select one of the three possible statement types "main" (':N'), "normal" ('N') and "(suppressible" ('/N'),

### L function:

Entry of the subroutine number to be called by the current program. After entering a subroutine number, the text "subroutine no." is displayed before the input field,

### G function:

Using the help key, you can display the possible G functions, Entry of other values is rejected as an error.

### X function:

Here, the target is entered. The maximum range is +/- 40000,000. The value is either interpreted as a distance (with G91) or as an absolute coordinate (with G90).

### F function:

Depending on the previous functions, either the feed rate (following an X function), a dwell time (following G04) or the number of repetitions (following G24) is entered. The appropriate text ("feed rate", "loop runthrough" or "dwell time") is displayed before this input field and the appropriate dimension after the input field,



M function:

The M function is output at the beginning of the statement. The M function MOO means "programmed halt", the M function M02 means program end, After M02, no further statements can be appended. After entering M02, the text "program end" is displayed before this input field and the text "program halt" is displayed after entering MOO.

**Significance of the function keys**

- < F1 > : With this function key you can display the next statement if the machining program is longer than one statement and the last statement is not currently displayed.
- < F2 > : Analogous to < F1 > , you can page back one statement,
- < F3 > : This key switches over to text representation.
- < F4 > : The function key < F4 > inserts a new statement before the statement currently displayed.
- < F5 > : The function key < F5 > deletes the displayed statement.
- < F6 > : If the machining program is syntactically correct, the program is stored on the previously selected device under the specified DB number with this key, If the program already exists on this device under this DB number, you will be asked whether or not to overwrite the data block.
- < F7 > : Using the help key you can select the alternatives for the fields "stat. type" and "G function".
- < F8 > : If you press the exit key you exit the input function without saving the data.

## 7 output

By pressing < F2 > (OUTPUT) in the basic mask ("function selection(') you branch to the "OUTPUT" function. Here, machine data or machining programs can be output from the module, the PG or from a floppy/hard disk drive. It is then possible to change the data and write it back to the source, The function keys < F1 >... < F8 > have the same assignment as in input, The masks are also identical with the exception of the header. Here, OUTPUT is displayed instead of INPUT.

The first mask is the block selection mask, Here, you must select the data block you wish to display. You can select machine data or machining programs using the function key < F7 > (HELP). After specifying

the block number,  
the axis number (only for machine data output) and  
the source device (with < F1 >... < F3 > ) from which the data block is to be read,

the first machine data/machining program mask will be displayed.

### 7.1 Output Machine Data

#### Description of the output fields

OUTPUT and M A C H I N E D A T A are displayed in the header. The version of the module ("INCRE" or "ABSOL") is displayed in the output field MODUL, the previously selected source device in DEVICE and the DB no. in BLOCK,

#### Description of the input fields

The input fields for machine data are completed with the stored values. You can modify the data and write them back to the source device with the function key < F6 > (TRANSFER). Otherwise the mask is the same as for the input of machine data.

### 7.2 Output Machining Program

#### Description of the output fields

OUTPUT and M A C H I N I N G P R O G R A M are displayed in the header The version or the module ("INCRE" or "ABSOL") is displayed in the output field MODUL, the previously selected source device in DEVICE and the DB no. in BLOCK.

#### Description of the input fields

The machining program of the selected data block is displayed. It is possible to change individual statements and to write them back to the source device with the function key <F6> (STORE). Otherwise, the mask is the same as for the input of machining programs.

## 8 Test

In this branch of the program you can test the IP246 module and the drive in all operating modes. Machining programs can be started manually and already existing machining programs can be tested, Actual values are displayed at the PG online. The test mode also allows machining programs to be generated in TEACH-IN.

### Note:

Owing to a hardware feature of the programmers, the keys have a repeat function. This means that if you press a key for a longer time, its key code will be written to the key buffer until it is processed. This means that commands will be processed until the buffer is empty. A STOP command may, therefore, not be executed immediately. This is not an error, the stop command will be executed. Commands entered accidentally after the stop command will, however, also be executed.

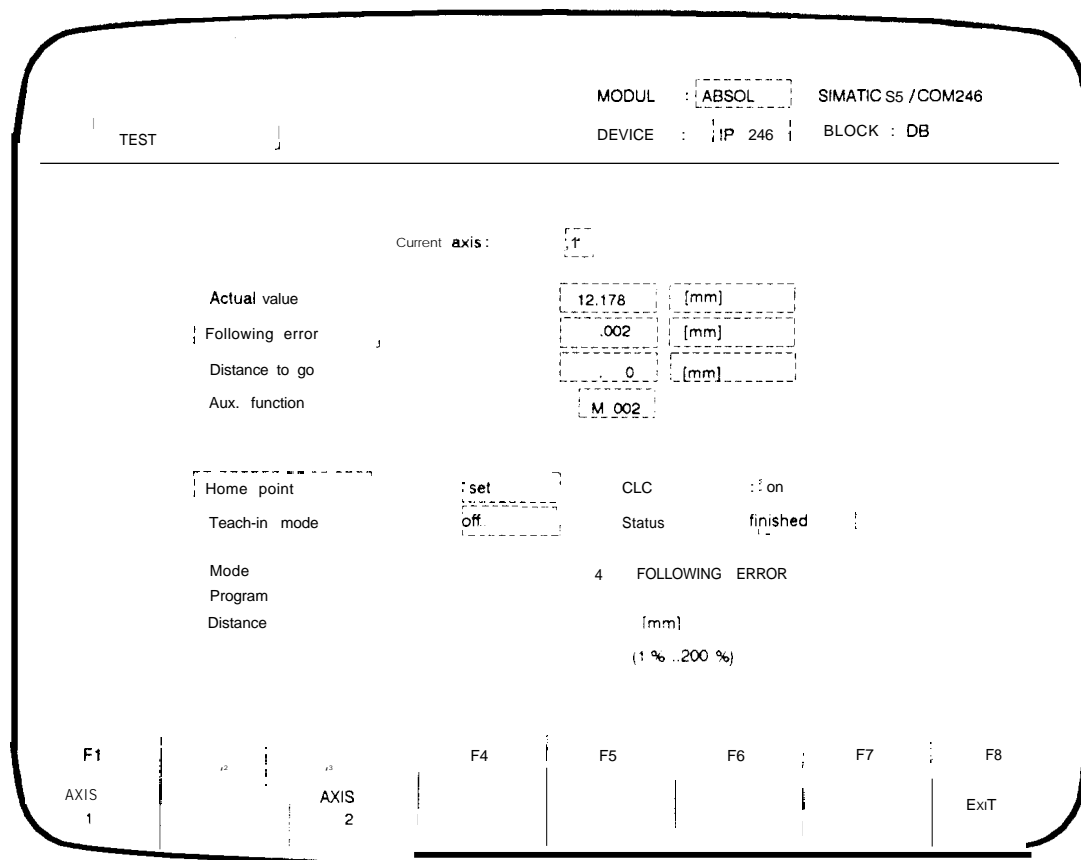
### 8.1 Starting the Test Mode

By pressing <F3> (TEST) in the basic mask (function selection) you branch to the "test" function.

#### Conditions:

The mode is online. You can change the mode in the presetting mask using the function key <F2> (ONLINE-OFFLINE).  
The link from the PG to the IP246 is established and  
the IP246 is operational (green LED lit).

In this section, each mask has values entered in the input and output fields. For the example, we have used an absolute version of the IP246 and the dimensional unit is in mm.



= input field    } = output field

The first mask in "test" is the test axis selection mask.

Fig. 8.1 -1: Test **axis** selection

Description of the output fields

T E S T is entered in the header. The version of the module ("INCRE" or "ABSOL") is displayed in the output field MODUL and "IP246" in DEVICE.

**Significance of the function keys**

- <F1>: Test axis 1. After pressing this key, the program branches to the mode mask,
- < F3 >: Test axis 2. After pressing this key, the program branches to the mode mask.
- < F8 >: The EXIT key returns you to the basic mask ("function selection"),

## 8.2 Modes

If you select the axis with < F1 > (axis 1 ) or < F3 > (axis 2) in the test axis selection mask, you branch to the mode mask, to the actual value display mode.

The screenshot shows a control interface for a machine tool. At the top, there is a header area with the following information:

- TEST (in a dashed box)
- INCREMENTAL ABSOLUTE START (in a dashed box)
- MODUL : ABSOL (in a dashed box)
- DEVICE : IP 246 (in a dashed box)
- SIMATIC S5 / COM246
- BLOCK : OB

Below the header, the main display area shows the following data:

- Current axis : 1 (in a dashed box)
- Actual value : 5.602 [mm] (in a dashed box)
- Following error : .002 [mm] (in a dashed box)
- Distance to go : 0 [mm] (in a dashed box)
- Aux. function : M 002 (in a dashed box)
- Home point : set (in a dashed box)
- Teach-in mode : off (in a dashed box)
- Mode : 6 INCREMENTAL ABSOLUTE (in a dashed box)
- Program : (empty)
- Distance : 5.602 [ . m . . m ]
- Override : 120 (1 % ..200 %)
- CLC : on (in a dashed box)
- Status : finished (in a dashed box)

At the bottom, there is a row of function keys (F1 to F8) with their corresponding actions:

|          |       |      |     |     |          |    |      |
|----------|-------|------|-----|-----|----------|----|------|
| F1       | F2    | F3   | F4  | F5  | F6       | F7 | F8   |
| OP. MODE | START | STOP | FWD | REV | TRANSFER |    | EXIT |

= input field [ ] = output field

Fig. 8.2-1: Mode mask

### Description of the output fields

The version of the module ("INCRE" or "ABSOL") is displayed in the output field MODUL and in "IP246" in DEVICE. The remaining text in the header depends on previous entries. Either simply "TEST" is entered or "TEST" and the current operating mode of the axis and the last command to be executed are displayed.

**Note:** If you return to the basic mask ("function selection") by pressing function key < F8 > (EXIT) in the test axis selection mask, COM246 starts operating mode 17 ("clear error"). This is then displayed in the mode mask in output field 3 in the header.

**Actual value:**

The current position coordinate (actual position value) of the selected axis is displayed. The value is displayed in the appropriate dimension.

The text "following error:" does not appear in the operating modes "JOG OPEN LOOP" (mode 3) and "FOLLOWING ERROR" (mode 4). In these modes, the text "speed ::" is displayed at this point.

Following error:

This field displays the difference between the actual position value and the setpoint (not in modes "JOG OPEN LOOP" and "FOLLOWING ERROR")

Speed:

The current speed of the axis is displayed (in modes "JOG OPEN LOOP" and "FOLLOWING ERROR").

Distance to go:

This displays the difference between the actual position value and the target coordinate. This only applies to modes "AUTOMATIC" and "AUTOMATIC SINGLE STATEMENT" "INCREMENTAL ABSOLUTE" and "INCREMENTAL RELATIVE".

Aux. function:

In the modes "AUTOMATIC" and "AUTOMATIC SINGLE STATEMENT" the programmed M function is displayed as a numerical value, The auxiliary function (M function) M02 is the default.

The text "home point:" is only displayed with the absolute version ("ABSOL"). With the incremental version ("INCRE"), the text "reference point:" is displayed here.

Home/reference point:

With the incremental version, this field shows whether the reference point is "set" or "reset", with the absolute version it shows whether the home point is "set" or reset (not set),

CLC (closed-loop controller):

This field indicates whether you are using closed-loop or open-loop control. The possible displays are "on" or "off".

Teach-in mode:

This displays whether the selected axis is in teach-in ("on") or not ("off")

Axis status:

Here, the status of the axis is displayed. Possible displays are "finished" and "running".

If there are no correct machine data for the axis on the module, then no actual value, no following error (speed) and no distance to go will be displayed. The statuses reference/home point, CLC, teach-in mode and axis status remain unchanged. Without machine data, only modes 4 (following error) and 17 (clear error) can be executed apart from input and output of data

Note:

With the incremental version of the IP246, a correct actual value display is only guaranteed when the module has not been switched off and on again after starting COM246 (online mode). After starting up the IP246 again, you must switch to the basic mask by pressing <F1> (BEGIN) in the presetting mask.

## Description of the input fields for changing modes

The inversely displayed input fields are only completed after pressing function key < F1 > (OP MODE). If you press < F1 >, the mask changes to the change mode function.

### Note:

The displayed values, actual value (actual position value), following error (speed), distance to go, auxiliary function and the displayed axis attributes (= > "Fundamentals of Positioning, Reference Manual", Section 6 "Axis Attributes"), are then no longer updated.

The function key < F1 > changes to "ACTUAL VALUES", the function key < F7 > changes to "HELP". By pressing < F1 > (ACTUAL VALUES) you return to the actual value display mode.

### Mode:

Here, the required mode and selected axis are entered. The mode can be selected from the mode table with the HELP key < F7 >. After entering the mode number (right-justified), the corresponding text is displayed to the right of the mode number. Modes 1..,19 are permitted. If a different number is specified, you branch automatically to the mode table. Depending on the selected mode, the function keys < F2 >... < F6 > have different functions. In mode 5 (REFERENCE/HOME POINT APPROACH), a further input field is displayed, Providing an incremental version has been selected (configuration mask), you can select between "set" and "run" by pressing the help key < F7 >.

### Program:

This input field can only be written to in modes 8 (AUTOMATIC), 9 (AUTOMATIC SINGLE STATEMENT) and 10 (TEACH-IN ON), In these cases, the machining program number must be entered.

### Distance:

The distance input field can only be written to in modes 6 (INCREMENTAL ABSOLUTE), 7 (INCREMENTAL RELATIVE), 12 (ZERO OFFET ABSOLUTE), 13 (ZERO OFFSET RELATIVE) and 15 (TOOL OFFSET). In each case the distance or coordinate must be entered in the selected dimension.

### Override:

This input field can only be written to in modes 1 (JOG SPEED 1), 2 (JOG SPEED 2), 3 (JOG OPEN LOOP), 6 (INCREMENTAL ABSOLUTE) and 7 (INCREMENTAL RELATIVE). You can change the speed of the axis stored in the machine data by a percentage (1%...200%).

## Significance of the function keys

< F1 > : With < F1 >, you can switch between the actual value display mode and the mode change function. In the actual value display mode the values actual value, following error (speed), distance to go, aux. function and the displayed axis attributes of the selected axis are displayed and continuously updated. If you select the mode change function the mode and corresponding parameters can be changed.

< F2 > : "START" is only permitted in modes 4...6, 8...12 and 14...19.

< F3 > : "STOP" is only permitted in modes 1...4 and 6...9.

< F4 > : The command "FWD" is permitted in modes 1...3, 7, 13 and 15. If a rotary axis is selected as the axis type, the "FWD" command is also permitted in mode 6.

< F5 > : The command "BACK" is permitted in modes 1.,3, 7, 13 and 15. If a rotary axis is selected as the axis type, the "BACK" command is also permitted in mode 6.



< F6 > : The function of the "TRANSFER" key depends on the mode.

In operating modes 1...3, 6 and 7 the speed of the current operating mode (axis status "running") can be changed. The number of the current operating mode must be entered in the mode change function. The speed is modified according to the override when the "TRANSFER" key is pressed. The resulting speed must remain within the permitted limits following the override change.

In the "AUTOMATIC SINGLE STATEMENT" mode, this key executes the next statement of an automatic program.

In the "AUTOMATIC" mode, the "TRANSFER" key is used to acknowledge a programmed halt (MOO).

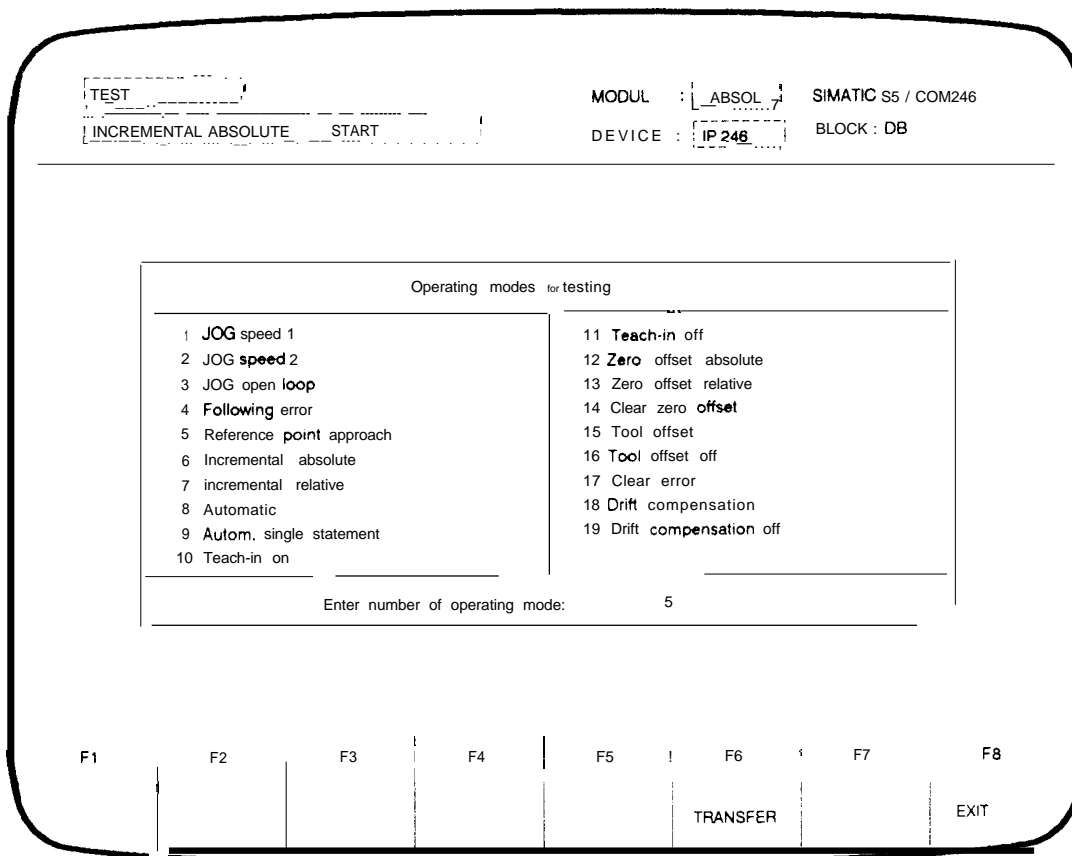
If the teach-in mode is active and the axis status is "finished", the "TRANSFER" key is used to save a statement.

< F7 > : Providing the cursor is located in the input field "mode", the HELP key < F7 > can be used to branch to the mode table. From this table you can select a mode and return to the mode mask with < F6 > (TRANSFER), In mode 5 (REFERENCE POINT), the HELP key can be used to switch between "SET" and "RUN" (only with the incremental version).

< F8 > : The EXIT key returns you to the test axis selection mask, The header remains unchanged.

### 8.3 Mode Table

By pressing the HELP key in the mode mask (mode change function), you can branch to the mode table mask. This contains all the possible modes and mode numbers.



= input field { ----- } = output field

Fig. 8,3-1: Mode table

**Description of the output fields**

The header remains unchanged.

**Description of the input field**

The mask has only one input field in which the number of the required mode is entered. All other values apart from those listed lead to the error message "FFF input prohibited".

**Significance of the function keys**

- < F6 > : Using the "TRANSFER" key the operating mode number is entered in the "mode" field of the mode mask. The corresponding text is displayed at the same time.
- < F8 > : The exit key returns you to the mode mask (mode change function). "FOLLOWING ERROR" is then entered as the operating mode.

## 9 Transfer

By pressing <F4> (TRANSFER) in the basic mask you branch to the transfer mask.

In this branch of the program you can transfer machine data or machining programs from one device to another.

The screenshot shows a terminal window with the following content:

```

TRANSFER
MACHINE DATA
MOOUL INCRE
SIMATIC S5 / COM246
DEVICE FD
BLOCK: DB 123

Data block : MACHINE DATA

Source Target
Device F0 IP 246 (* = all VDAT)
Block no. 123 123
Axis 1 1
Drive A
Filename EXAMPLE
Plant design, : LINEAR AXIS
Generated by : SMITH
Generated on : 12.06.89

F1 F2 F3 F4 F5 F6 F7 F8
TRANSFER HELP EXIT

```

= input field  = output field

Fig. 9-1: Transfer mask

### Description of the output fields

The version of the module ("INCRE" or "ABSOL") is displayed in the **MODUL** field. Following the start of the transfer, **TRANSFER** and either **MACHINING PROGRAM** or **MACHINE DATA** are entered in the header. The output fields **BLOCK** and **DEVICE** are completed with the appropriate values. The DB number of the data record to be transferred is displayed in **BLOCK** and the source device is entered in **DEVICE**.

## Description of **the** input fields

### Data block:

With < F7 > (HELP) you can select between machine data and machining programs.  
Device: with < F7 > (HELP) you can select the source or destination device, The possible entries are module (I P246), the programmer (PG) or the data drive (FD).

### DB no.

As the source, the number of the block to be transferred must be specified, The same number will be entered as the target. This can, however, be changed, The range of values is from 0...55. If a "\*" is entered for the DB no. of the source, all DBs (either machine data or machining programs) on the selected source device will be transferred to the destination device, The DB number of the destination device is then meaningless,

### Note:

The PG can only store one machine data record and one machining program

### Axis:

When transferring machine data, the axis number in the machine data record to be transferred must be entered under source, If there is no machine data record with this axis number on the selected device, the error message 'data block missing' is displayed. When transferring the machine data, it is possible to change the axis number of the target DB.

### Drive:

If the selected source device is a floppy or hard disk the name of the drive is also required. You can use the HELP key < F7 > to make the entry.

### File name:

If the source is a drive (floppy or hard disk) the file name must be selected using the help key, If there is no file on the selected drive with the extension .246 (incremental version) or .A46 (absolute version) no DB can be transferred. In this case the error message "data block missing" is displayed. If the target device is a drive, the file name selected in the presetting mask will be used and the corresponding data for plant designation, generated on and generated by will be displayed in the appropriate fields,

You can only transfer to the drive selected in the presetting mask,

## Significance of the function keys

< F4 > : This function key starts the transfer,

< F7 > : The help key can be used to make selections in the "block number", source device and destination device fields. Remember that no blocks can be transferred if the source and destination device are identical, Otherwise, possible source drives and the files contained can be selected.

< F8 > : Pressing this function key abandons the "TRANSFER" function and you return to the basic mask ("function selection").

## 10 Delete

Pressing <F5> (DELETE) in the basic mask ("function selection") branches to the delete mask,

In this program branch you can delete machine data or machining programs stored on a device (IP246, FD, PG).

= input field    } }    = output field

Fig. 10-1: Delete mask

### Description of the output fields

The version of the module ("INCRE" or "ABSOL") is displayed in the MODUL field. After starting the delete function, DELETE and either M A C H I N I N G P R O G R A M or M A C H I N E D A T A are displayed in the header. The output fields BLOCK and DEVICE are then completed with the appropriate entries. The DB number of the data record to be deleted is displayed in BLOCK and the device containing the data record to be deleted is displayed in DEVICE,

### Description of the input fields

Data block:

< F7 > (HELP) can be used to select between machine data and machining programs.

Axis:

If machine **data are to be deleted, the axis number of the machine data record to be deleted must be entered here. This number is stored in the machine data record**

Source device:

With < F7 > (HELP) you can select the device on which the data **block is to be deleted**. Possible selections are module (I P246), the programmer (PG) or the data drive (FD).

Block no:

The number of the block to be deleted is entered here, The range of values is 0...255, **If you enter "\*" all DBs** (machine data records or machining programs) on the selected device will be deleted.

### Significance of the function keys

< F5 > : This function key starts the delete function.

< F7 > : Using the help key you can select alternatives in the "data block" and "source device" fields.

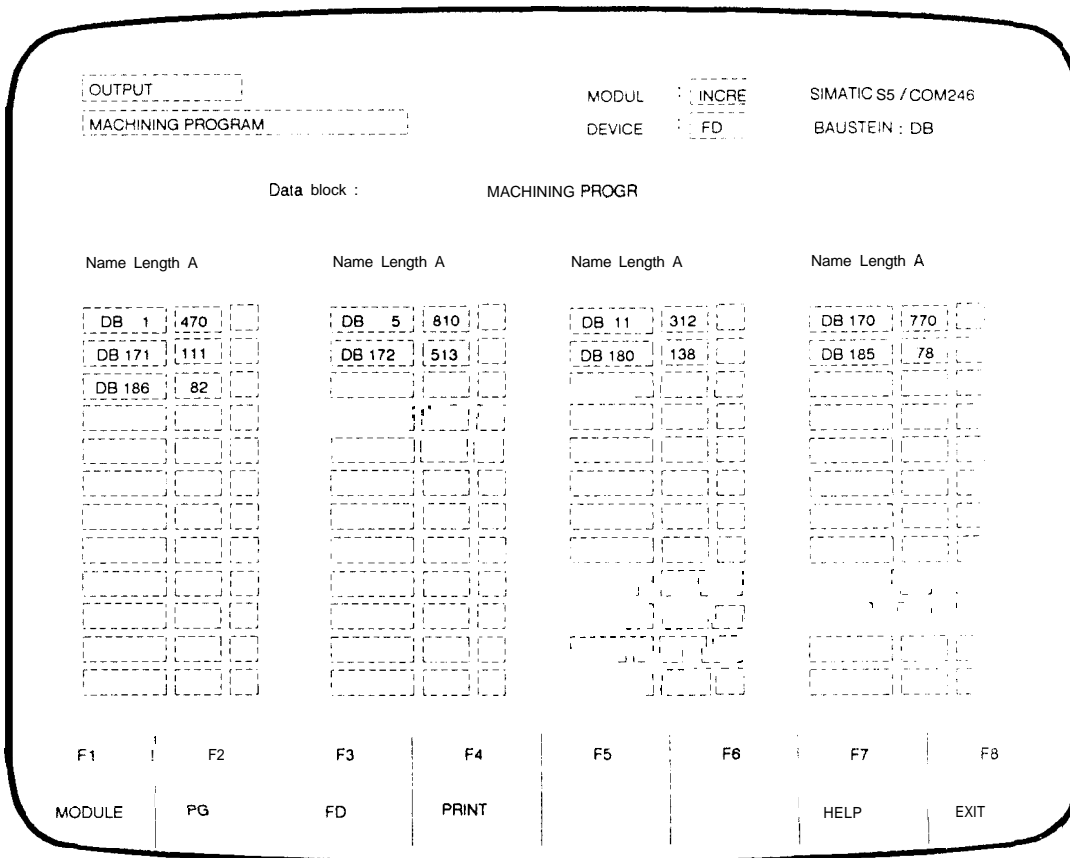
< F8 > : With this function key you abandon the delete function and return to the basic menu.

## 11 Information

By pressing < F7 > (INFORMATION) in the basic mask ("function selection") you branch to the information mask.

In this program branch, you can obtain an overview of all the machine data or machining programs stored on a device (IP246, PG, FD). One screen page can list a maximum of 48 entries. If there are more than 48 machine data records or more than 48 machining programs stored on a device, you can page forwards or backwards. The assignment of the function keys is automatically changed < F1 > (NEXT PAGE) and < F2 > (PREVIOUS PAGE). These two keys can be used to page forwards or backwards until there are no further entries to be listed. In this case the message "last page reached" is displayed.

After selecting the source device with the keys < F1 > ... < F3 > , the data blocks are displayed with their DB number and length. With machine data, the axis number for which the machine data record is intended is also displayed. By pressing < F8 > (EXIT) you return to the basic mask (function selection).



= input field      = output field

Fig. 11 -1: Information mask

### **Description of the output fields**

After starting the information function, INFORMATION and either M A C H I N I N G P R O G R A M or M A C H I N E D A T A is entered in the header, The source of the data is displayed in the DEVICE output field. The BLOCK output field remains unchanged.

### **Description of the input fields**

Data block:

Using <F7> (HELP), you can select between information about machine data or information about machining programs.

### **Significance of the function keys**

< F1 > , < F3 > :

With these function keys you select the devices (I P246, FD or PG) from which the data blocks are to be read. If there are more than 48 entries < F1 > and < F2 > are assigned the paging function.

< F4 >: This starts the printout of the data blocks.

< F7 >: The help key is used to select the type of data block (machine data or machining programs).

< F8 >: With the EXIT key you can exit the information function.



# SIEMENS

## SIMATIC S5

IP246 Positioning Module

Incremental 6ES5246-4UA31 / -4UA41

Absolute 6ES5246-4UB11 / -4UB21

Standard Function Blocks FB164 and FB165

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User's Guide

C79000-B8576-C655 -02

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# 1 General Notes

## 1.1 Overview

This part describes the two standard function blocks

FB164 (PER:POS)      “operating and monitoring the positioning module” and  
 FB165 (PER :PDAT)    “positioning module parameter assignment”

FB164 is used to operate and monitor the IP246 positioning module. With FB164 you can start the IP246 operating modes 1...19 from the user program. FB164 also supplies constantly updated information about the current status of an axis (errors, M functions, ... ). As soon as one of the monitoring modes is started, the selected value is read and output cyclically by FBI 64.

FB165 is used to assign parameters to the IP246. It is responsible for the data exchange between your user program and the IP246. By calling FB165, you can execute the following functions via the PC interface:

- read machine data and machining programs from the IP246, delete them and transfer them to the IP246,
- read the system identification from the IP246 and transfer it to the IP246,
- request an overview of the machine data or machining programs stored on the IP246 and
- read actual values (actual position value, following error or speed, distance to go).

The function blocks FB164 and FB165 are used in the following programmable controllers

**S5 115U**      (**CPU 941 to CPU 944**)  
**S5 135U**      (**CPU 922 and CPU 928**)  
**S5 150U**  
**S5 155U**

in conjunction with the following IP246 positioning modules

**6ES5 246-4UA31**    (incremental version for ventilated operation)  
**6ES5 246-4UA41**    (incremental version for non-ventilated operation)  
**6ES5 246-4UB11**    (absolute version for ventilated operation)  
**6ES5 246-4UB21**    (absolute version for non-ventilated operation)

This User's Guide assumes that you are familiar with the IP246 and the programmable controller.

The function blocks FBI 64 and FB165 are supplied on the diskette with one example under one of the following file names:

|         |             |               |
|---------|-------------|---------------|
| S5 115U | all CPUS    | :S5TA50ST.S5D |
| S5 135U | CPU 922/928 | :S5TB22ST.S5D |
| S5 150U |             | :S5TA40ST.S5D |
| S5 155U |             | :S5TA60ST.S5D |

## 1.2 Notes

The IP246 positioning module is addressed by means of pages. It has two positioning axes and therefore requires two page addresses,

**Function block FB164 must be called once for each axis, function block FB165 can be called conditionally.**

**Calls in the processor time interrupt 06s are not permitted.**

The function blocks FB164 and FB165 operate with the data handling blocks SEND and RECEIVE, FB165 also requires the FETCH data handling block.

The pages must be installed in the start-up OB (OB20, OB21 and OB22 or OB21 and OB22 for the S5 115U) with the SYNCHRON data handling block (FB125, FB185 and FB249).

### 1.2.1 Overview of the Handling Blocks

|          | S5 115U | S5 135U | S5150U | S5155U                |
|----------|---------|---------|--------|-----------------------|
| SYNCHRON | FB249   | FB125   | FB185  | FB125                 |
| SEND     | FB244   | FB120   | FB180  | FB120                 |
| RECEIVE  | FB245   | FB121   | FB181  | FB121                 |
| FETCH    | FB246   | FB122   | FB182  | FB122 only for FBI 65 |

### 1.2.2 Installing an Interface in OB20, OB21 or OB22 with the S5 135U

```

: JU FB125
NAME : SYNCHRON
SSNR : KY0,2 Interface 2
BLGR : KY0,0 Block size (always 0,0)
PAFE : FYI SYNCHRON parameter assignment error

```

The SYNCHRON call must be programmed for each interface to be addressed in the cyclic program section (cf. Section 4 "Examples").

## 1.3 Using FB164/FB165 in the S5 115U

### 1.3.1 Interrupting the User Program by Process and Time Interrupts in the S5 115U

The user program is always interrupted at command boundaries

If interrupt OBs are programmed in the user program in which the scratchpad flag area (flag byte FY200 to FY255) is used, you must ensure that this flag area is saved and loaded again before exiting the interrupt OBs.

It is not permitted to call data handling blocks in the interrupt branches

### 1.3.2 Start-up Characteristics of the S5 115U

Cyclic program execution following "cold restart" (OB21) and following an "automatic warm restart" (OB22) begins at the start of OB1.

The function blocks FB164 and FB165 are normally not called in the start-up OBs (OB21 and OB22).

In the start-up OBs (OB21 and OB22) the binary identifiers for all axes used must be deleted (overwritten with the value KH0000).

The binary identifiers required by FB164 are stored in the axis data block in data words DW n + 14. (n is the same as the parameter DWNR in FB164.)

The binary identifiers required by FB165 are in the parameter assignment data blocks (parameter: DBNR) in data words DW n + 6. (n is the same as the parameter DWNR in FB165.)

## 1.4 Using FB164/FB165 in the S5 135U (CPU922 and CPU928)

### 1.4.1 Interrupting the User Program by Process and Time Interrupts in the S5 135U (CPU922 and CPU928)

The **user** program is interrupted at the block boundaries or at the command boundaries if data block DX0 is assigned suitable parameters.

If interrupt OBs are programmed in the user program in which the scratchpad flag area (flag bytes FY200 to FY255) is used, you must ensure that this flag area is saved and loaded again before exiting the interrupt OBs. The same applies to the operating system data RS60 to RS63.

If the program can be interrupted at the command boundaries, the handling blocks must not be called in the interrupt branch. If this is, however, required, you must ensure that function block FBI 64 or function block FB165 cannot be interrupted during the cyclic program.

### 1.4.2 Start-up Characteristics of the S5 135U (CPU922 and CPU928)

Cyclic program execution following a "cold restart" (OB20) begins at the start of OB1

With the "warm restarts", OB21 (manual warm restart) or OB22 (automatic warm restart) the program is continued at the point of interruption after the start-up OBs have been run through

Function blocks FB164 and FB165 are not normally called in the start-up OBs (OB20 and OB22).

When using the positioning module in the S5 135U, you must ensure that the programmable controller executes a "cold restart after power up". An "automatic cold restart after power up" can be achieved by programming data block DX0 (block identifier **KH02xx**, parameter KH1 001, where xx corresponds to the block length/refer to the S5 135U manual).

The function "automatic cold restart after power up" calls the organization block OB22

In the start-up OBs (OB20 and OB22), the binary identifiers for all axes used must be deleted (overwritten with the value KH0000).

A manual warm restart is not permitted. OB21 contains a statement STP (direct change to the stop state).

The binary identifiers required by FB164 are stored in the axis data block (parameter: DBNR) in data words DW n + 14. (n is the same as the parameter DWNR in FB164.)

The binary identifiers required by FB165 are in the parameter assignment data blocks (parameter: DBNR) in data words DW n + 6. (n is the same as the parameter DWNR in FB165.)

## 1.5 Using FBI 64/FB165 in the S5 150U

### 1.5.1 Interrupting the User Program by Process and Time Interrupts in the S5 150U

The user program is interrupted at the block boundaries

If interrupt OBs are programmed in the user program in which the scratchpad flag area (flag bytes FY200 to FY255) is used, you must ensure that this flag area is saved and loaded again before exiting the interrupt OBs.

### 1.5.2 Start-up Characteristics of the S5 150U

Cyclic program execution following a "cold restart" (OB20) begins at the start of OB1.

With the "warm restarts", OB21 (manual warm restart) or OB22 (automatic warm restart) the program is continued at the point of interruption after the start-up OBs have been run through

When using the positioning module, a manual warm restart (OB21) or an automatic warm restart (OB22) is not permitted. Both start-up OBs contain the statement STP (change to stop state)

In the cold restart organization block OB20, the binary identifiers for all axes used must be deleted (overwritten with the value KH0000).

The binary identifiers required by FB164 are stored in the axis data block (parameter: DBNR) in data words DW n + 14. (n is the same as the parameter DWNR in FB164.)

The binary identifiers required by FB165 are in the parameter assignment data blocks (parameter: DBNR) in data words DW n +6. (n is the same as the parameter DWNR in FBI 65. )

## 1.6 Using FB164/FB165 in the S5 155U

### 1.6.1 Interrupting the User Program by Process and Time Interrupts in the S5 155U

The user program is interrupted at the block boundaries or at the command boundaries if data block DXO is assigned suitable parameters.

If interrupt OBs are programmed in the user program in which the scratchpad flag area (flag bytes FY200 to FY255) is used, you must ensure that this flag area is saved and loaded again before exiting the interrupt OBs. If the program can be interrupted at the command boundaries, the handling blocks must not be called in the interrupt branch. If this is, however, required, you must ensure that function block FBI 64 or function block FB165 cannot be interrupted during the cyclic program.



### 1.6.2 Start-up Characteristics of the S5 155U

Cyclic program execution following a “cold restart” (OB20) begins at the start of OB1

With the “warm restarts”, OB21 (manual warm restart) or OB22 (automatic warm restart) the program is continued at the point of interruption after the start-up OBs have been run through

Function blocks FB164 and FB165 are not normally called in the start-up OB (OB20)

When using the positioning module in the S5 155U, you must ensure that the programmable controller executes a “cold restart after power up”. An “automatic cold restart after power up” can be achieved by programming data block DXO (block identifier KH02xx, parameter KH1 001, where xx corresponds to the block length/refer to the S5 155U manual).

The function “automatic cold restart after power up” calls the organization block OB20

In the start-up OB (OB20) the binary identifiers for all axes used must be deleted (overwritten with the value KH0000). A manual warm restart is not permitted, OB21 contains a statement STP (direct change to the stop state).

The binary identifiers required by FB164 are stored in the axis data block (parameter: DBNR) in data words DW n + 14. (n is the same as the parameter DWNR in FB164.)

The binary identifiers required by FB165 are in the parameter assignment data blocks (parameter: DBNR) in data words DW n + 6. (n is the same as the parameter DWNR in FB165.)

**Note:**

To save and load the scratchpad flag area you must use the standard function blocks FB38 and FB39. The function blocks operate with a data block (see example in Section 4, DB255). This must be created up to and including data word DW820. The function blocks must be used in pairs, i.e. the interrupt OBs must not be exited prematurely with the statement BEC.

### 1.7 Using the Positioning Module in Multiprocessor Operation (applies to the S5 135U and S5 155U)

If the positioning module is used in a programmable controller with more than one processor, you must ensure that an axis is only ever addressed by one CPU module.

**Access by several CPUs to the same axis is not permitted and leads to program errors.**

## 2 The Standard Function Block FB164

### 2.1 Functional Description

The function block FB164 “operating positioning module” allows the following functions to be executed:

- Starting a job (modes 1...19) on the IP246 from the user program.
- Cyclic reading of the actual position value, following error/speed or distance to go from the IP246. These values are output as BCD or binary numbers depending on the assignment of the BCD parameter.
- Constant reading of the set mode, the current M function, the checkback signals ( => “Fundamentals of Positioning, Reference Manual”, Section 6 “Axis Attributes”) and the module error from the assigned interface. These are available at the parameter outputs of the function block or in the axis data block.

The function block FB164 can have parameters assigned directly or indirectly. With direct parameter assignment the user data required to start a mode (BA 1 .. 19) are at the inputs of the function block. With indirect parameter assignment, FBI 64 supplies the parameter values from the data block valid before its call.

For certain modes, specific job parameters are required. These must be stored in the axis data block as byte, word and double word parameters before the mode is started.

**Before calling FB164, the axis data block must be installed and contain valid values**

## 2.2 Calling Function Block FB164

### 2.2.1 S5135U, S5150U, S5 155U

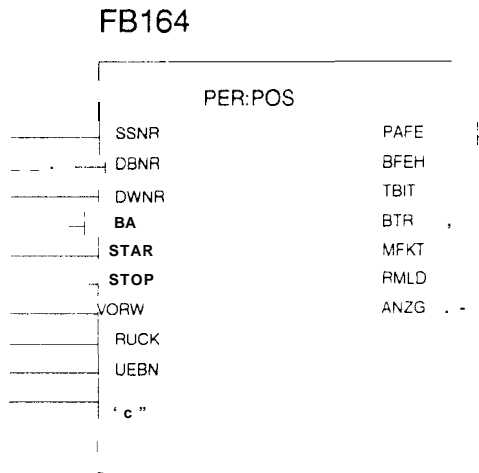
In STL (Statement List):

In LAD/CSF (Ladder Diagram or Control System Flowchart)

```

NAME : JU FB164
 : PER:POS
SSNR :
DBNR :
DWNR :
BA :
STAR :
STOP :
VORW :
RUCK :
UEBN :
BCD :
PAFE :
BFEH :
TBIT :
BTR :
MFKT :
RMLD :
ANZG :

```



### 2.2.2 S5115U

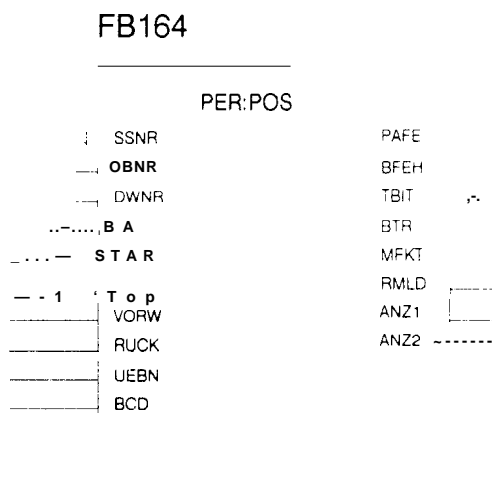
In STL (Statement List):

In LAD/CSF (Ladder Diagram or Control System Flowchart)

```

NAME : JU FB164
 : PER:POS
SSNR :
DBNR :
DWNR :
BA :
STAR :
STOP :
VORW :
RUCK :
UEBN :
BCD :
PAFE :
BFEH :
TBIT :
BTR :
MFKT :
RMLD :
ANZ1 :
ANZ2 :

```



## 2.3 Overview of the Parameters

| NAME | PARA TYPE | DATA TYPE | SIGNIFICANCE                                                |
|------|-----------|-----------|-------------------------------------------------------------|
| SSNR | D         | KF        | Interface number                                            |
| DBNR | D         | KY        | DB type, DB number (of axis data block)                     |
| DWNR | D         | K         | First data word in axis data block                          |
| BA   | D         | KF        | Mode (mode number)                                          |
| STSR | I         | BI        | START command for the axis                                  |
| STOP | I         | BI        | STOP command for the axis                                   |
| VORW | I         | BI        | FORWARD command for the axis                                |
| RUCK | I         | BI        | REVERSE command for the axis                                |
| UEBN | I         | BI        | ENTER command for the axis                                  |
| BCD  | I         | BI        | Parameter ANZG in BCD ('1' or binary ('0'))                 |
| PAFE | Q         | BI        | Parameter assignment error                                  |
| BFEH | Q         | BI        | Module error                                                |
| TBIT | Q         | BI        | Active bit                                                  |
| BTR  | Q         | B Y       | Output of the mode set for the axis                         |
| MFKT | Q         | BY        | Output of the M function of the axis                        |
| RMLD | Q         | BY        | Output of checkback signals (axis attributes) from the axis |
| ANZG | 0         | D         | Output of the selected monitoring job                       |

For the S5 115U, the parameters ANZ1 and ANZ2 correspond to the parameter ANZG.

|      |   |   |                                       |
|------|---|---|---------------------------------------|
| ANZ1 | Q | D | Output of the selected monitoring job |
| ANZ2 | Q | D |                                       |

## 2.4 Explanation of the Parameters

SSNR : D,KF x

Specification of the page number (cf. switch setting J64, "Hardware, Instructions", Section 3,2 "Setting the Module Address") of the corresponding axis,

x = interface (page number)  
 $0 \leq x \leq 255$

DBNR : D,KY x,y

Specification of the data block type and the data block number of the axis data block. With the S5 115U and S5 150U programmable controllers, data block type DX cannot be programmed.

x = data block type  
 x = 0 : data block type DB  
 x > 0 : data block type DX

Y = data block number  
 $5 \leq y \leq 255$  where x = 0  
 $1 \leq y \leq 255$  where x > 0  
 direct parameter assignment via the block parameters  
 (axis data block)  
 y = 0  
 indirect parameter assignment via the data block  
 opened before the FBI 64 call

DWNR : D,KF x

Specification of the first data word in the axis data block,

x = first data word  
 $0 \leq x \leq 236$   
 where:  $5 \leq$  parameter DBNR  $\leq 163$  and  
 $166 \leq$  parameter DBNR  $\leq 255$   
 $16 \leq x \leq 236$   
 where: parameter DBNR = 164  
 (DB164 = working DB for standard  
 function block FB164)  
 $48 \leq x \leq 236$   
 where: parameter DBNR = 165  
 (DB165 = working DB for standard  
 function block FB165)

BA : D,KF x

Specification of the mode or monitoring function to be started on the IP246.

x = mode (mode number) or number of the monitoring function

**1 <= x <= 19** and

**71 <= x <= 73** and

**x = 74** switch off monitoring

| Job number | Mode                       |
|------------|----------------------------|
| 1          | JOG speed 1                |
| 2          | JOG speed 2                |
| 3          | JOG open loop              |
| 4          | Following error            |
| 5          | Reference point approach   |
| 6          | Incremental absolute       |
| 7          | Incremental relative       |
| 8          | Automatic                  |
| 9          | Automatic single statement |
| 10         | Teach-in on                |
| 11         | Teach-in off               |
| 12         | Zero offset absolute       |
| 13         | Zero offset relative       |
| 14         | Clear zero offset          |
| 15         | Tool offset                |
| 16         | Tool offset off            |
| 17         | Clear error                |
| 18         | Drift compensation         |
| 19         | Drift compensation off     |

#### Monitoring functions

|    |                                                           |
|----|-----------------------------------------------------------|
| 71 | Actual position value                                     |
| 72 | Following error (speed for modes 3 and 4)                 |
| 73 | Distance to go                                            |
| 74 | Interrupt the cyclic execution of the last monitoring job |

**STAR** : I,BI            These parameters represent the possible commands  
**STOP** : I,BI            and start the data transfer to the positioning  
**VORW** : I,BI            module on the positive-going edge O --> 1.  
**RUCK** : I,BI            The following data from the axis data block  
**UEBN** : I,BI            are transferred:
 

- byte parameters (DR n),
- word parameters (DW n + 1 ) and
- double word parameters (DD n +3)

**BCD** : I,BI

If the BCD parameter has the signal state "1", the variables actual position value, following error or speed and distance to go are converted to a seven digit BCD number with sign. If the signal state is "0", these values are output in binary.

In the BCD format a maximum +/- 9999999 (urn, 0.0001 in, 0.001 degrees) can be represented, If one of these limits is violated, the output value (parameter output ANZG or the corresponding data words) is output as a binary number.

**PAFE** : Q,BI

If an error is made in the parameter assignment, the PAFE parameter has the signal state "1". The error can be identified by the assignment of

flag byte FY255

(=>"Planning, Installation and Service, Section 2 "Troubleshooting").

**BFEH** : Q,BI

The parameter BFEH (module error) has signal state "1" when the IP246 positioning module signals an error. The type of error can be identified from

flag byte FY254

(=>"Planning, Installation and Service, Section 2 "Troubleshooting").

TBIT : Q,BI

Active bit: The module is executing the transferred job (BA 1...19).

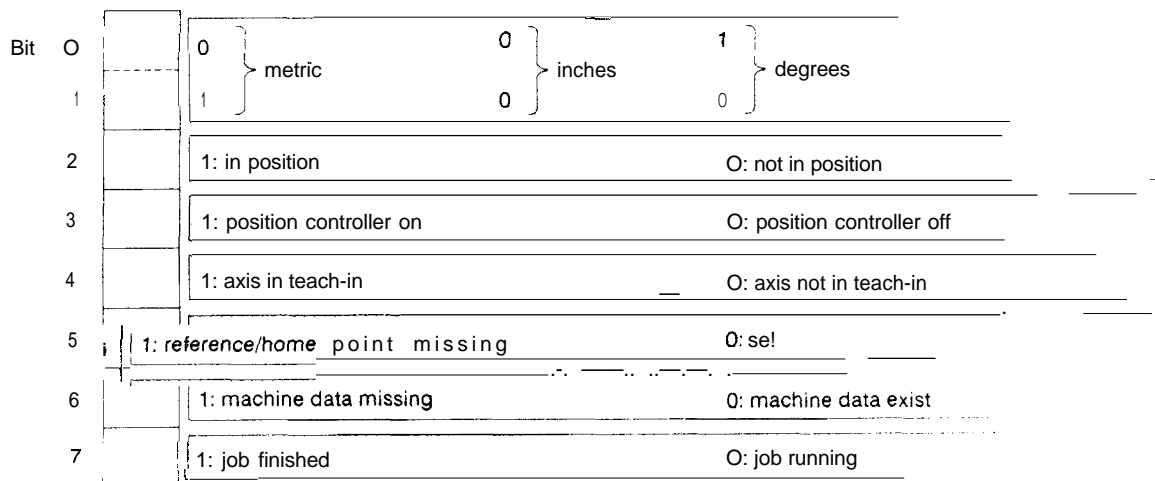
The "active bit" is set by function block FB164 when a job (BA 1...19) is transferred to the positioning module. After executing or abandoning the job, the active bit is reset by the IP246 (= > Section 2.6 "Relationship between the Parameter TBIT and the current Checkback Signals").

BTR : Q,BY

Output of the mode currently set on the IP246 module.

MFKT : Q,BY

During automatic operation (BA 8 and 9) the M functions programmed in the automatic program are output by the IP246 (= > "Fundamentals of Positioning, Reference Manual", Section 5.9 "The M Function"). In all other modes M02 is output.



RMLD : Q,BY

Output of the checkback signals (axis attributes) of the IP246 positioning module (= > "Fundamentals of Positioning, Reference Manual", Section 6 "Axis Attributes").



**ANZG** : Q,D with S5 115U: **ANZ1** : Q,W  
**ANZ2** : Q,W

Output of the actual position value (BA 71 set), the following error or speed (BA 72 set) and the distance to go (BA 73 set). If cyclic monitoring is switched off with mode 74, the value zero is output.

The output is either in BCD format (BCD = signal state "I") or binary (BCD = signal state "O").

If parameters are assigned indirectly the following output parameters of FB164 are no longer updated:

BTR - mode type  
 MFKT - M functions  
 RMLD - checkback signal (axis attributes)  
 ANZG - display of the monitoring job

The updated values must then be taken from the axis data block,

In the axis data block (parameter DBNR) only the value selected with modes 71...73 is updated. The other values are deleted (KH0000).

## 2.5 Notes on using Actual Operands

The designations STAR (I,BI), STOP (I,BI), VORW (I,BI), RUCK (I,BI), UEBN (I,BI) and PAFE (Q, BI), BFEH (Q,BI) and TBIT (Q,BI) must not be occupied by the "scratchpad flags",

The designations BTR (Q, BY), MFKT (Q, BY), RMLD (Q, BY) and ANZG (Q, D) or ANZ1(Q,W) and ANZ2(Q,W) must also not be occupied by the scratchpad flags used by function block FBI 64 (=> Section 2.8 "Technical Data of FB164").

When specifying data bytes, data words or a data double word, the information is stored in the axis data block. Make sure that the axis data area for a particular axis is not overwritten.

## 2.6 Relationship between the Parameter TBIT and the current Checkback Signals

### 2.6.1 General

A currently active job on the IP246 (BA 1...19) can be scanned for status "running" at parameter output TBIT. The parameter should be scanned when a change in the checkback signals (parameter RMLD) "axis in position" or "job finished" can no longer be detected owing to the cycle time of the user program ( => "Fundamentals of Positioning, Reference Manual", Section 6 "Axis Attributes").

With very short travel distances, e.g. in mode 7 "incremental relative" or with zero point offsets or tool length offsets, the new position could be reached ("position reached"), or the job already executed ("job finished") without a signal change at the appropriate bit in the checkback signals being visible.

If the parameter TBIT is used to start the next job, this can be achieved on each falling edge of the parameter. It is, however, not absolutely necessary that the parameter TBIT has the signal state "O" to start the next job. The parameter TBIT does not have the signal state "O" e.g. when a current job is abandoned (mode 1...19) or when an override change takes place (enter command). The parameter TBIT is not influenced by override changes.

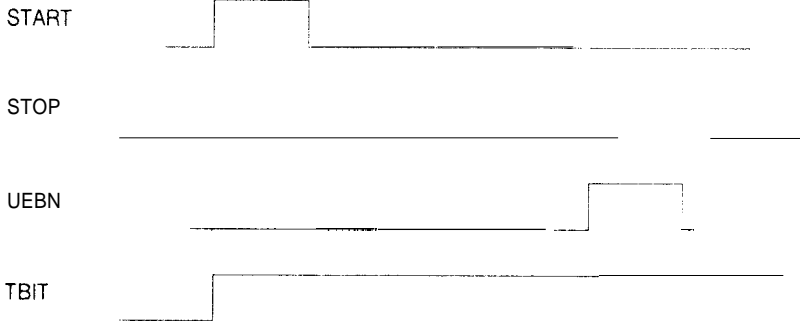
Each time a job is triggered (mode 1...19 with command), the parameter TBIT is set by FBI 64. The job (mode with command) is either allowed at this point or is not allowed. If the job is allowed, parameter TBIT is reset by the IP246 on completion of the job. For resetting parameter TBIT, the same conditions apply as for the axis attributes "position reached" or "job finished" in the checkback signals ( => "Fundamentals of Positioning, Reference Manual", Section 6 Axis Attributes"), If the job is not permitted at the present time or the command is not permitted with the current mode, any active job will be abandoned. The parameter TBIT is then reset after the job has been abandoned. If there is no job currently running (bit 7 in the checkback signals RMLD is set to "1" = "job finished"), parameter TBIT is reset again by the IP246 immediately.

### 2.6.2 The Parameter TBIT with the individual Modes

The following diagrams are not to scale and do not take into account the cycle time of the user program and the IP246.

Mode

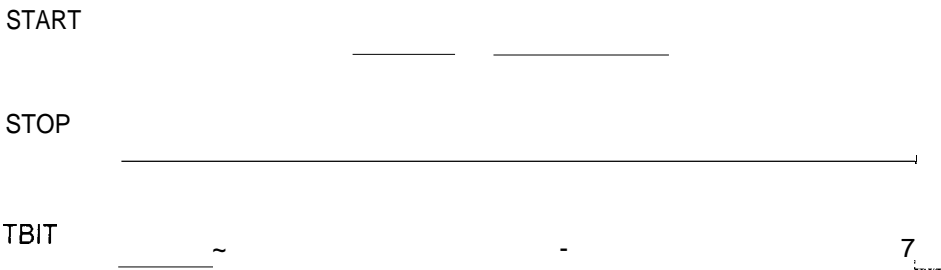
JOG speed 1 (mode 1)  
 JOG speed 2 (mode 2) and  
 JOG open loop (mode 3)



t

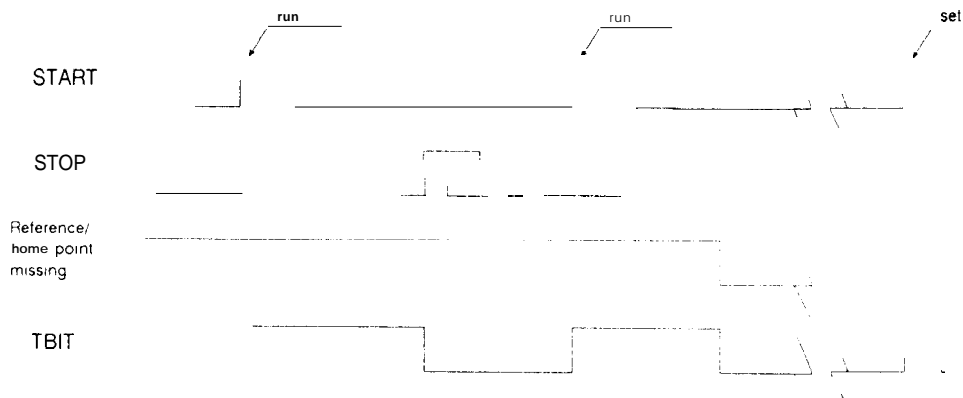
If an override change takes place while the axis is moving, this does not affect TBIT

Mode following error (mode 4)



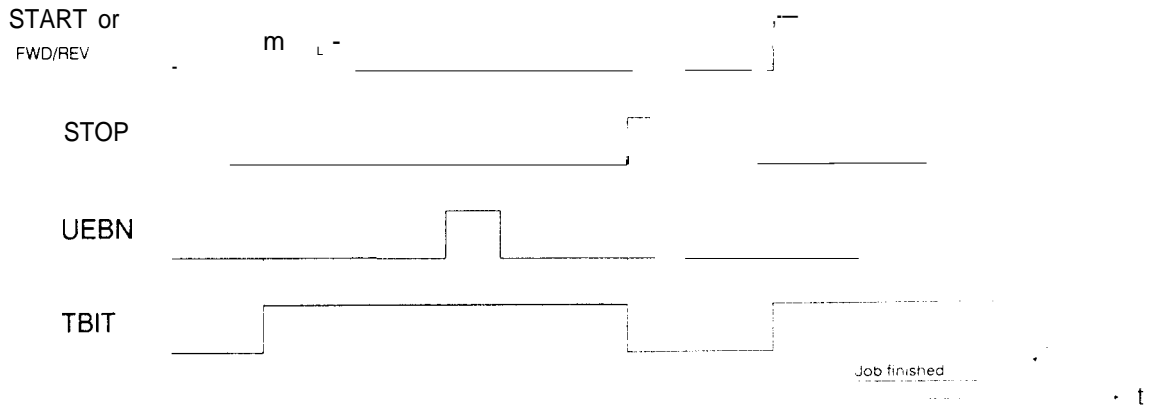
t

Mode reference/home point (mode 5)



t

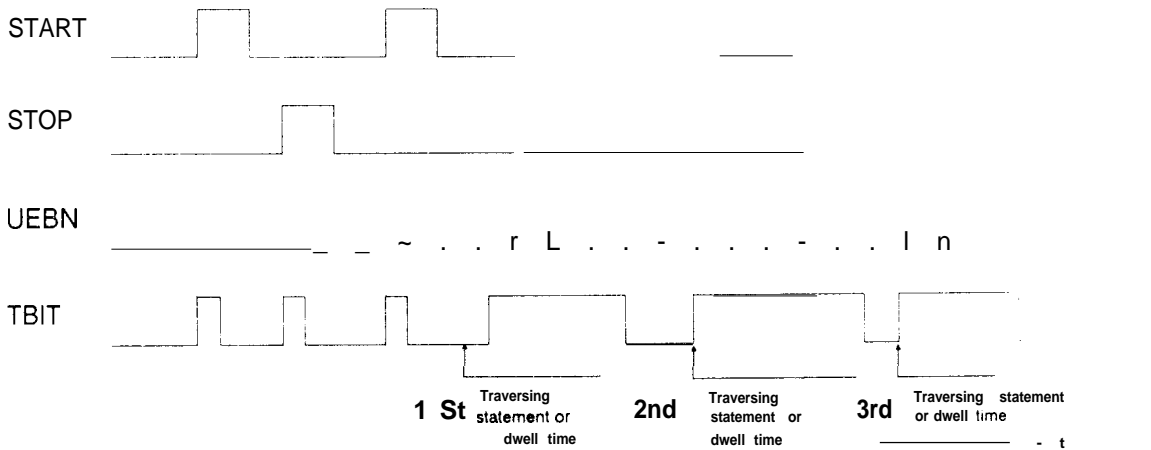
Mode - incremental absolute (mode 6) and  
 - incremental relative (mode 7)



Mode - automatic (mode 8)

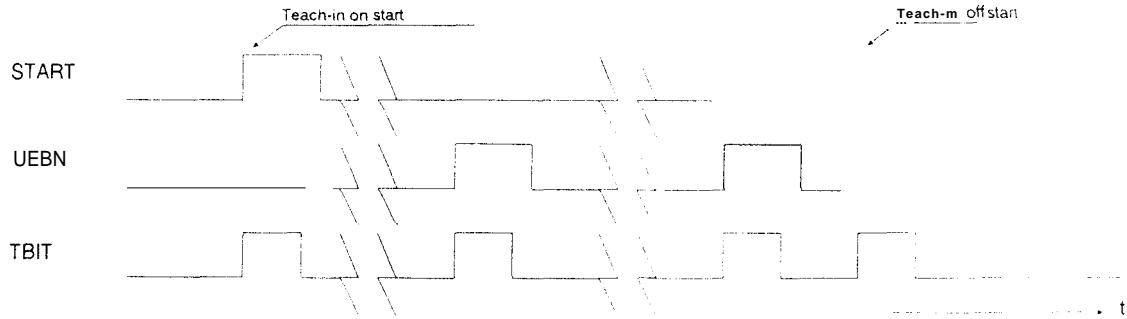


Mode automatic single statement (mode 9)



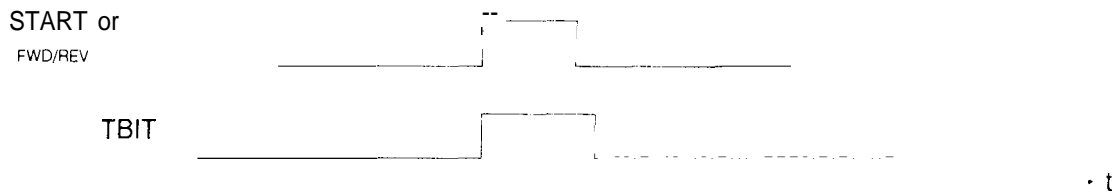
With the enter command (U EBN), the next statement of the automatic program (traversing job or dwell time) is started. If there is a stop between two statements in "automatic single statement" operation, the parameter TBIT is also set by FBI 64 and reset by the IP246.

- Mode
- teach-in on (mode 10) and
  - teach-in off (mode 11)



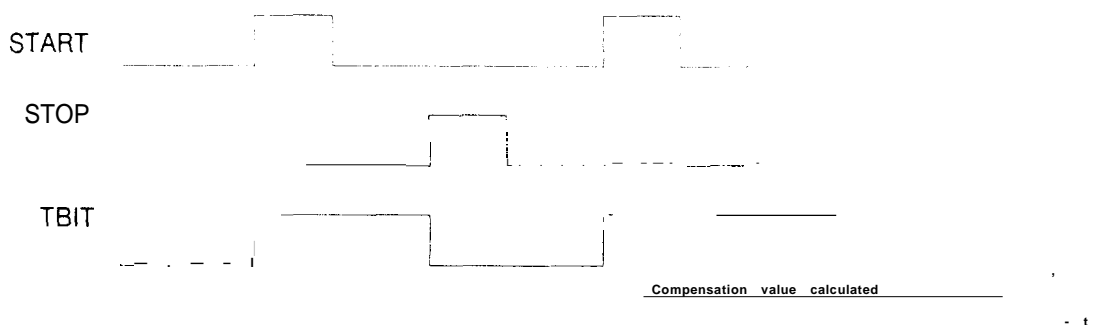
The parameter TBIT is reset by the IP246 after storing the position (UEBN) or on termination (STOP) of the teach-in. In teach-in, various positions can be approached, e.g. in incremental approach or in the JOG mode. The conditions explained for these modes also apply to the parameter TBIT.

- Mode
- zero offset absolute (mode 12),
  - zero offset relative (mode 13),
  - clear zero offset (mode 14),
  - tool offset (mode 15),
  - tool offset off (mode 16) and
  - clear error (mode 17)



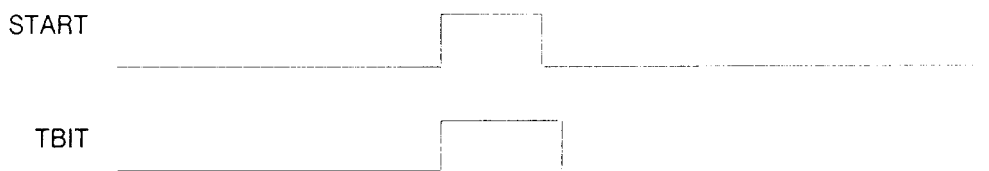
The parameter TBIT remains set until the mode is complete. These modes cannot be aborted

- Mode
- drift compensation (mode 18)



The parameter TBIT remains set until the mode is complete. The drift compensation mode can be aborted by a stop command

Mode - Drift compensation off (mode 19)



The parameter TBIT remains set until completion of the mode. This mode cannot be aborted

## 2.7 Data Area Requirements

The standard function block FBI 64 works with data block DB1 64. It requires data words DW8 to DW15 as its working area.

An axis data block must be specified using the parameter DBNR. This data block is used for the following:

- to store the monitoring values, checkback signals, M functions etc. read from the IP246
- for indirect assignment of parameters (DW1 to DW7) to the function block FBI 64 and
- to store the data required for the mode to be started.

### 2.7.1 Indirect Assignment of Parameters to FB164

It is possible to assign parameters to the function block FB164 indirectly. The value

KY 0,0

must be preset as the actual operand for parameter DBNR. With this assignment, FB164 takes the values for its parameters from the data block valid before its call,

All permitted data blocks can be used. Even data block DB164 or the axis data block would be possible,

Indirect parameter assignment requires data words DW1 to DW7 of the data block inclusive; these data words have a fixed assignment. When using DB164, this does not lead to conflicts, since FBI 64 uses DW8 to DW15 inclusive as its working area. If the axis data block was open before FB164 was called, you must enter at least the value 8 in DW5 (parameter DWNR) as the first data word to make sure that the data for indirect parameter assignment are not overwritten.

When using indirect parameter assignment, the same conditions apply to the individual parameters (DW1...DW7) of the open data block as for direct parameter assignment (= > Section 2.4 "Explanation of the Parameters" ).

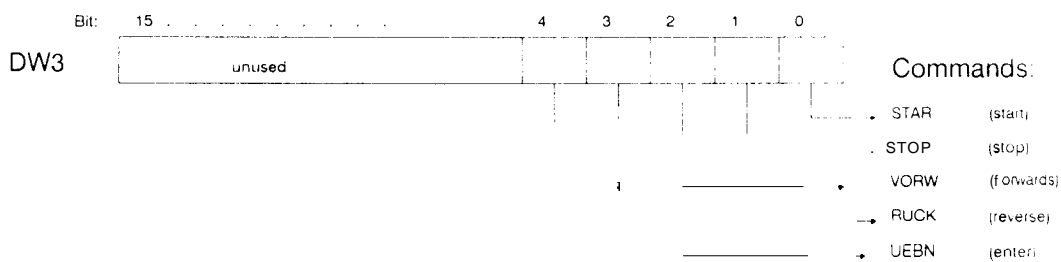
|     |                                                          | Recommended data format         |
|-----|----------------------------------------------------------|---------------------------------|
| DW0 | Free                                                     | KH                              |
| DW1 | Parameter BA, mode (mode number)                         | KF                              |
| DW2 | Free                                                     | KH                              |
| DW3 | Commands: STAR, STOP, VORW, RUCK, UEBN                   | KM                              |
| DW4 | Parameter DBNR KY DE type, number of the axis data block | KY                              |
| DW5 | Parameter DWNR (first data word)                         | KF                              |
| DW6 | Parameter SSNR interface or page number                  | KF                              |
| DW7 | Parameter BCD identifier output                          | KY 0,0= binary<br>KY 0, 1 = BCD |

You must assign values to data words DW1 to DW7 before the function block FBI 64 is called

**Note on programmable controllers S5 115U and S5 150U**

Data block type DX cannot be programmed with these units,

**Structure of data word DW3 (commands)**



**2.7.2 Structure of the Axis Data Block**

The data words from parameter DWNR to DWNR + 19 are required for an axis from the axis data block assigned with the parameter DBNR. The same data block can be used for several axes. The next axis can use the area from DWNR + 20 in the same data block.

The data block is structured as follows:

Axis 1 (parameter DWNR = n)

|           |                                                   | Recommended data format |
|-----------|---------------------------------------------------|-------------------------|
| DW n      | Used by FB164<br>BYTE parameter                   | KY                      |
| DW n + 1  | WORD parameter                                    | KF                      |
| DW n + 2  | high<br>DOUBLE WORD parameter                     | KH                      |
| DW n + 3  | low<br>occupied                                   | KH                      |
| DW n + 4  | occupied                                          | KH                      |
| DW n + 5  | high<br>actual position value of the axis         | KH                      |
| DW n + 6  | low                                               | KH                      |
| DW n + 7  | high<br>following error of the axis or            | KH                      |
| DW n + 8  | low<br>speed of the axis in mode 3 and 4          | KH                      |
| DW n + 9  | high<br>distance to go                            | KH                      |
| DW n + 10 | low                                               | KH                      |
| DW n + 11 | operating mode<br>M function                      | KY                      |
| DW n + 12 | checkback signals from the axis<br>error messages | KM                      |
| DW n + 13 | occupied                                          | KH                      |
| DW n + 14 | binary identifiers                                | KH                      |
| DW n + 15 | occupied                                          | KH                      |
| DW n + 16 | high<br>bits from the SEND block                  | KM                      |
| DW n + 17 | low                                               | KF                      |
| DW n + 18 | occupied                                          | KM                      |
| DW n + 19 | occupied                                          | KF                      |

Axis 2 (parameter DWNR = k)

|          |                                              |    |
|----------|----------------------------------------------|----|
| DW k     | Used by FB164<br>BYTE parameter              | KY |
| DW k + 1 | WORD parameter                               | KF |
| DW k + 2 | etc. (further structure analogous to axis 1) |    |



You must supply the following data words in the axis data block for each axis:

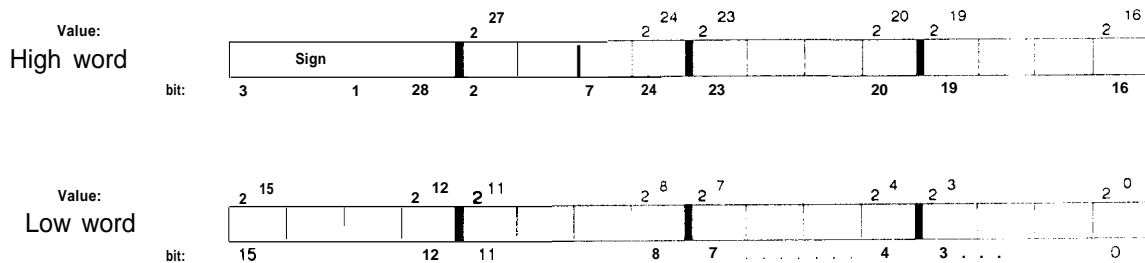
- DR n : byte parameter
- DW n + 1 : word parameter
- DW n + 2 : double word parameter

Depending on the mode (1...19; cf. parameter BA), the following convention applies:

| Mode                         | Command                                       | Byte parameter                                   | Word parameter | Double word parameter |
|------------------------------|-----------------------------------------------|--------------------------------------------------|----------------|-----------------------|
| 1 JOG speed 1                | Forwards<br>Reverse<br>Stop<br>Enter          |                                                  | Override       |                       |
| 2 JOG speed 2                | See JOG speed 1                               |                                                  | Override       |                       |
| 3 JOG open loop              | See JOG speed 1                               |                                                  | Override       |                       |
| 4 Following error            | Start<br>stop                                 |                                                  |                |                       |
| 5 Reference home point       | Start<br>stop                                 | Run: even<br>Set: 'odd'<br>only -4UA31<br>-4UA41 |                |                       |
| 6 incremental absolute       | Start<br>Stop<br>Forwards<br>Reverse<br>Enter |                                                  | Override       | Absolute target       |
| 7 Incremental relative       | See Incremental absolute                      |                                                  | Override       | Relative target       |
| 8 Automatic                  | Start<br>stop                                 | Program number                                   |                |                       |
| 9 Automatic single statement | Enter<br>stall<br>Stop<br>Enter               | Program number                                   |                |                       |
| 10 Teach-in on               | Start                                         | Program number                                   |                |                       |
| 11 Teach-in off              |                                               |                                                  |                |                       |
| 12 Zero offset absolute      |                                               |                                                  |                | Absolute coordinate   |
| 13 Zero offset relative      | Forwards<br>Reverse                           |                                                  |                | Relative value        |
| 14 Clear zero offset         | Start                                         |                                                  |                |                       |
| 15 Tool offset               | Forwards<br>Reverse                           |                                                  |                | Offset value          |
| 16 Tool offset off           | Start                                         |                                                  |                |                       |
| 17 Clear error               | Start                                         |                                                  |                |                       |
| 18 Drift compensation        | Start<br>stop                                 |                                                  |                |                       |
| 19 Drift compensation off    | Start                                         |                                                  |                |                       |

Parameters without an entry in the table are not evaluated by the IP246 positioning module.

In the parameter "PC BCD coded" in the machine data record of the axis, you can decide whether all distances and positions (double word parameter in the axis data block) supplied by the PC to the IP246 are to be interpreted as BCD or binary. (= > "Fundamentals of Positioning, Reference Manual", Section 4.8 "Other Parameters"), Bits 28...31 represent the sign. In binary representation, negative distances must be specified in two's complement.



Example: incremental absolute (mode 6) to 120000 urn and -120000 um.

|           |       |                                      |
|-----------|-------|--------------------------------------|
| 12000010  | ⇐ =>  | 0001 D4C016                          |
| binary    | ≡ =>  | 0000000000000001 11010100110000002   |
| BCD       | == => | 00000000000100100000 0000000000002   |
| -12000010 | == => | FFFE2B40 <sub>16</sub>               |
| binary    | ≡ =>  | 1111 1111 1111 111000101011010000002 |
| BCD       | == => | 11110000000100100000 0000000000002   |

For more detailed information about the significance of the parameters in the individual modes, refer to "Functions, Reference Manual".

The actual position, the following error (speed) and the distance to go are updated in the axis DB regardless of how parameters are assigned to FB164 (direct or indirect parameter assignment).

Only when indirect parameter assignment is selected and byte DR7 (corresponds to the parameter BCD) is not zero, are these values in BCD format in the axis DB. When direct parameter assignment is selected and the parameter BCD is a "1" signal, one of these values (BA 71 ...73) is available at the output parameter ANZG (ANZ1/ANZ2 for the S5 115U) of FB164 in BCD representation, **however, the value is stored in binary in the axis DB.**

Data words DW n +11 (axis mode, current M function) and DW n +12 (checkback signals from the axis, error message from the axis) of the axis DB are only updated with indirect parameter assignment. With direct parameter assignment they have the value KHOOOO.

The error message byte DR n +12 of the axis DB is identical to flag byte FY251 (= > "Planning, Installation and Service", Section 2 "Troubleshooting").

## 2.8 Technical Data of FB164

|                                                             | S5-115U                                                                                                                                                                         | <b>S5-135U</b>   |                                                                                                         |              |         | S5-150U           | <b>S5-155U</b>                                                               |      |                                                                                                        |  |
|-------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------------------------------------------------------------------------------------------------------|--------------|---------|-------------------|------------------------------------------------------------------------------|------|--------------------------------------------------------------------------------------------------------|--|
| Block number                                                | 164                                                                                                                                                                             | 164              |                                                                                                         |              |         | 164               | 164                                                                          |      |                                                                                                        |  |
| Block name                                                  | PER:POS                                                                                                                                                                         | PER:POS          |                                                                                                         |              |         | PER:POS           | PER:POS                                                                      |      |                                                                                                        |  |
| Library no.                                                 | P71200-S5164-D-1                                                                                                                                                                | P71200-S9164-D-1 |                                                                                                         |              |         | P71200-S41 64-D-1 | P71200-S61 64-D-1                                                            |      |                                                                                                        |  |
| Call length                                                 | 20 words                                                                                                                                                                        | 19 words         |                                                                                                         |              |         | 19 words          | 19 words                                                                     |      |                                                                                                        |  |
| Block length                                                | 1009 words                                                                                                                                                                      | 618 words        |                                                                                                         |              |         | 646 words         | 681 words                                                                    |      |                                                                                                        |  |
| Nesting depth                                               | 1                                                                                                                                                                               | 1                |                                                                                                         |              |         | 1                 | 1                                                                            |      |                                                                                                        |  |
| Secondary blocks                                            | Integrated handling blocks                                                                                                                                                      | Handling blocks  |                                                                                                         |              |         | Handling blocks   | Handling blocks                                                              |      |                                                                                                        |  |
| Occupation of data area                                     | -19 data words from parameter DWNR of the axis data block DBNR<br>-DB164 occupied from data word DW0 to DW15<br>-In indirect parameter assignment via DBx: data word DW1 to DW7 |                  |                                                                                                         |              |         |                   |                                                                              |      |                                                                                                        |  |
| Occupation in flag area                                     | FY206 to FY255 as scratchpad flags                                                                                                                                              |                  | FY206 to FY255 as scratchpad flags                                                                      |              |         |                   | FY200 to FY255 as scratchpad flags                                           |      | FY202 to FY255 as scratchpad flags                                                                     |  |
| Occupation in system data area                              | none                                                                                                                                                                            |                  | RS60 and RS61                                                                                           |              |         |                   | yes                                                                          |      | yes                                                                                                    |  |
| System statements                                           | yes                                                                                                                                                                             |                  | yes                                                                                                     |              |         |                   | yes                                                                          |      | yes                                                                                                    |  |
| Miscellaneous                                               | interrupts blocked at times in the FB by commands IA/RA. An 1A command is cancelled by this.                                                                                    |                  | Handling blocks FB120 SEND, FB121 RECEIVE and FBI 25 SYNCHRON must be loaded. Special functions called. |              |         |                   | Handling blocks FB180 SEND, FB181 RECEIVE and FB185 SYNCHRON must be loaded. |      | Handling blocks FB120 SEND, FB121 RECEIVE and FB125 SYNCHRON must be loaded. Special functions called. |  |
| Maximum run-times in ms<br>( ) with binary-BCD conversion   | CPU 941                                                                                                                                                                         | CPU 942          | CPU 943                                                                                                 | CPU 344      | CPU 922 | CPU 928           | CPU 328/:                                                                    |      |                                                                                                        |  |
| Idling, monitoring off                                      | 2.7                                                                                                                                                                             | 8.7              | 5.2                                                                                                     | 1.1          | 8.8     | 3.3               | 2.7                                                                          | 0.8  | 1.0                                                                                                    |  |
| Monitoring on mode =71, 72, 73                              | 34.4<br>(81.0)                                                                                                                                                                  | 13.8<br>(18.0)   | 12.4<br>(14.2)                                                                                          | 6.0<br>(6.8) | 12.1    | 5.9               | 5.7                                                                          | 5.6  | 4.4                                                                                                    |  |
| For command transfer (STAR, STOP, VORW, RUCK, UEBN)         | 40.6                                                                                                                                                                            | 17.8             | 11.0                                                                                                    | 5.6          | 11.8    | 7.6               | 6.0                                                                          | 5.2  | 4.1                                                                                                    |  |
| Extra runtime required for FB with direct param. assignment | 2.2                                                                                                                                                                             | 1.9              | 1.7                                                                                                     | 0.07         | 0.3     | 0.1               | 0.1                                                                          | 0.04 | 0.03                                                                                                   |  |

## 2.9 Using Function Block FB164

In cyclic operation it is not possible to address a module both with indirect and direct parameter assignment.

**Function block FBI 64 works with data block DB164. This** must be installed up to and including data word DW15. A particular assignment of the data words is not necessary.

Data block DB164 is divided into two areas, in which data words DW1 to DW7 are reserved for indirect assignment of parameters to the function block. Data words DW8 to DW15 are the working area for FB164. You must **not** change the working area.

Before calling FB164, the axis parameters (byte, word and double word parameters) must be written to the axis data block (parameter DBNR) as required for the mode to be started. The data block must be a minimum of x words long, where

$$x = \text{parameter DWNR} + 19$$

e.g.:      **axis 1 : parameter DWNR = 1    -> x = 20**  
              **axis 2 : parameter DWNR = 21 -> x = 40**

If only one axis is required, the data block must be available up to and including data word DW20

If axis 1 and axis 2 are used and if the parameters for the axes are contained in one data block this must be available up to and including data word DW40. The data block number (parameter DBNR) and the data word number (parameter DWNR; start address in the data block) can be selected as required.

The data block is set up with a programmer, e.g. with the PG685 STEP5 under S5-DOS (stage III) using the following commands (after exiting the presetting mask):

```

< F1 > (input)
< F1 > (block)
Pc (input device)
DB160 (block) enter key < | >
DW 0: KY = 000,000
DW 1: KF = +00000
DW 2: KH = 0000
DW 3: KH = 0000

DW 19: KF = +00000 enter key < | >

```

The function block FB164 must be called unconditionally once per cycle for each axis. This is necessary in order to update the edge flags of the parameters STAR, STOP, VORW, RUCK and UEBN.

To ensure that the signal edge evaluation is effective, the selected mode must remain active in the function block until the traversing movement is complete.

Once a job has been triggered, it is sent to the positioning module immediately when the function block FB164 is next called.

A job is only automatically repeated when a parameter assignment error in the SEND data handling block is signalled.

As soon as a valid monitoring job (BA = 71, 72, 73) is recognized, it is executed at each JU FB164 call.

Mode 74 interrupts the cyclic monitoring. The monitoring function is resumed when one of the modes BA 71, 72 or 73 is transferred.

The information read is written to the axis data block as follows: (with parameter DWNR = n):

|                          |                                     |
|--------------------------|-------------------------------------|
| DW n + 5 and DW n + 6 :  | actual position value binary or BCD |
| DW n + 7 and DW n + 8 :  | following error binary or BCD       |
| DW n + 9 and DW n + 10 : | distance to go binary or BCD        |

The output at parameter ANZG (ANZ1 and ANZ2 with the S5 115U) or in the axis data block is in binary in fixed point double word format (32 bits).

- with direct parameter assignment: when the parameter BCD has the signal state "0",  
with indirect parameter assignment: when data byte DR7 of the open DB has the value KH00.

The output is as a seven digit BCD number with sign

- with direct parameter assignment: when the parameter BCD has the signal state "1",  
with indirect parameter assignment: when data byte DR7 of the open DB is not equal to KH00.

If a conversion from binary to BCD is not possible (representable BCD numerical range exceeded), the content of the parameter ANZG (ANZ1 and ANZ2 with the S5 115U) is unchanged with **direct parameter assignment**. If the representable BCD numerical range is exceeded with **indirect parameter assignment**, the monitoring value is stored as a 32-bit fixed point number (2's complement) in the axis data block.

The positioning module IP246 does not service interrupts

With indirect parameter assignment, the current data block (DB or DX) must be open and must have values supplied before function block FB164 is called.

### 2.9.1 Special Feature of the Parameter STOP

The STOP command has the highest priority and can be transferred during any mode. If mode  $71 \leq BA \leq 73$  is selected, the module is not read for one cycle and the stop command is transferred to the positioning module with mode 1 (JOG 1). In the following PC cycle, the module is read once again.

#### Exception

If mode 4 "following error" is active, it can only be aborted with mode 4 and the STOP parameter signal = "1". Any other parameter assignment is displayed as an error by setting the PAFE parameter and the error bit F255.5 (the specified parameter is illegal or the command is not allowed for this mode).

If the STOP signal is constantly active (static), no start, forwards or backwards or enter job will be sent to the module.

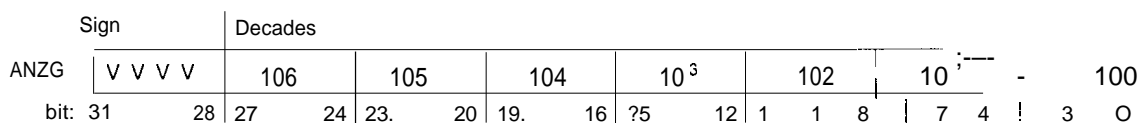
### 2.9.2 Special Features of the Parameters **VORW** and **RUCK**

If modes 1 to 3 (JOG 1, 2 and 3) are selected, these commands result in a jogging operation. On a signal change from 0--> 1, the axis is started in the selected direction, on the signal change from 1-->0, the axis is stopped. It is also possible to transfer the STOP command. If a signal change 0 --> 1 of the commands VORW and RUCK is recognized simultaneously, the STOP command is sent to the axis.

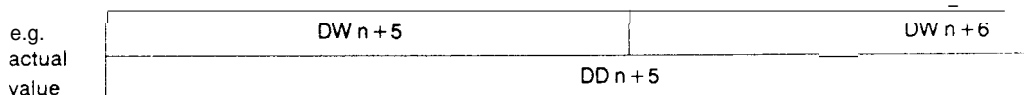
To ensure that the signal evaluation is effective, the mode must remain valid in the function block until the traversing movement is complete.

### 2.9.3 BCD Output

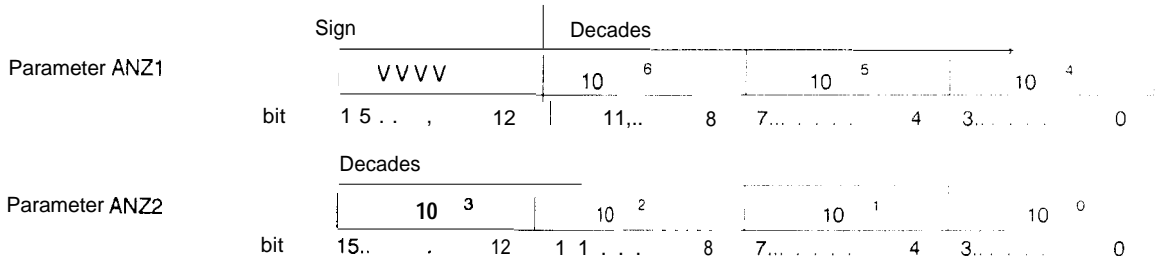
With the S5-135U, -1 50U, -155U:



In the axis DB



**2.9.4 BCD Output with the S5 115U**



## 3 Standard Function Block FB165

### 3.1 Functional Description

The function block “assigning parameters to the positioning module” handles the data exchange between the user program and the IP246 positioning module. Each valid job number causes a data transfer IP246 < = = = > PC.

Data exchange PC = = = > IP246:

The data to be transferred is located in a data block of your choice (source DB). With direct parameter assignment, the data block must be planned at the block parameters of FB165, with indirect parameter assignment, in the axis data block.

Data exchange IP246 = = = > PC:

The data to be read from the IP246 positioning module is stored in a data block in the PC memory (destination DB). With direct parameter assignment, this data block must be planned at the block parameters of FB165 and with indirect parameter assignment in the axis data block.

The following functions are possible via the PC interface using FB165:

- read machine data and machining programs from the IP246, delete and transfer them,
- read the SYSID from the IP246 (BA 70) and transfer them to the IP246 (BA 24),
- request an overview of machine data or machining programs stored on the IP246 and read actual values (actual position value, following error or speed, distance to go) simultaneously.

The function block FB165 can have parameters assigned directly or indirectly. With direct parameter assignment, the data and parameters for a job are applied to the parameter inputs of FB 65. With indirect parameter assignment, the axis data block is planned in the data block valid before its call. The remaining parameters are taken by FB165 from the axis data block.

Before FB165 is called, the axis data block must be set up and with indirect parameter assignment must be supplied with the values required to start the mode.



### 3.2 Calling Function Block FB165

In STL (Statement List):

```

NAME
SSNR
DBNR
DWNR
BA
Q-DB
QANF
Z-DB
ZANF
ANST
PAFE
BFEH

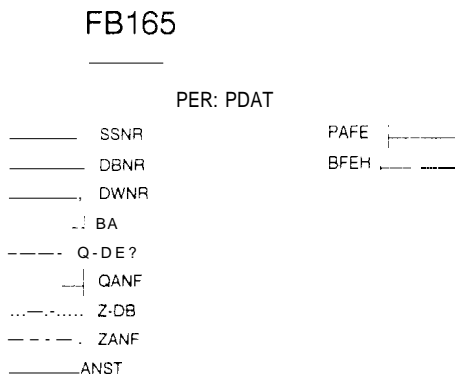
```

```

JU FB165
PER:PDAT

```

In LAD/CSF (Ladder Diagram or Control System Flowchart)



### 3.3 Overview of the Parameters

| NAME | PARA TYPE | DATA TYPE | SIGNIFICANCE                                           |
|------|-----------|-----------|--------------------------------------------------------|
| SSNR | D         | KF        | Interface number                                       |
| DBNR | D         | KY        | DB type, DB number (of the axis data block)            |
| DWNR | D         | KF        | First data word in the axis DB                         |
| BA   | D         | KF        | Binary/BCD conversion, mode                            |
| Q-DB | D         | KY        | DB type, DB number (of source DB)                      |
| QANF | D         | KF        | Start address DW in source DB                          |
| Z-DB | D         | KY        | DB type, DB number (of destination DB)                 |
| ZANF | D         | KF        | Start address DW in destination DB                     |
| ANST | I         | BI        | Trigger data transfer with direct parameter assignment |
| PAFE | Q         | BI        | Parameter assignment error                             |
| BFEH | Q         | BI        | Module error                                           |

### 3.4 Explanation of the Parameters

**SSNR :** D,KF x

Specification of the page number (cf. switch setting J64, "Hardware, Instructions", Section 3.2 "Setting the Module Address") of the appropriate axis.

x = interface (page number)

$0 < = X < = 255$

**DBNR :** D,KY x,y

Specification of the data block type and data block number of the axis data block. With the programmable controllers S5 115U and S5 150U it is not possible to program the data block type DX.

x = data block type

x = 0 : data block type DB

x > 0 : data block type DX

Y = data block number

$5 < = y < = 255$  where x = 0

$1 < = y < = 255$  where x > 0

direct parameter assignment via the block parameters

y = 0

indirect parameter assignment via the data block operation before the FB165 call

**DWNR :** D,KF x

Specification of the first data word in the axis data block.

x = first data word

$0 < = X < = 241$

where:  $5 < = \text{parameter DBNR} < = 163$  and  
 $166 < = \text{parameter DBNR} < = 255$

$48 < = x < = 241$

where: parameter DBNR = 165  
 (DB165 = working DB for FB165)

$16 < = x < = 241$

where: parameter DBNR = 164  
 (DB164 = working DB for standard function block FB164)

BA : D,KY x,y

Specification of the mode to be executed, selection binary/BCD conversion.

x = 0 : no binary/BCD conversion  
 x > 0 : binary/BCD conversion of actual position value, following error (or speed) and distance to go.  
 Evaluation only in mode BA 66.

Y = operating mode (job number)

20 <= y <= 24 write and delete jobs

64 <= y <= 70 read jobs

| Job number | Operating mode                   |            |
|------------|----------------------------------|------------|
| 20         | input machine data               | *one axis  |
| 21         | delete machine data              | *one axis  |
| 22         | input machining program          | *both axes |
| 23         | delete machining program         | *both axes |
| 24         | input SYSID                      | *both axes |
| 64         | read machine data directory      | *both axes |
| 65         | read machining program directory | *both axes |
| 66         | read actual values               | *one axis  |
| 67         | read machine data                | *one axis  |
| 68         | read machine data overview       | *both axes |
| 69         | read machining program           | *both axes |
| 70         | read SYSID                       | *both axes |

Q-DB : D,KY x,y

Specification of the source data block. For the programmable controllers S5 115U and S5 150U it is not possible to program data block type DX.

X = data block type

x = 0 : data block type DB  
 x > 0 : data block type DX

Y = source data block number

1 <= y <= 255  
 in modes 20, 22 and 24 (write jobs)  
**the specified data block (source DB)  
 is in the PC memory.**

0 <= y <= 255  
 in modes 67 and 69 (read jobs)  
**the specified data block (source DB)  
 is in the RAM of the positioning module.**

QANF : D,KF x

Specification of the first data word from which the data is to be read out of the specified source DB.

X = source first data word

$$0 \leq x \leq n$$

a source first data word is only required for modes 20, 22 and 24 (write jobs)

(n = max. 2047 words; max. data block length, the advisable range is between 0 and 255)

Z-DB : D,KY x,y

Specification of the destination data block, For the programmable controllers S5 1 15U and S5 150U it is not possible to program the data block type DX.

x = data block type

x = 0 : data block type DB

x > 0 : data block type DX

y = destination block number

$$1 \leq y \leq 255$$

for modes 64 to 70 (read jobs)

**the specified data block (destination DB) is in the PC memory.**

$$0 \leq y \leq 255$$

for modes 20 to 23 (write and delete jobs)

**the specified data block (destination DB) is in the RAM of the positioning module.**

ZANF : D,KF x

Specification of the first data word from which data will be written to the specified destination DB

X = destination first data word

$$0 \leq x \leq n$$

a destination first data word is only required for modes 64 to 70 (read jobs)

(n = max. 2047 words: max. data block length, the advisable range is between 0 and 255)

**ANST** : I,BI

When assigning parameters via the block parameters (direct parameter assignment) the pending job is executed on a signal change from "0" to "1" at the ANST parameter. You must set the parameter. If the job (mode) has been completed, the parameter is reset by the function block FBI 65 (acknowledged).

**PAFE** : Q,BI

The parameter PAFE has the signal state "1" if the parameter assignment is incorrect. The error can then be identified in

flag byte FY255

(=> "planning, Installation and Service", Section 2 "Troubleshooting").

**BFEH** : Q,BI

The parameter BFEH (module error) has signal state "1" when an error is signalled by the positioning module. The error can be identified in

flag byte FY254

(=> "planning, Installation and Service", Section 2 "Troubleshooting").

### 3.5 Notes on using Actual Operands

The parameters ANST (I,BI), PAFE (Q,BI) and BFEH must not be occupied by the "scratchpad flags" of function block FB165 (see technical data).

### 3.6 Overview of the Permitted and Advisable Parameter Area for the Standard Function Block FB165

| BA | DBNR            | DwNR            | Q-DB                             | QANF            | Z-DB               | ZANF            |
|----|-----------------|-----------------|----------------------------------|-----------------|--------------------|-----------------|
| 20 |                 |                 | DB5...DB255<br>or<br>DX1...DX255 | DW0...<br>DW255 |                    |                 |
| 21 |                 |                 |                                  |                 | DB0...<br>DB255    |                 |
| 22 |                 |                 | DB5...DB255<br>or<br>DX1...DX255 | DW0...<br>DW255 |                    |                 |
| 23 |                 |                 |                                  |                 |                    |                 |
| 24 |                 |                 | DB5...DB255<br>or<br>DX1...DX255 | DW0...<br>DW255 |                    |                 |
| 64 | DB5...<br>DB255 | DW0...<br>DW241 |                                  |                 |                    |                 |
| 65 |                 |                 |                                  |                 |                    |                 |
| 66 |                 |                 |                                  |                 | DB5...<br>DB255    |                 |
| 67 |                 |                 | DB0...<br>DB255                  |                 | or<br>DX1<br>DX255 | DW0...<br>DW255 |
| 68 |                 |                 |                                  |                 |                    |                 |
| 59 |                 |                 | DB0...<br>DB255                  |                 |                    |                 |
| 70 |                 |                 |                                  |                 |                    |                 |

Exceptions in the grey fields are DB164 and DB165:

|       |                  |       |                  |       |               |
|-------|------------------|-------|------------------|-------|---------------|
| DB165 | DW48...<br>DW241 | DB165 | DW48...<br>DW241 | DB165 | DW48<br>DW241 |
| DB164 | DW16<br>DW241    | DB164 | DW16<br>DW241    | DB164 | DW16<br>DW241 |

Data block type DX can only be selected in the programmable controllers S5 135U and S5 155U.

The data blocks without a grey background are located in the RAM of the positioning module.

When assigning data blocks, remember that if you use DB165 as the axis data block for the parameters DBNR, Q-DB or Z-DB (indirect parameter assignment), data words DW3 to DW47 are required by function block FB165 (working area of FB165). You must not use these data words for any other purpose.

### 3.7 Data Area Requirements

The standard function block FB165 works with data block DB165. It requires data words DW3 to DW47 inclusive for its working area.

An axis data block must be specified using the parameter DBNR. A job field with a length of 15 data words must be available in this axis data block for each axis.

#### 3.7.1 Indirect Assignment of Parameters to **FB165**

It is possible to assign parameters to the function block FB165 indirectly. The parameter DBNR must have the

value KY 0,0

set as the actual operand. FB165 then obtains the parameters DBNR and DWNR from the data block open before its call. The remaining input parameters are supplied from the specified axis data block.

Any permitted data block can be used, Even data block DB165 or the axis data are possible

Indirect parameter assignment requires data words **DW1** and **DW2** of the open data block.

When using DB165, conflicts do not arise, since FB165 uses DW3 to DW47 as its working area. If the axis data block is open before FB165 is called, you must enter at least the value 3 in DW2 (parameter DWNR) as the first data word, to ensure that the data are not overwritten when using indirect parameter assignment.

Structure of the data block with indirect parameter assignment,

|     |                                                                | Recommended data format |
|-----|----------------------------------------------------------------|-------------------------|
| DW0 | Free                                                           | KH                      |
| DW1 | Parameter DBNR KY DB type, DB number<br>of the axis data block | KY                      |
|     | & - - - - -                                                    |                         |
| DW2 | Parameter DWNR (first data word)                               | KF                      |

You must supply values for DW1 and DW2 when using indirect parameter assignment before function block FB165 is called.

The DB type (DL1) and DB number (DR1) define the axis data block, The DW number (DW2) indicates the start of the job field of the job to be executed in the axis data block.

3.7.2 Structure of the Axis Data Block for an Axis

The data words from parameter DWNR to DWNR +14 inclusive are required for an axis from the axis data block selected with the parameter DBNR. The same data block can be used for several axes, the next axis then occupies the area from DWNR + 15.

The data block is structured as follows:

| Axis 1    | (Parameter DWNR = n)                                       | Recommended data format |
|-----------|------------------------------------------------------------|-------------------------|
| DW n      | Parameter BA; binary/BCD conversion (only BA 66), op. mode | KY                      |
| DW n + 1  | Parameter Q-DB; DB type, source data block                 | KY                      |
| DW n + 2  | Parameter QANF; source first data word                     | KF                      |
| DW n + 3  | Parameter Z-DB; DB type, destination data block            | KY                      |
| DW n + 4  | Parameter ZANF; destination first data word                | KF                      |
| DW n + 5  | Parameter SSNR; interface number                           | KF                      |
| DW n + 6  | binary identifiers                                         | KY                      |
| DW n + 7  | high bits from the SEND block                              | KM                      |
| DW n + 8  | low bits from the SEND block                               | KF                      |
| DW n + 9  | occupied                                                   | KM                      |
| DW n + 10 | occupied                                                   | KF                      |
| DW n + 11 | high bits from the FETCH block                             | KM                      |
| DW n + 12 | low bits from the FETCH block                              | KF                      |
| DW n + 13 | occupied                                                   | KM                      |
| DW n + 14 | occupied                                                   | KF                      |

There must be a "job field" with this structure for each axis addressed.

The data words DWn to DWn + 5 inclusive must only be completed if the function block is to have parameters assigned indirectly.

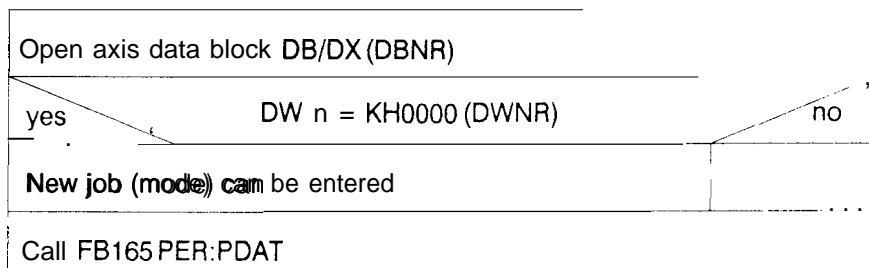


The data words  $DWn + 6$  to  $DWn + 14$  are used by function block FBI 65 and you can only read them, E.g. evaluation of the interface in the high byte of the condition code bytes:

$DL n + 7$  and  $DL n + 11$ : High byte of the condition codeword. Corresponds to flag byte FY250.

With indirect parameter assignment, you enter the required mode in data word  $DWn$  of the axis data block. The function block FB165 executes the entered mode and acknowledges by entering the value KH0000 in data word  $DWn$ . A new mode can now be entered.

Schematic diagram of indirect parameter assignment:



### 3.8 Structure of the Source or Data Blocks in the PC Memory for the Individual Modes

#### 3.8.1 Structure of a Machine Data DB in the PC Memory

**BA = 20:** machine data transferred from PC to IP246.

**BA = 21:** machine data deleted on the IP246,

**BA = 67:** machine data read from the IP246.

The individual machine data are explained in "Fundamentals of Positioning, Reference Manual", Section 4 "Machine Data and their Structure".

Structure of the data blocks DBx from data word DWn:  
typical values have been entered.

|           | Recommended data format |    | Header information                                                    |
|-----------|-------------------------|----|-----------------------------------------------------------------------|
| DW n      | + 00070                 | KF | Length in words                                                       |
| DW n + 1  | 0044                    | KH | 00, 'D'                                                               |
| DW n + 2  | 066,001                 | KY | "B", DB number of the data record                                     |
| DW n + 3  | 000,001                 | KY | Module number, axis number                                            |
| DW n + 4  | 001,000                 | KY | Dimensional unit (mm), machine data error                             |
| DW n + 5  | + 09000                 | KF | Max, acceleration/deceleration [mm/see ^2]                            |
| DW n + 6  | + 01000                 | KF | Acceleration forwards [mm/see" 2]                                     |
| DW n + 7  | + 01500                 | KF | Acceleration reverse [mm/sec ^2]                                      |
| DW n + 8  | + 01000                 | KF | Deceleration forwards [mm/see ^2]                                     |
| DW n + 9  | + 01500                 | KF | Deceleration reverse [mm/see" 2]                                      |
| DW n + 10 | + 00002                 | KF | Pulse evaluation (double)                                             |
| DW n + 11 | + 00025                 | KF | 10* resolution [mm/1000 pulses]<br>=> resolution = 2,5 mm/1000 pulses |
| DW n + 12 | +00166                  | KF | 10* gain factor [l/see] => gain factor = 16.6 l/see                   |
| DW n + 13 | 0000                    | KH | Backlash compensation value [um]                                      |
| DW n + 14 | 0000                    | KH |                                                                       |
| DW n + 15 | 0000                    | KH | Standstill monitoring [um]<br>(0.1mm)                                 |
| DW n + 16 | 0064                    | KH |                                                                       |
| DW n + 17 | 0000                    | KH | Maximum following error[um]<br>(25.0 mm)                              |
| DW n + 18 | 61A8                    | KH |                                                                       |
| DW n + 19 | 0000                    | KH | Reference/home point[um]<br>(0.0 mm)                                  |
| DW n + 20 | 0000                    | KH |                                                                       |

(Continued on the following page)

Recommended data format

|           |      |     |   |                                                                |
|-----------|------|-----|---|----------------------------------------------------------------|
| DW n + 21 | FFF9 | KH  | } | Range start or software limit switch start [urn] (-400,000 mm) |
| DW n + 22 | E580 | KH  |   |                                                                |
| DW n + 23 | 0007 | KH  | } | Range end or software limit switch end [urn] (500.000 mm)      |
| DW n + 24 | A120 | KH  |   |                                                                |
| DW n + 25 | 0000 | KH  | } | Tool length offset [urn] (2.3mm)                               |
| DW n + 26 | 08FC | KH  |   |                                                                |
| DW n + 27 | 0000 | KH  | } | Zero offset 1 [urn] (10.0mm)                                   |
| DW n + 28 | 2710 | KH  |   |                                                                |
| DW n + 29 | 0000 | KH  | } | Zero offset 2 [urn] (25.0mm)                                   |
| DW n + 30 | 61A8 | KH  |   |                                                                |
| DW n + 31 | 0000 | KH  | } | Zero offset 3 [urn] (3.250 mm)                                 |
| DW n + 32 | OCB2 | K H |   |                                                                |
| DW n + 33 | FFFE | KH  | } | Zero offset 4 [urn] (-75.0mm)                                  |
| DW n + 34 | DB08 | KH  |   |                                                                |
| DW n + 35 | 0000 | KH  | } | Maximum speed [mm/min] (20000mm/min)                           |
| DW n + 36 | 4E20 | KH  |   |                                                                |
| DW n + 37 | 0000 | KH  | } | JOG speed 1 forwards [mm/min] (18000mm/min)                    |
| DW n + 38 | 4650 | KH  |   |                                                                |
| DW n + 39 | 0000 | KH  | } | JOG speed 1 reverse [mm/min] (17000mm/min)                     |
| DW n + 40 | 4268 | KH  |   |                                                                |
| DW n + 41 | 0000 | KH  | } | JOG speed 2 forwards [mm/min] (10000mm/min)                    |
| DW n + 42 | 2710 | KH  |   |                                                                |
| DW n + 43 | 0000 | KH  | } | JOG speed 2 reverse [mm/min] (10000mm/min)                     |
| DW n + 44 | 2710 | KH  |   |                                                                |
| DW n + 45 | 0000 | KH  | } | Incremental speed [mm/min] (17500mm/min)                       |
| DW n + 46 | 445C | KH  |   |                                                                |

(Continued on the following page)

## Data block DBx from data word DWn (continued)

|           |         | Recommended<br>data format |                                                                           |
|-----------|---------|----------------------------|---------------------------------------------------------------------------|
| DW n +47  | 0000    | KH                         | Reference speed 1[mm/min]<br>(12000mm/min)                                |
| DW n +48  | 2EE0    |                            |                                                                           |
| DW n + 49 | 0000    | KH                         | Reference speed 2 [mm/min]<br>(8000mm/min)                                |
| DW n + 50 | 1F40    |                            |                                                                           |
| DW n +51  | 0000    | KH                         | Reference direction; 0 = fwd. 1 = rev                                     |
| DW n +52  | 0000    |                            |                                                                           |
| DW n +53  | 0001    | KH                         | PC BCD coded; 0 = no, 1 = yes<br>Bit 7 → 1 = rotary axis; 0 = linear axis |
| DW n +54  | 0000    |                            |                                                                           |
| DW n + 55 | 0000    | KH                         | Number of absolute encoder revolutions<br>(only with absolute version)    |
| DW n + 56 | 0000    |                            |                                                                           |
| DW n + 57 | 0FA0    | KH                         | Number of pulses or steps per<br>encoder revolution (4000)                |
| DW n + 58 | 0000    |                            |                                                                           |
| DW n + 59 | 2710    | KH                         | Distance per encoder revolution [urn/rev]<br>(10.000mm/rev)               |
| DW n + 60 | 0000    |                            |                                                                           |
| DW n +61  | 0000    | KH                         | 1 = home point valid, 0 = home point invalid<br>(only absolute version)   |
| DW n +62  | 0000    |                            |                                                                           |
| DW n + 63 | 00F5    | KH                         | Area used internally (only absolute version)<br>Do not overwrite!         |
| DW n +64  |         |                            |                                                                           |
| DW n +65  |         | KH                         |                                                                           |
| DW n +66  | f r e e |                            |                                                                           |
| DW n +67  |         | KH                         |                                                                           |
| DW n +68  |         |                            |                                                                           |
| DW n + 69 |         | KH                         |                                                                           |
|           |         |                            |                                                                           |

Machine data DBs in the PC have a constant length of 70 words (DWn to DWn + 69)

Parameters requiring two words, e.g. backlash compensation, are 32-bit fixed point numbers. Negative values are stored as 32-bit fixed point numbers in 2's complement. When the value is input or interpreted, remember that the programmer does not make any suitable format available for this.

**The machine data can only be transferred, read or deleted via the axis interface (parameter SSNR).**

### 3.8.2 Structure of a Machining Program DB in the PC Memory

|                |                                                  |
|----------------|--------------------------------------------------|
| <b>BA = 22</b> | machining programs transferred from PC to IP246, |
| <b>6A = 23</b> | machining programs deleted on the IP246,         |
| <b>6A = 69</b> | machining programs read from the IP246.          |

The structure and syntax of machining programs is explained in "Fundamentals of Positioning, Reference Manual", Section 5 "Machining Programs and their Structure".

Structure of data block DBx from data word DWn as an example:

```

% 1 EXAMPLE ; main program DB1, comment
N1 X100 F1000 M10 ; 1st statement
N2 M02 ; 2nd statement

```

|           | Recommended data format | Header information |                                                                   |
|-----------|-------------------------|--------------------|-------------------------------------------------------------------|
| DW n      | +00025                  | KF                 | Length of the machining program, number in words                  |
| DW n + 1  | 0044                    | KH                 | 00, 'D'                                                           |
| DW n + 2  | 066,001                 | KY                 | 'B', DB number of the machining program                           |
| DW n + 3  | +00000                  | KF                 | Machining program error                                           |
| DW n + 4  | <b>+00000</b>           | KF                 | Number of the incorrect statement                                 |
| DW n + 5  | 2520                    | KH                 | % = main program; blank hundreds                                  |
| DW n + 6  | 2031                    | KF                 | Blank (tens), '1' (ones) of the machining program number in ASCII |
| DW n + 7  | 2045                    | KH                 | Blank 'E'                                                         |
| DW n + 8  | 5841                    | KH                 | "X", 'A'                                                          |
| DW n + 9  | 4D50                    | KH                 | 'M', 'P'                                                          |
| DW n + 10 | 4C45                    | KH                 | 'L', 'E'                                                          |
| DW n + 11 | 0A00                    | KH                 | < LF >                                                            |
| DW n + 12 | 4E31                    | KH                 | 'N', '1'                                                          |
| DW n + 13 | 2058                    | KH                 | Blank, 'X'                                                        |
| DW n + 14 | 3130                    | KH                 | '1', 'o'                                                          |
| DW n + 15 | 3020                    | KH                 | 'O', Blank                                                        |
| DW n + 16 | 4631                    | KH                 | 'F', '1'                                                          |
| DW n + 17 | 3030                    | KH                 | 'o', 'o'                                                          |
| DW n + 18 | 3020                    | KH                 | 'O', Blank                                                        |
| DW n + 19 | 4D31                    | KH                 | 'M', '1'                                                          |
| DW n + 20 | 300A                    | KH                 | 'O', < LF >                                                       |
| DW n + 21 | 4E32                    | KH                 | 'N', '2'                                                          |
| DW n + 22 | 204D                    | KH                 | Blank, 'M'                                                        |
| DW n + 23 | 3032                    | KH                 | 'o', '2'                                                          |
| DW n + 24 | 0A00                    | KH                 | < LF >                                                            |

1st statement

2nd statement  
(without DR n + 24)

The length of the machining program depends on the number of programmed statements. The machining program DB can have a maximum length of 512 words.

If a machining program DB is generated or modified in the PC, the length in words must be updated in DWn. The length of the machining program is the area from data word DWn up to and including the data word in which <LF> follows M02 (DWn + y).

**Machining programs are not restricted to a specific axis. They can be transferred, read and deleted via any interface of the IP246 (parameter SSNR - axis 1 or axis 2).**

### 3.8.3 Structure of the SYSID of the IP246 in the PC Memory

The system identification SYSID (module identifier) can be

- transferred in part to the IP246 with **BA = 24**
- and
- read completely from the IP246 with **BA = 70**.

The structure of the system identification for the IP246 is described in "Functions, Reference Manual", Section 3.19 "SYSID Input".

#### 3.8.3.1 Read SYSID (BA = 70)

The system identification SYSID stored in data block DBx from data word DWn taking the example of an absolute version of the IP246. The system identification occupies nine words when read from the IP246.

|          |         | Recommended data format |                                                 |                                  |
|----------|---------|-------------------------|-------------------------------------------------|----------------------------------|
| DW n     | 'IP'    | KS                      | } Module version<br>here IP246 absolute version |                                  |
| DW n + 1 | '24'    | KS                      |                                                 |                                  |
| DW n + 2 | '6A'    | KS                      |                                                 |                                  |
| DW n + 3 | 'A0'    | KS                      |                                                 |                                  |
| DW n + 4 | '1.'    | KS                      |                                                 | } Firmware release<br>here AO1.1 |
| DW n + 5 | '1'     | KS                      |                                                 |                                  |
| DW n + 6 | 000,000 | KY                      | DRn +6: module number                           |                                  |
| DW n + 7 | 000,000 | KY                      | DRn +7: slot number                             |                                  |
| DW n + 8 | 000,000 | KY                      | DRn +8: page number                             |                                  |

### 3.8.3.2 SYSID Input (BA = 24)

The system identification SYSID is stored in data block DBx from data word DWn. The system identification is limited to three data words when writing to the IP246.

|          |            | Recommended data format |                        |
|----------|------------|-------------------------|------------------------|
| DW n     | 000,000 KY | DRn:                    | module number [0...99] |
| DW n + 1 | 000,000    | KYDR n + 1:             | slot number [0,,255]   |
| DW n + 2 | 000,000    | KY DR n + 2:            | page number[0...255]   |

If the same data block is used for reading the SYSID from the module and for writing the SYSID to the module, then the value in the parameter QANF must be increased by six (writing to the IP246) compared with the value in the parameter ZANF (reading from the IP246).

### 3.8.4 Structure of the Machine Data Directory

The machine data directory can be read from the IP246 with

**BA = 64**

The machine data directory has a constant length of four data words. If the machine data record is missing for an axis, the data words have the value zero.

The machine data directory in data block DBx from data word DWn has the following structure:

|          |         | Recommended data format |                                   |          |
|----------|---------|-------------------------|-----------------------------------|----------|
| DW n     | 000,001 | KY                      | DB no. of the machine data record | } Axis 1 |
| DW n + 1 | + 00070 | KF                      | Length in words                   |          |
| DW n + 2 | 000,005 | KY                      | DB no. of the machine data record | } Axis 2 |
| DW n + 3 | + 00070 | KF                      | Length in words                   |          |



### 3.8.5 Structure of the Machining Program Directory

The machining program directory can be read from the IP246 with

**BA = 65**

The length of the directory is variable and depends on the number of machining programs on the positioning module. A maximum of **256** machining programs can be stored on the IP246 (DB0 to DB255). In the directory, two data words are required for each machining program. The directory can therefore be a maximum of **512 words long**.

The entries in the directory are not sorted according to the DB number but are stored in the order in which they are entered on the **IP246**.

if the data block (**DBx**) selected for entry of the machining programs is not long enough, the remaining data are stored in the next data block (**DBx + 1**) from data word DWO.

A destination start address (parameter **ZANF**) can only be selected for **DBx**. Entries are made only up to data word **DW255** in the data blocks **DBx** and **DBx + 1**.

If two DBs are required, data block **DBx** must be installed up to and including **DW255**. Otherwise the program will be aborted with an error message.

The following rule applies to the length of data block **DBx**:

$$\text{length} = (\text{possible entries} * 2) + \text{destination start address ZANF}$$

for **DBx + 1** the following applies:

$$\text{length} = \text{remaining entries} * 2.$$

A further switch to a data block **DBx + 2** is not possible. If the directory cannot be stored completely in the PC memory, the job is aborted with an error message.

**Example 1**

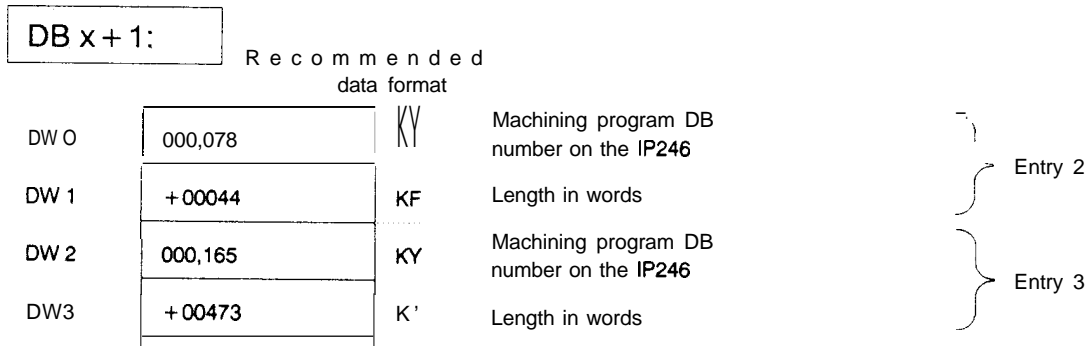
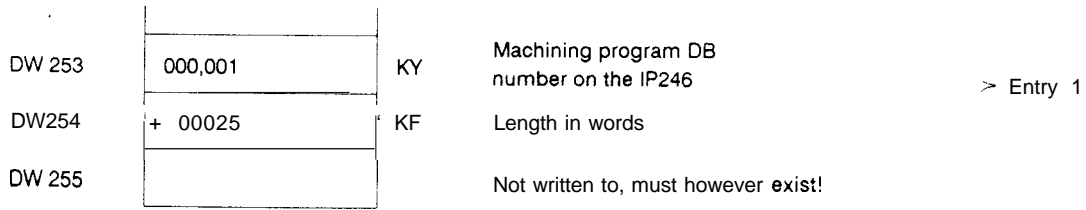
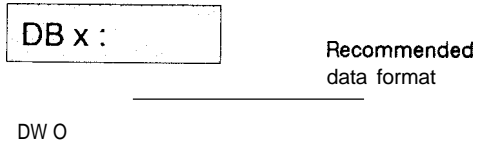
The positioning module has the maximum number of machining programs (256). Data word DW0 must be specified as the destination start address. The data blocks DBx and DBx + 1 must be installed up to and including data word DW255. The machining program directory is stored in data blocks DBx and DBx + 1 from data word DW0 onwards.

| DB x : |         | Recommended data format |                                          |             |
|--------|---------|-------------------------|------------------------------------------|-------------|
| DW 0   | 000,001 | KY                      | Machining program DB number on the IP246 | ➤ Entry 1   |
| DW 1   | + 00025 | KF                      | Length in words                          |             |
| DW 2   | 000,078 | KY                      | Machining program DB number on the IP246 | ➤ Entry 2   |
| DW 3   | + 00044 | KF                      | Length in words                          |             |
|        |         |                         |                                          |             |
| DW 254 | 000,165 | KY                      | Machining program DB number on the IP246 | - Entry 128 |
| DW 255 | + 00473 | KF                      | Length in words                          |             |

| DB x + 1: |                | Recommended data format |                                                 |              |
|-----------|----------------|-------------------------|-------------------------------------------------|--------------|
| DW 0      | <b>000.050</b> | KY                      | Machining program DB number on the IP246        | -- Entry 129 |
| DW 1      | +00126         | KF                      | Length in words                                 |              |
| DW 2      | 000,092        | KY                      | <b>Machining program DB number on the IP246</b> | ➤ Entry 130  |
| DW 3      | + 00145        | KF                      | <b>Length in words</b>                          |              |
|           |                |                         |                                                 |              |
| DW 254    | 000,187        | KY                      | Machining program DB number on the IP246        | ➤ Entry 256  |
| DW 255    | + 00035        | KF                      | Length in words                                 |              |

**Example 2**

There are three machining programs on the positioning module, the destination start address in DBx is data word DW253. The directory is then stored as follows:



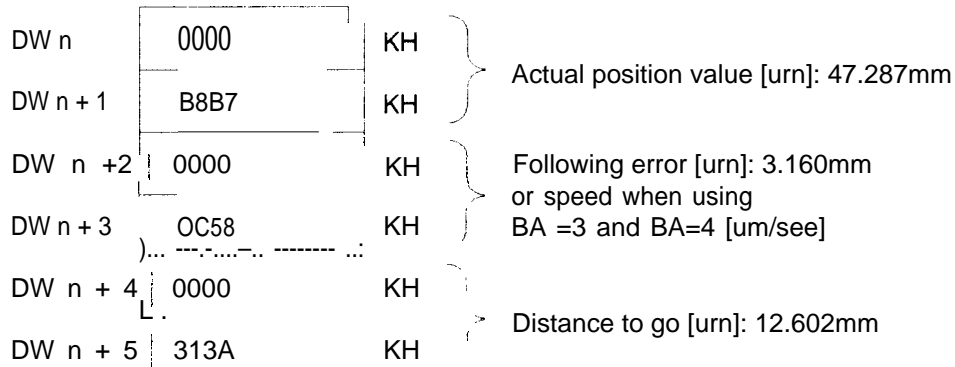
### 3.8.6 Occupation of the Data Word when reading Actual Values

The actual values (actual position value, following error or speed and distance to go) can be read from the IP246 with FBI 65 using mode

**BA = 66.**

They require a constant length of six data words.

The actual values are stored in data block DBx from data word DWn as follows:



The actual position value, the distance to go and the following error are interpreted as 32-bit fixed point numbers. Negative values are stored as 32-bit fixed point numbers in 2's complement

It is, however, possible to output the actual values as BCD numbers, This is achieved with direct parameter assignment by means of the block parameter

**BA = KY 255,66**

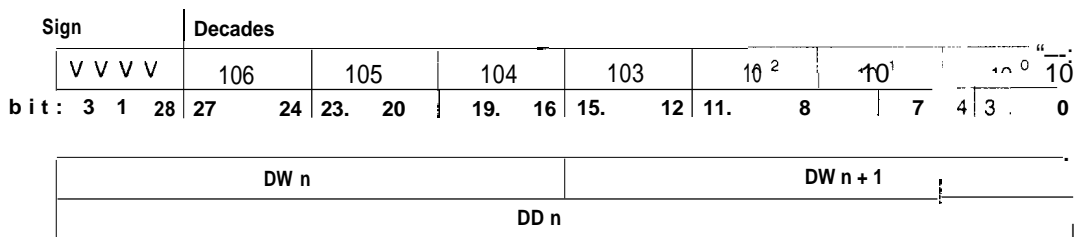
or with indirect parameter assignment using the job field of the axis data block in data word

**DWn = KY 255,66**

The actual values are then stored as seven decade BCD numbers with sign in the destination DB (parameter Z-DB).

In the BCD format, the maximum value which can be represented with a 32-bit number is +/- 9999999 urn (0.0001 in, 0.001 degrees). If a conversion from binary to BCD is not possible (representable BCD range exceeded), the value is entered in the data block as a 32-bit fixed point number (2's complement). The monitoring values which could not be converted can be read from flag byte FY249 (.= > "Planning, Installation and Service", Section 2 "Troubleshooting")

Structure of the BCD number:



e.g.  
actual position value

### 3.8.7 Structure of the Machine Data Overview

The machine data overview is an extended machine data directory. The overview can be read from the IP246 with

$$BA = 68$$

Ten data words are required. If there is no machine data record on an axis, the data words are assigned the value zero.

The machine data overview stored in data block DBx from data word DWn is as follows:

|          |               |    |                                     |          |
|----------|---------------|----|-------------------------------------|----------|
| DW n     | +00001        | KF | Machine data DB number on the IP246 |          |
| DW n + 1 | +00000        | KF | Module number                       |          |
| DW n + 2 | +00001        | KF | Axis number                         | } Axis 1 |
| DW n + 3 | +00070        | KF | Length of machine data DB in words  |          |
| DW n + 4 | +00023        | KF | Machine data error                  |          |
| DW n + 5 | +00002        | KF | Machine data DB number on the IP246 |          |
| DW n + 6 | +00000        | KF | Module number                       |          |
| DW n + 7 | +00002        | K' | Axis number                         | } Axis 2 |
| DW n + 8 | <b>+00070</b> | K' | Length of machine data DB in words  |          |
| DW n + 9 | K - J K F     |    | Machine data error                  |          |

### 3.9 Technical Data

|                                                      | S5-115U                                                                                                                                                                                                                                           |              |             | S5-135U                                                                             |             |            | S5-150U                                                                       |            |                   | S5-155U                                                                       |  |  |
|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------|-------------------------------------------------------------------------------------|-------------|------------|-------------------------------------------------------------------------------|------------|-------------------|-------------------------------------------------------------------------------|--|--|
| Block number                                         | 165                                                                                                                                                                                                                                               |              |             | 165                                                                                 |             |            | 165                                                                           |            |                   | 165                                                                           |  |  |
| Block name                                           | PER:PDAT                                                                                                                                                                                                                                          |              |             | PER:PDAT                                                                            |             |            | PER:PDAT                                                                      |            |                   | PER:PDAT                                                                      |  |  |
| Library number                                       | P71200-S5165-D-1                                                                                                                                                                                                                                  |              |             | P71200-S9165-D-1                                                                    |             |            | P71200-S4165-D-1                                                              |            |                   | P71200-S6165-D-1                                                              |  |  |
| Call length                                          | 13 words                                                                                                                                                                                                                                          |              |             | 13 words                                                                            |             |            | <b>13 words</b>                                                               |            |                   | 13 words                                                                      |  |  |
| Block length                                         | 646 words                                                                                                                                                                                                                                         |              |             | 533 words                                                                           |             |            | 567 words                                                                     |            |                   | <b>624 words</b>                                                              |  |  |
| Nesting depth                                        | 1                                                                                                                                                                                                                                                 |              |             | 1                                                                                   |             |            | -                                                                             |            |                   | 1                                                                             |  |  |
| Secondary blocks                                     | Integrated handling blocks                                                                                                                                                                                                                        |              |             | Handling blocks                                                                     |             |            | Handling blocks                                                               |            |                   | Handling blocks                                                               |  |  |
| Occupation of data area                              | <ul style="list-style-type: none"> <li>- 15 data words from parameter DWNR of the axis data block DBNR</li> <li>- DB165 occupied from data word DW0 to DW47</li> <li>- In indirect parameter assignment via DBx: data word DW1 and DW2</li> </ul> |              |             |                                                                                     |             |            |                                                                               |            |                   |                                                                               |  |  |
| Occupation of flag area                              | FY206 to FY255 as scratchpad flags                                                                                                                                                                                                                |              |             | FY218 to FY255 as scratchpad flags                                                  |             |            | FY200 to FY255 as scratchpad flags                                            |            |                   | FY200 to FY255 as scratchpad flags                                            |  |  |
| Occupation in system data area                       | none                                                                                                                                                                                                                                              |              |             | RS60 and RS61                                                                       |             |            | yes                                                                           |            |                   | yes                                                                           |  |  |
| System statements                                    | yes                                                                                                                                                                                                                                               |              |             | yes                                                                                 |             |            | yes                                                                           |            |                   | yes                                                                           |  |  |
| Miscellaneous                                        | Interrupts blocked at times in the FB by commands IA/RA. An IA command is cancelled by this.                                                                                                                                                      |              |             | <b>Handling blocks FB120 SEND, FB121 RECEIVE and FB125 SYNCHRON must be loaded.</b> |             |            | Handling blocks FBI 80 SEND, FB181 RECEIVE and FB185 SYNCHRON must be loaded. |            |                   | Handling blocks FB120 SEND, FB121 RECEIVE and FBI 25 SYNCHRON must be loaded. |  |  |
| Maximum runtimes in ms                               | Dependent on the BA and the selected field, ze (standard value = 0)                                                                                                                                                                               |              |             |                                                                                     |             |            |                                                                               |            |                   |                                                                               |  |  |
|                                                      | CPU 941                                                                                                                                                                                                                                           | CPU 942      | CPU 943     | <del>CPU 944</del>                                                                  | CPU 922     | CPU 928    | CPU 92812                                                                     |            |                   |                                                                               |  |  |
| Write and delete jobs BA20 to BA24                   | 25.7 to 32.4                                                                                                                                                                                                                                      | 9.6 to 17.4  | 5.5 to 13.6 | 3.8 to 9.1                                                                          | 3.0 to 13.0 | 1.0 to 6.6 | 0.5 to 6.3                                                                    | 1.7 to 3.8 | <b>2.0 to 5.9</b> |                                                                               |  |  |
| S5 cycles (min.)                                     | 2-6                                                                                                                                                                                                                                               |              |             | 2-4                                                                                 |             |            | 2-4                                                                           |            |                   | 2-4                                                                           |  |  |
| Read jobs BA64 to BA70                               | 125.8 to 34.5                                                                                                                                                                                                                                     | 18.0 to 15.0 | 0 to 13.0   | 6.5 to 7.5                                                                          | 3.2 to 13.0 | 3.0 to 6.6 | 1.0 to 6.3                                                                    | 2.5 to 3.2 | 1.8 to 6.1        |                                                                               |  |  |
| With BA66 max.                                       | 81.0                                                                                                                                                                                                                                              | 21.2         | 14.8        | <b>8.3</b>                                                                          |             |            |                                                                               |            |                   |                                                                               |  |  |
| S5 cycles (min.)                                     | 2-4                                                                                                                                                                                                                                               |              |             | 2-4                                                                                 |             |            | 2-3                                                                           |            |                   | 2-3                                                                           |  |  |
| Extra runtime of FB with direct parameter assignment | 2.2                                                                                                                                                                                                                                               | <b>1.3</b>   | <b>1.7</b>  | <b>0.07</b>                                                                         |             |            |                                                                               |            |                   |                                                                               |  |  |

### 3.10 Notes on Starting Up the Positioning Module IP246 via the PC Interface

If you start up the positioning module via the PC interface, the system identification (SYSID) must be transferred to the module before the machine data are transferred. After power up, the following defaults apply:

|               |         |
|---------------|---------|
| module number | = 0,    |
| slot number   | = 0 and |
| - page number | = 0.    |

The machine data can then be transferred to the module. Only machine data with a module number (DLn + 3 of the machine data DB) identical to the module number in the SYSID (DRn + 6 or DRn) are permitted.

If the machine data are valid, the axis can be moved in the JOG mode or incremental relative mode. Absolute targets can only be approached with both the incremental and absolute version after calibration of the axis (mode 5).

There is no "overwrite mode" for machine data. If an axis requires new machine data, the following operations must be carried out:

delete the "old" machine data record on the axis (BA21 )

- transfer the "new" machine data record to the axis via the interface assigned to it (BA20).

A machine data record on the IP246 can be assigned any permitted DB number (DB0 to DB255). There is, however, only ever one machine data record for an axis. The assignment of the machine data records to the axes is made using the axis number in the machine data record (DRn +3). The axes can therefore be assigned a machine data record with the same DB number, however, with a different axis number (= > "Functions, Reference Manual", Section 3.17,1 "Enter Machine Data" or Section 3.17.2 "Delete Machine Data"). For more information about machine data, refer to "Fundamentals of Positioning, Reference Manual", Section 4 "Machine Data and their Structure".

A maximum of 256 machining programs (**DB0 to DB255**) can be stored on the positioning module. An existing machining program cannot be overwritten. If you wish to modify a machining program stored on the IP246, then a certain procedure must be adhered to, just as with the machine data:

- output the machining program (machining program DB) from the IP246 to the PC memory, unless it already exists there (BA 69),
- delete the machining program (machining program DB) on the IP246 (BA 23)
- transfer the modified machining program to the IP246 (BA 22).

A machining program is not restricted to an axis. Both axes can execute the same machining program simultaneously. Machining programs can be transferred, read and deleted via any interface (axis) of a module. A machining program can, however, only be deleted when the other axis is not using this machining program (= > "Functions, Reference Manual", Section 3.18 "Executing Machining Programs"). For more information about machining programs, refer to "Fundamentals of Positioning, Reference Manual", Section 5 "Machining Programs and their Structure".

### 3.11 Using the Function Block

**In cyclic operation it is not possible to address a module both with indirect and direct parameter assignment.**

Function block FB165 works with data block DB165. This must be installed up to and including data word DW47. A particular assignment of the data words is not necessary.

Data block DB165 is divided into two areas, in which data words DW1 and DW2 are reserved for indirect assignment of parameters to the function block. Data words DW3 to DW47 are the working area for FBI 65. You must not change the working area.

When assigning parameters to FB165, remember that the specified data blocks of the source and destination parameters must exist and must be adequately long.

The axis data block (parameter DBNR) must have the following length:

$$\text{length} = \text{parameter DWNR} + 14$$

The DB/DX number and the DW number can be selected as required.



The data block is set up with a programmer, e.g. with the PG 685 STEP 5 under S5-DOS (stage III) with the following commands (after exiting the presetting mask):

```

< F1 > (input)
< F1 > (block)
P c (input device)
DB160 (block) enter key < | >

DW 0: KY = 000,000
DW 1: KY = 000,000
DW 2: KY = 000,000
DW 3: KY = 000,000

```

```

DW14: KY = 000,000 enter key < | >

```

**FB165** can be called conditionally. The call must be made cyclically until the assigned mode is completely executed. The mode (job) runs

with direct parameter assignment as long as the parameter ANST has the signal state "1",  
with indirect parameter assignment as long as data word DWn is not equal to KH0000 in the axis data block.

You must ensure **that the parameter assignment is not overwritten while a mode is being executed.**

With indirect parameter assignment, the current data block must be open and supplied with the parameters **DBNR (DW1)** and **DWNR (DW2)** before the function block **FB165** is called.

The positioning module **IP246** does not service interrupts.

## 4 Examples

### 4.1 General Notes on the Examples

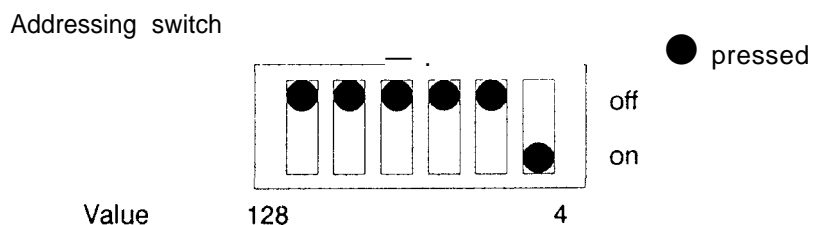
The following examples of the use of FB164 and FB165 are on the diskette supplied. The examples can be loaded completely in the PC memory to test the module. They illustrate a possible parameter assignment for an axis.

All the required blocks are available. The diskette also provides a complete "program framework" which you can use.

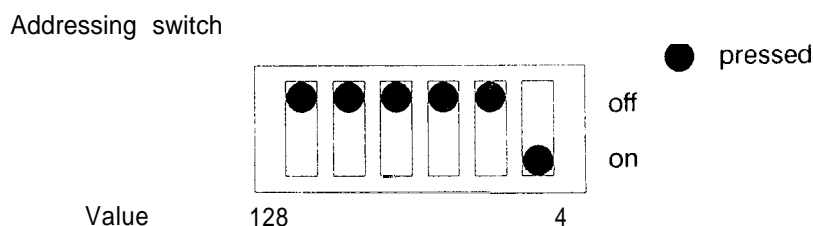
### 4.2 Hardware Requirements

The following is required to implement the examples:

- one digital input module 6ES5420-.... coded as IB4 \*)



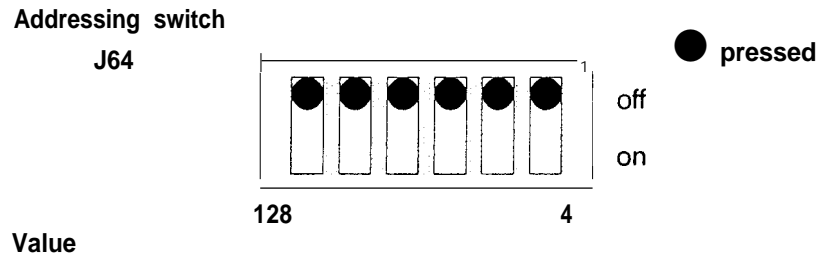
- one digital output module 6ES5441. . . . . coded as QB4 \*)



\*) The following applies for the S5 115U:

- one digital input module 6ES5420-.... (fixed slot addressing) inserted in slot number 1 in the central controller (IB4 to IB7).
- one digital output module 6ES5441. . . . . (fixed slot addressing) inserted in slot number 2 in the central controller (QB8toQB11 ).

- one IP246 positioning module coded as page number 0 ( => “Hardware, Instructions”, Section 3.3 “Setting the Module Address”) inserted in a CP slot in the central controller of the programmable controller.



The remaining jumpers on the IP246 must be set for the specific plant ( => “Hardware, Instructions”, Section 3.2 “Setting the Module Address”),

### 4.3 Assignments for the Examples

#### 4.3.1 Digital Inputs: (valid for all Programmable Controllers)

IB4            BA                    Mode with indirect parameter assignment in format KF

Mode with direct parameter assignment:

|       |          | *** FB1 64 ***                                   | *** FBI 65 ***              |
|-------|----------|--------------------------------------------------|-----------------------------|
| I 4.0 | REF      | Reference/home point                             | Read SYSID                  |
| I 4.1 | TIPP1    | JOG 1                                            | Read machine data directory |
| I 4.2 | TIPP2    | JOG 2                                            | Read actual values          |
| I 4.3 | SMR      | Incremental relative                             | Read machine data           |
| I 4.4 | IW       | Read actual value                                | Read machine data overview  |
| I 4.5 | SA       | Read following error                             | Write SYSID                 |
| I 4.6 | RW       | Read distance to go                              | Write machine data          |
| I 4.7 | LLOE     | Clear cyclic monitoring                          | Delete machine data         |
| I 5.0 | STAR     | START command                                    |                             |
| I 5.1 | STOP     | STOP command                                     |                             |
| I 5.2 | VORW     | FORWARDS command                                 |                             |
| I 5.3 | RUCK     | REVERSE command                                  |                             |
| I 5.4 | UEBN     | Enter data command                               |                             |
| I 5.5 | BCD      | Output in BCD code                               |                             |
| I 5.6 | INDI.AUF | Indirect param. ass. enter job FB165             |                             |
| I 5.7 | DIR. AUF | Direct param. ass. trigger job FB165             |                             |
| I 6.0 | POS/PDAT | 0 = execute FB164 / 1 = execute FB165            |                             |
| I 6.1 | IN/DI    | 0) = indirect / 1 = direct parameter assignment  |                             |
| I 6.2 |          | Overwrite DB with KHFFFF (FB191 and FB192/FB165) |                             |
| I 6.3 | RFEH     | Clear retentive error                            |                             |
| I 6.4 |          |                                                  |                             |
| I 6.5 |          |                                                  |                             |
| I 6.6 |          |                                                  |                             |
| I 6.7 |          |                                                  |                             |

If none of the inputs I 4.0 to I 4.7 has signal state "1" in FB164, then the set mode is "following error" (mode 4) with direct parameter assignment.

#### 4.3.2 Digital Outputs: (valid for S5-135U, S5-150U and S5-155U)

|       |      |                                            |
|-------|------|--------------------------------------------|
| Q 4.0 | PAFE | Parameter assignment error FB164 and FB165 |
| Q 4.1 | BFEH | Module error FB164 and FB165               |
| Q 4.2 | TBIT | Active bit FBI 64                          |
| Q 4.3 |      |                                            |
| Q 4.4 |      |                                            |
| Q 4.5 |      |                                            |
| Q 4.6 |      |                                            |
| Q 4.7 |      |                                            |
| QB5   | PAFE | Image of the PAFE byte FY255, retentive    |

|       |       |                                |
|-------|-------|--------------------------------|
| Q 6.0 | PAFES | PAFE retentive FB164 and FB165 |
| Q 6.1 |       |                                |
| Q 6.2 |       |                                |
| Q 6.3 |       |                                |

#### 4.3.3 Digital Outputs: (valid for S5-115U)

|              |       |                                             |
|--------------|-------|---------------------------------------------|
| Q 8.0        | PAFE  | Parameter assignment error FB164 and FBI 65 |
| Q 8.1        | BFEH  | Module error FB164 and FB165                |
| Q 8.2        | TBIT  | Active bit FB164                            |
| Q 8.3        |       |                                             |
| <b>Q 8.4</b> |       |                                             |
| <b>Q 8.5</b> |       |                                             |
| <b>Q 8.6</b> |       |                                             |
| <b>Q 8.7</b> |       |                                             |
| QB9          | PAFE  | Image of the PAFE byte FY255, retentive     |
| Q 10.0       | PAFES | PAFE retentive FB164 and FBI 65             |
| Q 10.1       |       |                                             |
| Q 10.2       |       |                                             |
| Q 10.3       |       |                                             |

#### 4.3.4 Occupation of the Data Area

The data blocks DB150, DB151 and DB152 are occupied from DWO to DW32. These data blocks are used to save the scratchpad area and the free system data area.

In the S5 155U, the data block DB255 must be stipulated with a length of 826 words

#### 4.3.5 Occupation of the Flag Area

|       |        |                                              |
|-------|--------|----------------------------------------------|
| F 0.0 | NULL   | "RLO 0" flag                                 |
| F 0.1 | EINS   | "RLO 1" flag                                 |
| FY4   |        | Corresponds to IB4                           |
| FY5   |        | Corresponds to IB5                           |
| FY6   |        | Corresponds to IB6                           |
| FY7   |        | Corresponds to IB7                           |
| FY14  |        | Corresponds to QB4 or QB8 with the S5-115U   |
| FY15  |        | Corresponds to QB5 or QB9 with the S5-115U   |
| FY16  |        | Corresponds to QB6 or QB10 with the S5-1 15U |
| FY17  |        | Corresponds to QB7 or QB11 with the S5-115U  |
| FY50  | RBTR   | Mode checkback signal                        |
| FY51  | RM-FKT | M function checkback signal                  |
| FY52  | RPOS   | Module checkback signals                     |
| FD60  | ANZ    | Condition codewords of the monitoring job    |

|        |         |                             |
|--------|---------|-----------------------------|
| FY99   | PAFE    | SYNCHRONPAFE byte           |
| FY100  | BTR     | Mode selection              |
| FYI 01 | BEF     | Command selection           |
| FYI 02 | TBIT    | Image job active            |
| FYI 05 | FLM/IMP | Signal edge and pulse flags |

Scratchpad flags from FY200 to FY255

#### 4.3.6 Block Assignments

|        |          |                                                            |
|--------|----------|------------------------------------------------------------|
| OB1    | ZYK      | Cyclic program execution                                   |
| OB2    | IRA      | Process interrupt servicing IR-A or I 0.0                  |
| OB13   | WECK     | Time interrupt servicing                                   |
| OB20   | NEUSTAR  | Cold restart at programmable controller (not with S5 115U) |
| OB21   | MANWIED  | Manual warm restart/cold restart with S5 115U              |
| OB22   | AUTWIED  | Automatic warm restart                                     |
| FB50   | INDX.164 | Example indir. param. ass. FB164 via DX block              |
| FB51   | IP246DIR | Example dir. param. ass. FB165                             |
| FB52   | IP246IND | Example indir. param. ass. FB165                           |
| FB53   | IP246DI  | Example dir. param. ass. FB164                             |
| FB54   | IP246IN  | Example indir. param. ass. FB164                           |
| FB120  | SEND     | HTB AG S5-135U/155U                                        |
| FB121  | RECEIVE  | Handling block S5 135 U/155U                               |
| FBI 22 | FETCH    | Handling block S5 135 U/155U                               |
| FB123  | CONTROL  | Handling block S5 135 U/155U                               |
| FB124  | RESET    | Handling block S5 135 U/155U                               |
| FB125  | SYNCHRON | Handling block S5 135 U/155U                               |
| FB151  | BS-RETT  | Save BS60 to BS63                                          |
| FB152  | BS-LAD   | Load BS60 to BS63                                          |
| FB164  | PER:POS  | Standard FB for control of the positioning module          |
| FB165  | PER:PDAT | Standard FB for data transfer                              |
| FB180  | SEND     | Handling block S5 150U                                     |
| FB181  | RECEIVE  | Handling block S5 150U                                     |
| FB182  | FETCH    | Handling block S5 150U                                     |
| FBI 83 | CONTROL  | Handling block S5 150U                                     |
| FB184  | RESET    | Handling block S5 150U                                     |
| FB185  | SYNCHRON | Handling block S5 150U                                     |
| FB244  | SEND     | Handling block S5 115U                                     |
| FB245  | RECEIVE  | Handling block S5 115U                                     |
| FB246  | FETCH    | Handling block S5 115U                                     |
| FB247  | CONTROL  | Handling block S5 115U                                     |
| FB248  | RESET    | Handling block S5 115U                                     |
| FB249  | SYNCHRON | Handling block S5 115U                                     |

|       |          |                                                         |
|-------|----------|---------------------------------------------------------|
| DB104 | SMDAT    | Write machine data                                      |
| DB106 | SPRG     | Write machining program                                 |
| DB107 | SSYS-ID  | Write <b>SYSID</b>                                      |
| DB150 | RET OB2  | Save flags <b>OB2</b>                                   |
| DB151 | RET OB13 | Save flags <b>OB13</b>                                  |
| DB152 | RET ANL  | Save flags <b>OB21/OB22</b> (not required with S5 115U) |
| DB160 | IP246AN1 | User <b>DB</b>                                          |
| DB161 | IP246AN2 | User <b>DB</b> (not used in example)                    |
| DB164 | IP-FB164 | Fixed working <b>DB</b> for <b>FB164</b>                |
| DB165 | IP-FB165 | Fixed working <b>DB</b> for <b>FB165</b>                |
| DB166 | IP246AN3 | User <b>DB FB165</b> , indirect parameter assignment    |
| DB167 | IP246AN4 | User <b>DB FB165</b> , direct parameter assignment      |
| DB200 | LMDIR    | Read machine data directory                             |
| DB201 | LPRGDIR  | Read machining program directory                        |
| DB203 | LIW      | Read actual values                                      |
| DB204 | LMDAT    | Read machine data                                       |
| DB205 | LMDATÜB  | Read machine data overview                              |
| DB206 | LPRG     | Read machining program                                  |
| DB207 | LSYS-ID  | Read <b>SYSID</b>                                       |
| DX160 | IP246AN3 | User <b>DX</b> (only with S5 135U and S5 155U)          |
| DX161 | IP246AN4 | User <b>DX</b> (only with S5 135U and S5 155U)          |

### 4.4 Schematic Diagrams of the Organization Blocks (Program Framework)

#### 4.4.1 OBI

|                                                               |             |                          |            |                            |    |
|---------------------------------------------------------------|-------------|--------------------------|------------|----------------------------|----|
| Copy ID4 to FD4                                               |             |                          |            |                            |    |
| yes                                                           | direct      | param. ass.<br>F 6.1 = 1 | and<br>and | execute FB164<br>F 6.0 = 0 | no |
| Call FB53                                                     |             |                          |            |                            |    |
| yes                                                           | indirect    | param. ass.<br>F 6.1 = 0 | and<br>and | execute FB164<br>F 6.0 = 0 | no |
| Call FB54 or FB50 (DX) only with S5 135U and S5 155U          |             |                          |            |                            |    |
| yes                                                           | direct      | param. ass.<br>F 6.1 = 1 | and<br>and | execute FB165<br>F 6.0 = 1 | no |
| Call FB51                                                     |             |                          |            |                            |    |
| yes                                                           | indirect    | param. ass.<br>F 6.1 = 0 | and<br>and | execute FB165<br>F 6.0 = 1 | no |
| Call FB192: copy DB                                           |             |                          |            |                            |    |
| yes                                                           | Clear error |                          |            |                            | no |
| FY15 = 0, reset F 16.0<br>Copy FD14 to QD4 (QD8 with S5 115U) |             |                          |            |                            |    |



#### 4.4.2 The Interrupt OBs

|                                                                     |
|---------------------------------------------------------------------|
| Process interrupt OBs and time interrupt OBs                        |
| Save flags ->FY200 to FY255<br>Save operating system data (S5 135U) |
| User program if interrupt                                           |
| Load operating system data (S5 35U)<br>Load flags ->FY200 to FY255  |
| END                                                                 |

#### 4.4.3 OB21 and OB22 with S5 115U OB20 and OB22 with S5 135U OB20 with S5 150U and S5 155U

|                                        |
|----------------------------------------|
| F 0.0 = RLO "0"                        |
| F 0.1 = RLO "I"                        |
| Synchronize interface                  |
| Clear binary identifiers for each axis |
| User program                           |
| END                                    |

#### 4.4.4 OB21 with S5 135U, S5 150U and S5 155U OB22 S5 150U

|                                   |
|-----------------------------------|
| STP (direct change to stop state) |
|-----------------------------------|

#### 4.5 Example of Function Block FB164

In the example, function block FB164 PER:POS works with the function blocks FB53 and FB54 and with data blocks DB160 and DB164.

The following requirements must be met:

- input of I 6.0 must have signal state "0"
- the type of parameter assignment can be selected via input I 6.1:
  - signal state "0" = indirect parameter assignment via FB54
  - signal state "1" = direct parameter assignment via FB53

The function block FB53 shows direct parameter assignment to FB164, FB54 shows indirect parameter assignment.

With indirect parameter assignment, the actual operands are stored in DB160 from data word DW1 to DW7.

The example of indirect parameter assignment covers all possible modes, whereas the example for direct parameter assignment is restricted to the following modes:

- reference point approach
- JOG 1 and 2
- incremental relative
- read actual value, following error and distance to go
- disable monitoring
- following error

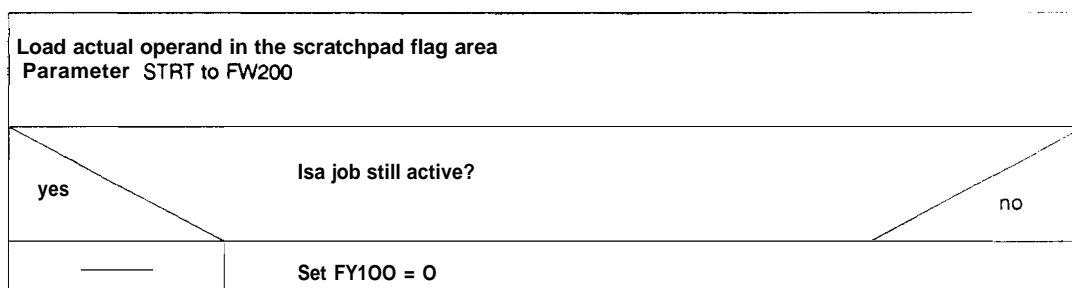
##### 4.5.1 The Function Block FB53 (Schematic Diagrams)

The function block FB53 shows the use of the function block FB164 with direct parameter assignment via the block parameters. FB164 must be called for each required mode.

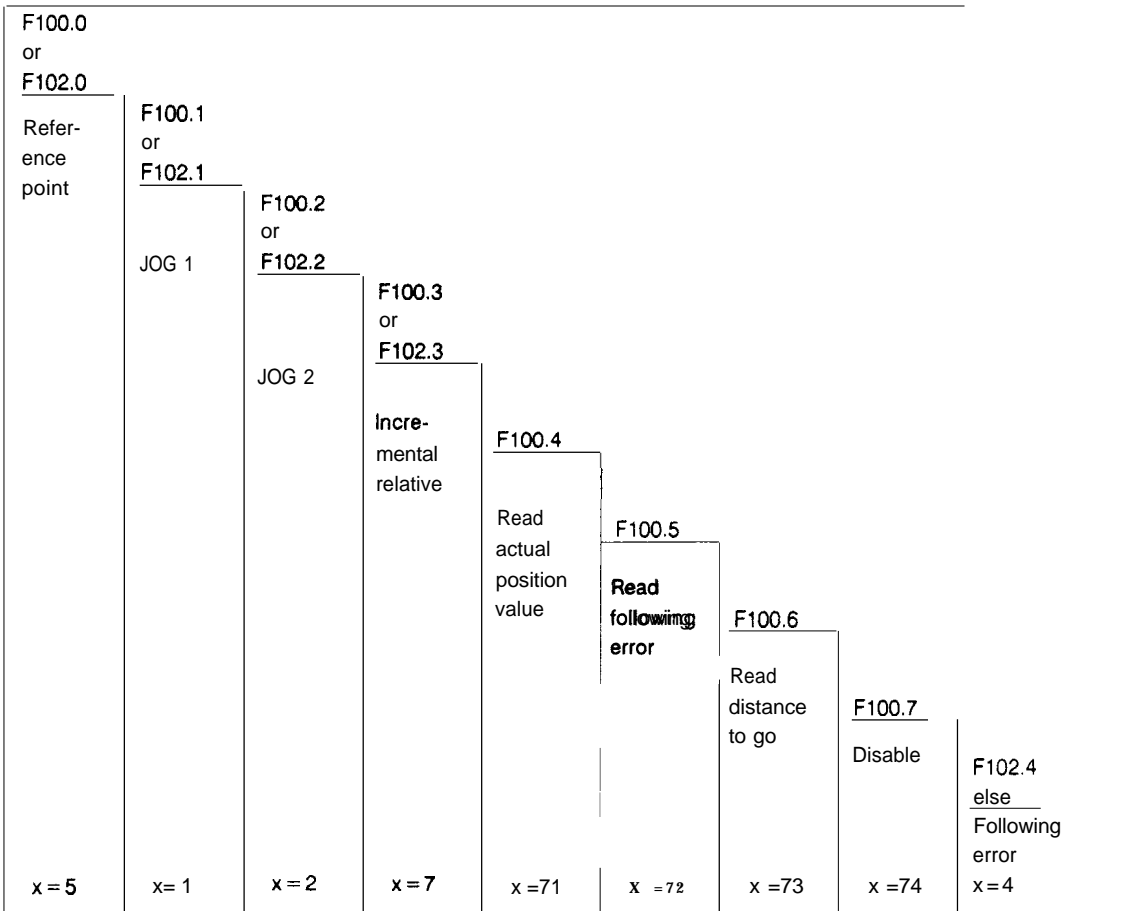
Segment 1:

|                           |
|---------------------------|
| Parameter list: STRT 1, W |
|---------------------------|

Segment 2:



Segment 3:



Call function block **FB164** depending on command

**FB164**

NAME : PER : POS  
 SSNR : KF + 0  
 DBNR : KY0, 160  
 DWNR : KF + 8  
 BA : KF + x  
 STAR : F 101.0  
 STOP : F 101.1  
 VORW : F 101,2  
 RUCK : F 101.3  
 URBN : F 101.4  
 BCD : F 101.5  
 PAFE : F 14.0  
 BFEH : F 14.1  
 TBIT : F 14.2  
 BTR : FY50  
 MFKT : FY51  
 RMLD : FY52  
 ANZG : FD60

or ANZ1 : FW60  
 ANZ2: FW62 } with the S5 115U

Assign auxiliary flags F 102.0 to F 102.4,  
 as long as output F 14.2 "TBIT" still has signal 1.

Segment 4:

|     |                                                                            |
|-----|----------------------------------------------------------------------------|
| yes | Parameter <b>PAFE</b> 0-> 1 edge ? (FY 105)                                |
|     | Set <b>PAFE</b> retentive F 16.0<br>Store <b>PAFE</b> byte (FY255) in FY15 |

Segment 5:

|    |
|----|
| BE |
|----|

### 4.5.2 The Function Block FB54 (Schematic Diagrams)

Function block FB54 shows the use of function block FB164 with indirect parameter assignment via the data block DB1 60. The assignment of the data words is fixed!

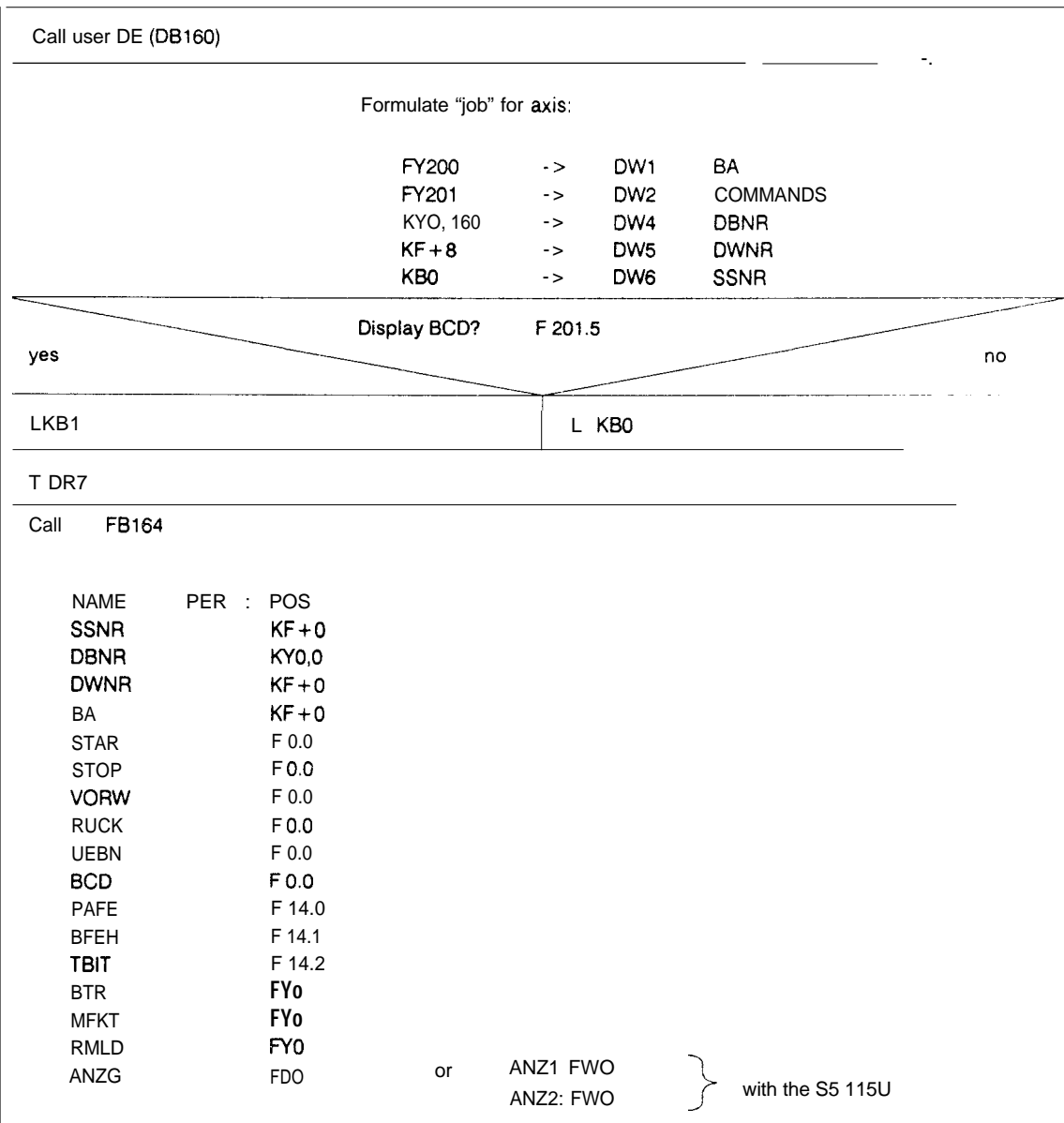
Segment 1:

Parameter list: **STRT**,W

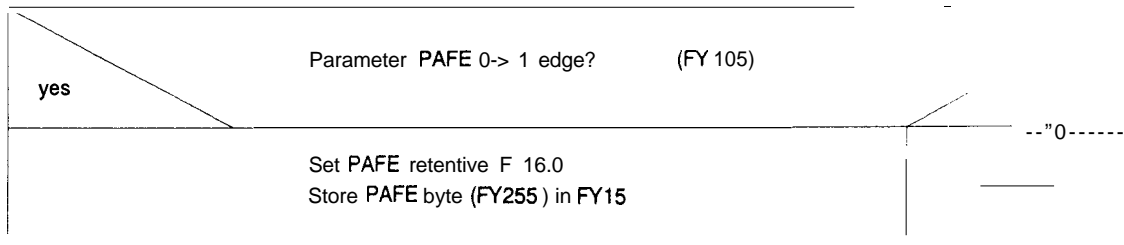
Segment 2:

Load actual operand in the scratchpad flag area: **STRT** -> FW200

Segment 3:



Segment 4:



Segment 5:



## 4.6 Example of Function Block FB165

In the example, function block FB165 works with the function blocks FB51 and FB52 and with the data blocks DB104, 106 and 107 (for write data), DB165 (working DB), DB166, 167 (axis DBs) and DB200 to 207 (for read data).

The following requirements must be met:

- input I 6.0 must have signal state "1"
- the type of parameter assignment can be selected via input 16.1:
  - signal state "O" = indirect parameter assignment via FB52
  - signal state "1" = direct parameter assignment via FB51.

Function block FB51 shows the direct parameter assignment of FB165, FB52 shows indirect parameter assignment.

With indirect parameter assignment, the actual operands (job field) is stored in data block DB166 from data word DW1 to DW6.

The example of indirect parameter assignment covers all possible modes, whereas the example of direct parameter assignment is restricted to the following modes:

- read SYSID
- read machine data directory
- read actual values
- read machine data
- read machine data overview
- write SYSID
- write machine data
- delete machine data

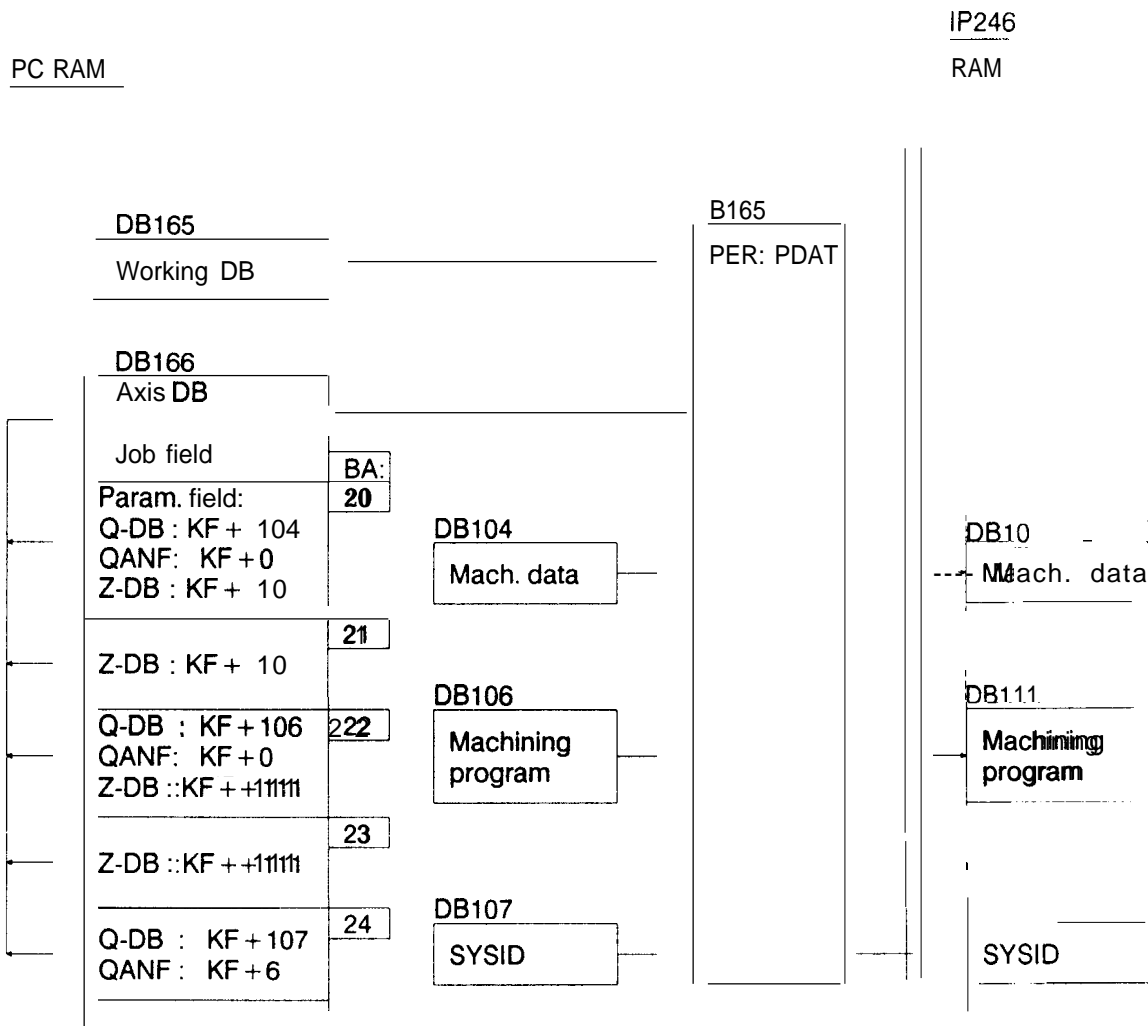
#### 4.6.1 Overview of the Relationship between the Mode and the Data Blocks in the RAM of the CPU and the Positioning Module

Machine data and machining programs are stored on the positioning module as data blocks.

The absolute DB and DW numbers refer to the example.

##### 4.6.1.1 Writing Data to the IP246 and Deleting Data on the IP246

Modes BA: 20 to 24 ( => "Functions, Reference Manual")



To be able to transfer a data record to the positioning module, you must supply the following parameters to the function block:

Mode (BA), source (Q-DB, QANF) and destination parameters (Z-DB)

Parameters not required are assigned KF +0.

Example:

Parameter assignment to transfer the machine data (PC-> IP246):

|                       |          |                    |
|-----------------------|----------|--------------------|
| - Mode BA :           | KF + 20  |                    |
| - Source DB Q-DB :    | KF + 104 | = DB104 PC memory  |
| - Source start QANF : | KF + 0   | = DW0 from DW0     |
| - Dest. DB Z-DB :     | KF + 10  | = DB10IP246 memory |
| - Dest. start ZANF :  | KF + 0   | = irrelevant       |

The machine data DB (DB104) in the PC memory is transferred as machine data DB(DB10) to the IP246 memory.

If the machine data record is to be deleted, the following parameter assignment must be made:

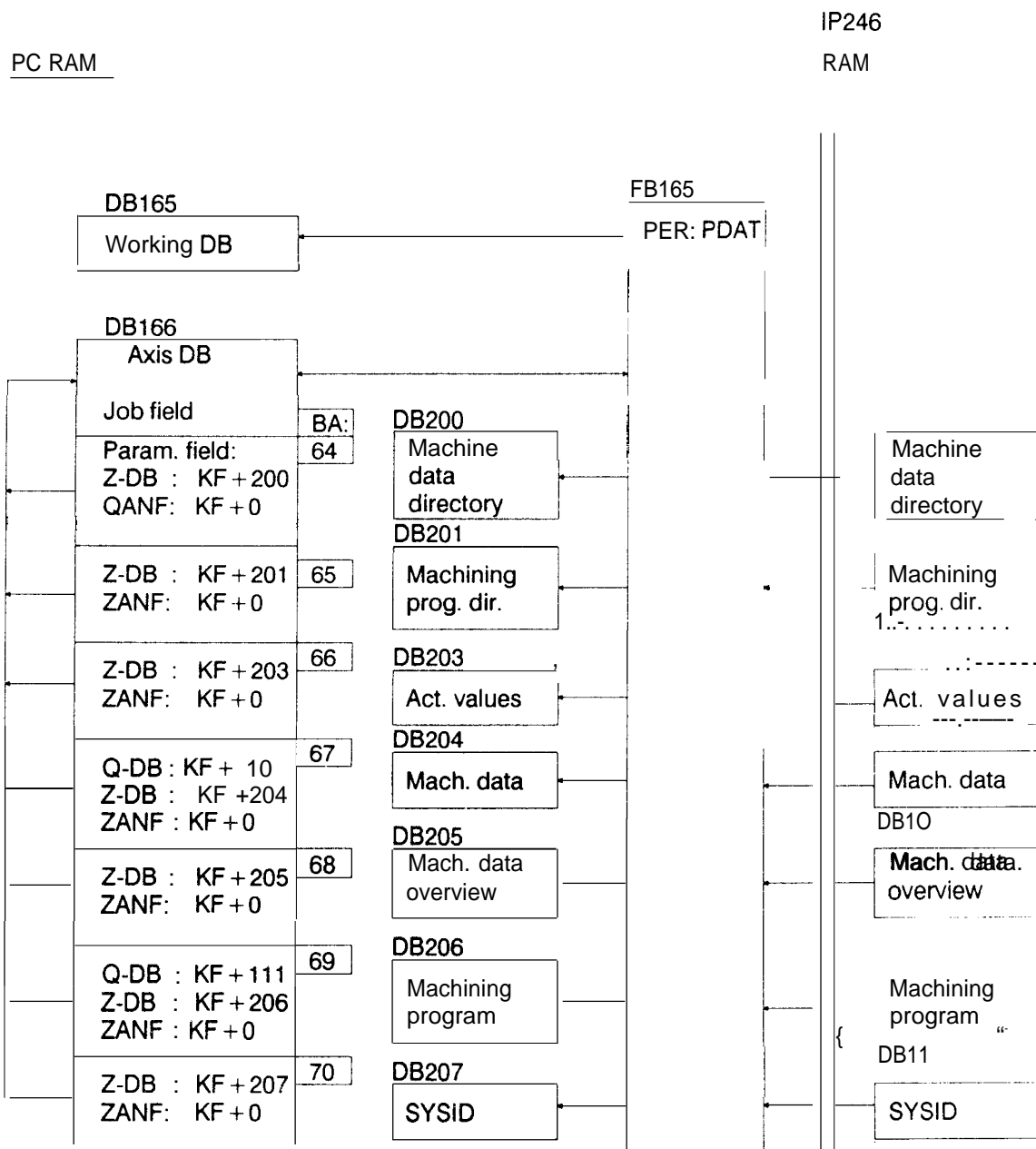
|                       |         |                    |
|-----------------------|---------|--------------------|
| - Mode BA :           | KF + 21 |                    |
| - Source DB Q-DB :    | KF + 0  | = irrelevant       |
| - Source start QANF : | KF + 0  | = irrelevant       |
| - Dest. DB Z-DB :     | KF + 10 | = DB10IP246 memory |
| - Dest. start ZANF :  | KF + 0  | = irrelevant       |

The machine data DB (DB10) on the positioning module is deleted.



### 4.6.1.2 Reading Data from the IP246

Modes BA 64 to 70 (= > "Functions, Reference Manual")



To be able to read a data record from the positioning module, the following parameters must be specified for the function block:

mode (BA), source (Q-DB) and destination parameters (Z-DB, ZANF)

Parameters not required are assigned KF + 0.

**Example:**

Parameter assignment to read machine data (I P246-> PC):

- Mode BA : KF +67
- Source DB Q-DB : KF + 10 = DB10 IP246 memory
- Source start ZANF : KF +0 = irrelevant
- Dest. DB Z-DB : KF +204 = DB204 PC memory
- Dest. start ZANF : KF +0 = DW0 from DW0

The machine data DB (DB10) on the positioning module IP246 is stored as machine data DB (DB204) from data word DW0 in the PC memory.

**4.6.2 The Function Block FB51 (Schematic Diagrams)**

The function block FB51 shows the use of the function block FB165 with direct parameter assignment via the block parameters. FB165 must be called once for all required modes.

DB167 from DW0 to DW14 is used as the axis data block.

**Segment 1:**

Parameter list: STRT 1, W

**Segment 2:**

**Load parameters in -> FW200**

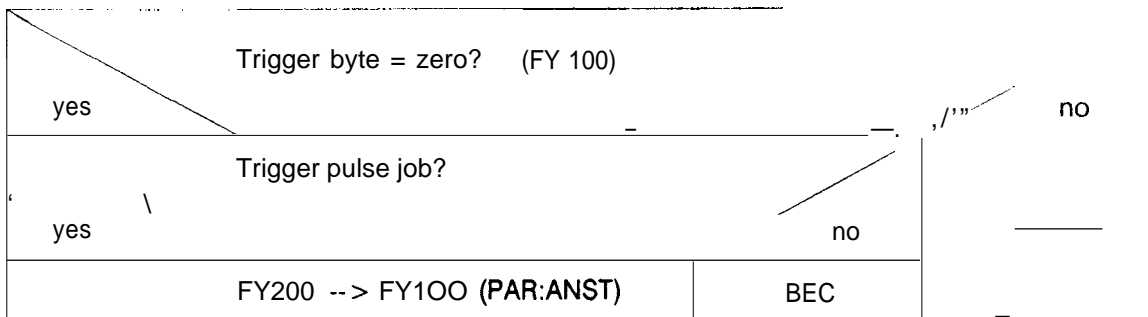
Signal edge evaluation (rising) F 201.7

}

F 105.1 EDG

F 202.1 PUL

**Segment 3:**



Segment 4:

|                |                          |               |              |                     |            |            |            |                             |
|----------------|--------------------------|---------------|--------------|---------------------|------------|------------|------------|-----------------------------|
| Job execution: |                          | A             | F 100. x     |                     |            |            |            | Call according to priority! |
| ANST:          |                          | JC            | FB165        |                     |            |            |            |                             |
| F100.0         |                          |               |              |                     |            |            |            |                             |
| BA = 70        | F100.1                   |               |              |                     |            |            |            |                             |
| Z-DB = 207     | 3A = 64                  | F100.2        |              |                     |            |            |            |                             |
| ZANF = 0       | Z-DB = 200               | BA = 66       | F100.3       |                     |            |            |            |                             |
|                | ZANF = 0                 | Z-DB = 203    | BA = 67      | F100.4              |            |            |            |                             |
|                |                          | ZANF = 0      | Q-DB = 0, 10 | 3A = 68             | F100.5     |            |            |                             |
|                |                          |               | Z-DB = 205   | Z-DB = 204          | BA = 24    | F100.6     |            |                             |
|                |                          |               | ZANF = 0     | ZANF = 0            | Q-DB = 107 | BA = 20    | F100.7     |                             |
|                |                          |               |              |                     | Z-DB = 104 | BA = 21    |            | else                        |
|                |                          |               |              |                     | Z-DB = 10  | Z-DB = 10  |            |                             |
| SYSID          | M a c h . data directory | Actual values | Mach. data   | Mach. data overview | SYSID      | Mach. data | Mach. data | B<br>E<br>U                 |
| read           |                          |               |              | write               |            | delete     |            |                             |

FBI 65 call depending on command

FB165

NAME : PER :PDAT

SSNR : KF + 0

DBNR : KYO, 167 (DBn = DB167)

DWNR : KF + 0 (DWn = DWO)

BA : KYx, Y

Q-DB :

QANF : } Parameters not required  
Z-DB : } are assigned zero!  
ZANF :

PAFE : F 14.0

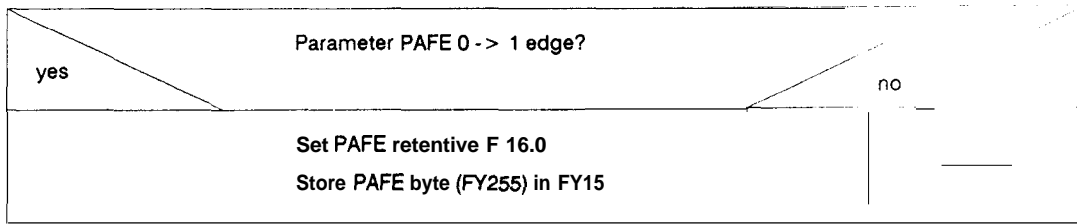
BEFEH : F 14.1

yes PAR:ANST = 0 ?

no

Set FY100 = 0

Segment 5:



Segment 6:



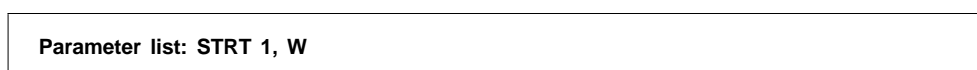
### 4.6.3 The Function Block FB52 (Schematic Diagrams)

The function block FB52 shows the use of the function block FBI 65 with indirect parameter assignment via data block DB166. The assignment of data words (DWn to DWn + 6) is fixed!

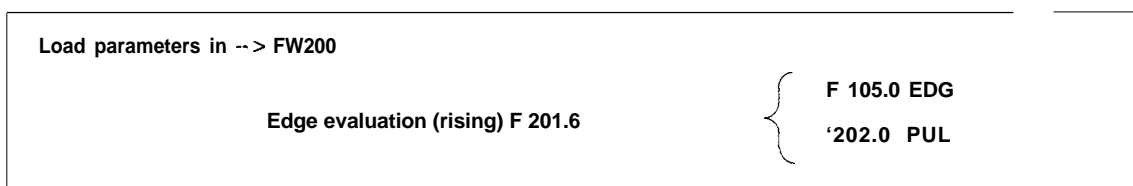
The pointer to the "job field" is entered in data block DB165. The data block number must be stored in data word DW1 and the data word number in data word DW2.

|       |     |         |                            |
|-------|-----|---------|----------------------------|
| DB165 | DW1 | KY0,166 | --> DB166 from DW1 to DW15 |
|       | DW2 | KF + 1  |                            |

Segment 1:



Segment 2:



Segment 3:

|                                                                                                                                                       |                                                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| <p><b>C DB166 User DB for FB165</b></p>                                                                                                               |                                                                                 |
| <p>Coordination word</p>                                                                                                                              | <p>&gt; &lt; Zero? (DWn = DW1)<br/>= F 202.1 (aux. flag for condition call)</p> |
| <p>\ no</p>                                                                                                                                           | <p>yes</p>                                                                      |
| <p>Pulse "enter job" present?</p>                                                                                                                     |                                                                                 |
| <p>yes</p>                                                                                                                                            | <p>no</p>                                                                       |
| <p>Assign job C DB165<br/>KY0,166 --&gt; DW1 (DBn-DB166)<br/>KF+1 --&gt; DW2 (DWn-DW1)</p>                                                            |                                                                                 |
| <p>Write or delete job, 20 &lt;= BA &lt;= 24?</p>                                                                                                     |                                                                                 |
| <p>yes</p>                                                                                                                                            | <p>no</p>                                                                       |
| <p>Assign calculated values:<br/>DW job =<br/>b + ((BA-a)x4)<br/>where a =20 and b = 16<br/>BA --&gt; FY200<br/>a --&gt; FY203<br/>b --&gt; FY204</p> | <p>Read job?<br/>64 &lt;= BA &lt;= 70 ?</p>                                     |
|                                                                                                                                                       | <p>yes</p>                                                                      |
|                                                                                                                                                       | <p>no</p>                                                                       |
| <p>BA --&gt; FY200<br/>a --&gt; FY203<br/>b --&gt; FY204</p>                                                                                          |                                                                                 |
| <p>Calculate the address of the job field<br/>of the source/destination parameters</p>                                                                |                                                                                 |
| <p>(DWn --&gt; FY205)<br/>(DWn +2 --&gt; FY206)</p>                                                                                                   |                                                                                 |
| <p>Formulate job: (DB166)</p>                                                                                                                         |                                                                                 |
| <p>BA --&gt; DW1 BA<br/>DDn --&gt; DD2 Q-DB, QANF<br/>DDn +2 --&gt; DD4 Z-DB, ZANF</p>                                                                |                                                                                 |
| <p>Assign job: C DB165</p>                                                                                                                            |                                                                                 |
| <p>KY0,166 --&gt; DW1 (DBn = DB166)<br/>KF+1 --&gt; DW2 (DWn = DW1)</p>                                                                               |                                                                                 |

Segment 4 :

|                                                                                                                                                                                                                                                                                                                    |    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Call DB165                                                                                                                                                                                                                                                                                                         |    |
| Auxiliary flag for conditional call = "O"? (A F 202.1)                                                                                                                                                                                                                                                             |    |
| yes                                                                                                                                                                                                                                                                                                                | no |
| Call function block <b>FB165</b><br>FB165<br>NAME : PER : PDAT<br>SSNR           KF +0<br>DBNR           KY0,0<br>DWNR           KF +0<br>BA               KY0,0<br>Q-DB           KY0,0<br>QANF           KF +0<br>Z-DB           KY0,0<br>ZANF           KF +0<br>PAFE           F 14.0<br>BFEH           F 14.1 |    |

Segment 5:

|                                     |    |
|-------------------------------------|----|
| Parameter PAFE O -> 1 edge? (FY165) |    |
| yes                                 | no |

Segment 6:

|    |
|----|
| BE |
|----|

# SIEMENS

## SIMATIC S5

IP246 Positioning Module

Incremental **6ES5246-4UA31 / -4UA41**

Absolute **6ES5246-4UB11 / -4UB21**

Planning, Installation and Service

---

Installation Guide

C79000-B8576-C656-02

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## 1 Notes on Planning

The following requirements must be met to allow problem-free use of the IP246:

- the drive has adequate power reserves
- there is no mechanical play in the control loop
- the machine data were compiled and optimized carefully
- the hardware installation is immune to HF interference. The installation guidelines were adhered to in every respect.

### 1.1 Selecting the Drive

- The drive must have sufficient power reserves, i.e. it must never be operated at the power limit. The closed-loop control can otherwise no longer function correctly, since the rotary speed of the motor can no longer follow the rotary speed setpoint.
- The drive should be operated at a speed close to its rated speed to allow the resolution of the output voltage to be used to the full.

### 1.2 Mechanical Aspects

- Within the position control loop there must be no play. Otherwise, the drive tends to oscillate and all the advantages of closed-loop position control are lost.
- The position encoder should always be coupled directly to the motor shaft.
- The hardware limit switches connected to the IP246 must be arranged so that the axis can brake from its maximum speed before the safety limit switches for the drive are reached.

### 1.3 The Position Encoder

- With the incremental version of the IP246, only encoders with two pulse trains displaced at 90° from each other and having a zero marker can be used.
- With the incremental version, it is advisable to use encoders with 5 V differential signals to improve immunity to interference.
- You must select the encoder resolution so that at low speeds there are still sufficient pulses per time interval for evaluation. The minimum resolution should be greater than the positioning accuracy by a factor of 10.
- At  $v_{\max}$  the limit frequencies of the encoder and the module must not be exceeded.

### 1.4 The Module

When using the IP246, the machine data can be varied over a wide range. The limits of the entries must, however, not be exceeded. It is, for example, not possible to fall below the minimum speed or exceed the maximum speed by including an override. By manipulating the machine data, the actual maximum traversing speed may exceed 65000 m/min. Manipulating the machine data in this way does, however, have consequences, e.g. for the selection of the position encoder. For this reason, you should plan the machine data before buying and installing the components.

## 1.5 Planning the Machine Data

The following data about the drive and the mechanical parts must be known when the machine data are compiled.

### Rated speed of the motor

This is the speed of the motor when there is a 10 V input signal at the power unit. It is not necessarily the same as the speed indicated on the rating plate. For safety reasons, the speed should be taken from the commissioning report of the drive.

Speed of the motor at 10 V input signal

•  $n_{10\text{ V}} =$   [rev/min]

### Maximum permitted deceleration of the drive

This value can be taken from the data sheets of the drive or from its commissioning report (see equation 1, 2)

Maximum permitted deceleration

•  $b_{\text{perm}} =$   [mm/sec<sup>2</sup>]

### Position encoder data

Pulses (steps) per revolution

•  $z =$   [pul/rev]

Number of revolutions (with multi-turn absolute position encoders)

•  $n =$   [pul]

### Axis data

if necessary, transmission ratio motor/axis

•  $\ddot{u} =$

Distance travelled per axis revolution

•  $x_d =$   [mm]

Axis backlash

•  $l =$   [mm]

**Hardware limit switches**

With linear axes, hardware limit switches should be fitted to the axis.

Type of limit switch

NC or NO

Coordinates (see eq. 7):

Hardware start limit switch

• X<sub>HS</sub> =  [mm]

Hardware end limit switch

• X<sub>HE</sub> =  [mm]

Machine data record

Module number

• 0-99

Axis

• 1,2

Measuring system

• mm/inches/degrees

Axis type

• linear/rotary

Maximum deceleration

• 10....9999 mm/sec<sup>2</sup> b<sub>max</sub> =  [mm/se.']

|                                                             |
|-------------------------------------------------------------|
| $b_{\max} = \frac{v_{\max}}{t_{\max}} \quad (\text{Eq. 1})$ |
|-------------------------------------------------------------|

where

v<sub>max</sub> = maximum speed (see eq. 8)

t<sub>max</sub> = maximum deceleration from v<sub>max</sub> to standstill

$$b_{\max} \geq b_{perm} \quad (\text{eq. 2})$$

Acceleration forward

• 10...9999 mm/sec<sup>2</sup>       $a_f =$   [mm/sec<sup>2</sup>]

Deceleration forward

• 10...9999 mm/sec<sup>2</sup>       $b_f =$   [mm/sec<sup>2</sup>]

Acceleration reverse

• 10...9999 mm/sec<sup>2</sup>       $a_r =$   [mm/sec<sup>2</sup>]

Deceleration reverse

• 10...9999 mm/sec<sup>2</sup>       $b_r =$   [mm/sec<sup>2</sup>]

$$a_f = \frac{v_f}{t_a} \quad b_f = \frac{v_f}{t_b} \quad (\text{eq. 3})$$

Whereby:

$$a_f, b_f, a_r, b_r < b_{\max} \quad (\text{eq. 4})$$

$v_f$  = traversing speed forwards

$t_a$  = acceleration time forwards

$t_b$  = deceleration forwards

(reverse direction analogous)

Pulse evaluation (only with incremental version, use the highest possible value)

• 1,2,4      1 =

Resolution factor (only with incremental version, is not evaluated in online operation with firmware > A2.1)

• 0.1...99.9      R =  [mm/1000 put]

$$A = \frac{\ddot{u} \cdot X_d \cdot 1\,000}{l \cdot z} \quad (\text{eq. 5})$$

Gain ( $k_v$ ) factor (practical starting value for empirical optimization  $k_v = 16.61/\text{s}$ )

• 0.1...99.91/s       $k_v =$        1/s

Backlash compensation

• 0.000...64.999       $l =$        [mm]

Standstill monitoring

• 0.000...64.999      " " =       [mm]

Maximum following error

• 0.000...99.999       $AS_{\max} =$        [mm]

$$AS_{\max} > \frac{V_{\max} [\text{mm/min}]}{TV [1/\text{s}] \cdot 60} \quad (\text{eq. 6})$$

At  $AS_{\max} = 99.999$  the monitoring is disabled.

Reference/home point coordinate

• +/-40000 mm       $X_{\text{Ref}} =$        [mm]

Software start limit switch

• +/-40000 mm      " S S =       [mm]

Software end limit switch

• +/-40000 mm      " S E =       [mm]

$$X_{\text{HS}} < X_{\text{SS}} < X_{\text{Ref}} < X_{\text{SE}} < X_{\text{HE}} \quad (\text{eq. 7})$$

Tool length offset

• +/-40000 mm       $To =$        [mm]

Zero offset 1

• +/-40000 m m       $Z_{O1} =$   [mm]

Zero offset 2

• +/-40000 m m       $Z_{O2} =$   [mm]

Zero offset 3

• +/-40000 m m       $Z_{O3} =$   [mm]

Zero offset 4

• +/-40000 m m       $Z_{O4} =$   [mm]

Maximum speed  $V_{max}$  (at 10V)

• 1...65000 mm/min       $V_{max} =$   [mm/min]

$V_{max} = u \times d \cdot n_{10V} \text{ (eq. 8)}$

All other speeds must be less than  $V_{max}$

JOG speed 1 forwards

• 1...65000 mm/min       $V_{f1} =$   [mm/min]

JOG speed 1 reverse

• 1...65000 mm/min       $V_{r1} =$   [mm/min]

JOG speed 2 forwards

• 1...65000 mm/min       $V_{f2} =$   [mm/min]

JOG speed 2 reverse

• 1...65000 mm/min       $V_{r2} =$   [mm/min]

(The speed specified for JOG speed 2 also applies to JOG open loop)

Incremental speed

• 1...65000 mm/min       $V_i =$   [mm/min]

**Reference speed 1 (only for incremental position encoder)**

- 1...65000 mm/min       $V_{ref1} =$   [mm/min]

**Reference speed 2 (only for incremental position encoder)**

- 1...65000 mm/min       $V_{ref2} =$   [mm/min]

|                                               |
|-----------------------------------------------|
| $V_{max} \geq V_{ref1} \geq V_{ref2}$ (eq. 9) |
|-----------------------------------------------|

**Reference direction**

- fwd/rev

**Position encoder data****Pulses per encoder revolution (only for incremental position encoder)**

- $Z_{inc} =$   [pul/rev]

**Steps per encoder revolution (only for absolute position encoder)**

- $Z_{abs} =$   [steps/rev]

**Number of revolutions for absolute position encoder**

- $n_{abs} =$   [rev]

**Distance per encoder revolution**

- $d =$   [mm]

**Destination information from PC coded in BCD**

- yes/no

**Polarity of the hardware limit switches**

- positive = NO  
negative = NC



## 1.6 Installation

### 1.6.1 Preliminary Remarks

- Plastic flooring and carpets and plastic or rubber soles can lead to static charges of up to several kV. Integrated circuits are sensitive to such high-voltage discharges. Never touch conductors and components without previously discharging your body to earth.
- Modules, power supply and encoder cables must only be removed or inserted when the controller is switched off. All external components, transmitters, drives, power electronics etc. must be installed and optimized according to the manufacturers' instructions. The complete emergency stop circuitry must function according to the appropriate regulations and the emergency stop limit switch must be installed, especially with linear axes.

### 1.6.2 Module Test

Visual test (see "Hardware, Instructions", Section 3.1 '(Position of the Jumpers and Switches'))

check the jumpers

ok

check the required page address

ok  - c  
h

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

**Position encoder supply**

● **Incremental position encoder**

| Jumper | Position encoder power supply |                |              |                |
|--------|-------------------------------|----------------|--------------|----------------|
|        | 5 V encoder                   |                | 24 V encoder |                |
|        | via IP                        | external       | via IP       | external       |
| x 17   | 1 2 3<br>                     | 1 2 3<br>0 0 0 | 1 2 3<br>    | 1 2 3<br>0 0 0 |
| X 18   | 1 2 3<br>                     | 1 2 3<br>      | 1 2 3<br>    | 1 2 3<br>      |
| x 20   | 1 2 3<br>                     | 1 2 3<br>      | 1 2 3<br>    | 1 2 3<br>      |

ok

ok

ok

● **Absolute position encoder**

| Jumper | Current sourcing encoder | Current sinking encoder |
|--------|--------------------------|-------------------------|
| X 17   | 1 2 3<br>                | 1 2 3<br>               |

ok

**BASP evaluation**

Digital outputs disabled by BASP signal X 21 jumper 3-2 inserted

ok

Digital outputs not disabled by BASP signal X 21 jumper 1-2 inserted

ok

**Electrical test**

Insert the IP246 in a CP slot with the PC switched off.

Switch on the PC.

The LEDs flash alternately; following this, the green LED is lit continuously and the red LED is off.

The start-up has been completed correctly.

ok

### 1.6.3 Wiring Check

Check the cable routing

ok

- Check that control cables and power cables are separated and are not kinked.

ok

- Check that the cables from and to the controller are shielded over their whole length, and are grounded on the controller side.

ok

The laying and routing of ground lines is particularly important, since inadequate cable cross sections in ground loops or when the ground is not connected can interfere with the operation. The localization and elimination of such interference can take considerable time.

Make sure that the earth lines have an adequate cross section and are correctly routed and connected.

With 5 V position encoders, check that the inverse signal lines are twisted pairs,

ok

ok

Check that the  $n_{set}$  and BS analog signal lines are twisted.

ok

Check the following cables for short circuits, line breaks and correct pin assignment according to the hardware description.

• Position encoder lines channel 1

ok

• Position encoder lines channel 2

ok

• Setpoint line

ok

• Digital signal line

ok

• **FUM signal wired?**

ok

• **24 V supply**

ok

Connect the cables when the power is switched off and screw them tight.

ok

## 1.7 Assigning Parameters to the IP246

Before you check the interaction between the IP246 and your drive, bring the drive into the permitted traversing range, i.e. between the hardware limit switches "start" and "end". Make sure that you can reach the emergency stop switch at all times!

Switch the PC on.

At this point in time you do not need a CPU program. If you have selected the setting "digital outputs blocked by BASP" on the IP246, the CPU must be in the "run" mode. The CPU should not address the IP246 during the first phase of the start-up.

Switch the 24 V power supply on (the power unit remains switched off).

Establish the connection to the PG.

Start COM246 (online operation).

With all other actions you take, please note the error message line on the programmer. If a problem occurs, you will obtain information about the type of problem.

Transfer the machine data and machining programs to the IP246.

If an error message occurs, you must check and, if necessary, correct the machine data according to the message received.

### Testing the axes

Select the test mode for axis 1.

Start the "following error" mode (BA 4).

Checkback signals:

Axis status: running

ok

Closed loop controller: off

ok

If an error message occurs you must eliminate the problem and start mode 4 again.

Switch on the power unit for axis 1.

The axis must remain still and its drift must be hardly perceptible. If this is not the case, repeat the fine adjustment for O V.

Stop BA 4.

Checkback signals:

Axis status: finished

ok

Closed loop controller: on

ok

### Check the direction of rotation of the position encoder

Note: if the position encoder rotates in the wrong direction the position control loop (closed loop controller on) has a positive feedback. This means that instead of stopping, the drive is brought to maximum speed. During this test you must make sure that the drive can be switched off immediately at any time. If the drive begins to oscillate when it is standing still, you must reduce the gain factor!

#### Note:

A **traversing** movement forwards always means a movement in the direction of the software end limit switch, which must have a higher coordinate value than the software start limit switch. The IP246 outputs a positive output voltage (rotary speed setpoint). If an incremental position encoder is used, the encoder must be connected to the module so that the resulting direction of rotation causes the counter chip on the IP246 to count upwards. The counter on the incremental version of the IP246 counts upwards when signal A is recognized before signal B. An absolute encoder must supply increasing values when the traversing direction is forwards and decreasing values when the direction is in reverse.

The same rules regarding the direction of rotation of the encoder and the motor for a linear axis also apply to a rotary axis. A traversing movement in a clockwise direction (forwards) always means a positive output voltage (speed setpoint) and a traversing movement in an anti-clockwise (reverse) means a negative output voltage. If the axis travels in a clockwise direction, the counter chip of the incremental version of the IP246 must count upwards, and an absolute position encoder with the absolute version must record increasing values. A movement forwards is in the direction of the end of the range, which is the same point as the start of the range but must always be more positive than the start of the range.

Select mode 3 ("JOG open loop").

Select a low speed with "override" (approx. 1-5%)

Enter the command "forward" and monitor the actual value,  
The actual value must increase.

#### If the actual position value reduces, switch off the power unit immediately!

In this case, you must swap the position encoder signals A and /A (with 5 V encoders) or A and B (with 24 V encoders) and repeat the direction of rotation. When traveling forwards, the actual position value must increase and must decrease when the direction is reversed.

### Check the hardware limit switches

Travel forwards in mode 3,

Trip the hardware end limit switch manually and keep it activated.

The traversing movement must be stopped with the error message "end limit switch tripped". Repeating the command "mode 3 forwards" must not lead to any movement.

ok 

Travel in the reverse direction in mode 3.

Release the hardware end limit switch during the movement.

Trip the start limit switch.

The traversing movement must be stopped with the error message “start limit switch tripped”. Repeating the command “BA 3 reverse” must not lead to a movement,

ok

Start BA 3 “forward” and release the hardware start limit switch during the movement. Traversing movements in both directions are now possible again (= > “Fundamentals of Positioning, Reference Manual”, Section 7.3 “The Digital Inputs for Hardware Limit Switches”).

### Check the following error

Traverse a longer distance in JOG 1 or JOG 2, observe the following error and stop again. You should observe a following error which becomes almost constant after some time and which returns to zero after braking. With the drive standing still, the following error can fluctuate up to approximately +/-3 increments depending on the adjustment of the drive. If it fluctuates more than this, you must either increase the gain factor ( $k_v$ ) or readjust the drive. During the traversing movement, the following error should have a value similar to that shown in the equation below:

$$x_d [\text{mm}] = \frac{v[\text{mm/min}]}{60 \cdot k_v [1/\text{s}]}$$

### Determining the reference point with the incremental version

Select “reference point **approach**”.

Enter the “start” command.

The drive must execute a traversing routine. After that the checkback signal “reference point set” must appear.

ok

### Possible errors:

1. The drive does not move, although the message “reference point set” is displayed: you have accidentally executed “**set**” reference point.
2. The drive moves, but does not reduce speed at the **precontact** and does not find the reference point:  
either the **precontact** is defect or a “NC” contact was connected.
3. The drive reduces speed at the **precontact**, but then continues to the limit switch. The **check-back** signal “reference point deleted” appears:  
the zero marker signal of the encoder is not being received by the **IP246**. Check the **precontact** and zero signals.

If the reference point exists, the software limit switches are also effective.

JOG in mode 1 or 2 in both directions and check whether the software limit switches respond before the hardware limit switches are reached. If necessary, you must displace the coordinates of the software limit switches so that the drive comes to a standstill before the hardware limit switches are reached.

#### Determining the home point with the absolute version

Select "set home point".

Enter the "start" command.

The drive does not move. The checkback signal "home point set" appears.

#### Possible error:

The parameters assigned to the absolute position encoder are not suitable for the connected encoder.

#### Incremental approach

Once the coordinate system is established, you can approach absolute target positions.

Enter various target positions in modes BA6 and BA7 and check the final position.

#### Executing automatic programs

Write a short machining program and transfer it to the module.

Test the program in modes BA8 and BA9.

#### Teach-in

Select BA10 ("teach-in on").

Enter a program number.

Start BA10.

Checkback signal: teach-in mode on

ok 

Travel to various positions and store them with enter.

Start BA11 ("teach-in off").

Execute the program generated in teach-in. If required, extend the program in DIN or text representation with the following:

dwel times,

loops,

programmed halt,

speed changes etc.

**Try out the other operating modes**

- . Zero offset absolute (BA12) ok
- Zero offset relative (BA13) ok
- Clear zero offset (BA14) ok
- Tool offset (BA15) ok
- Tool offset off (BA16) ok
- . Clear error (BA 17) ok

Create an error e.g. "external STOP occurred".  
The error message appears on the PG ok

Start BA17.  
The error message is cleared ok

- Drift compensation (BA18) ok
- Drift compensation off (BA19) ok

Save the optimized machine data and machining programs on diskette.

If required, go through the same routine for axis 2.

## 1.8 Control of the IP246 by the Programmable Controller

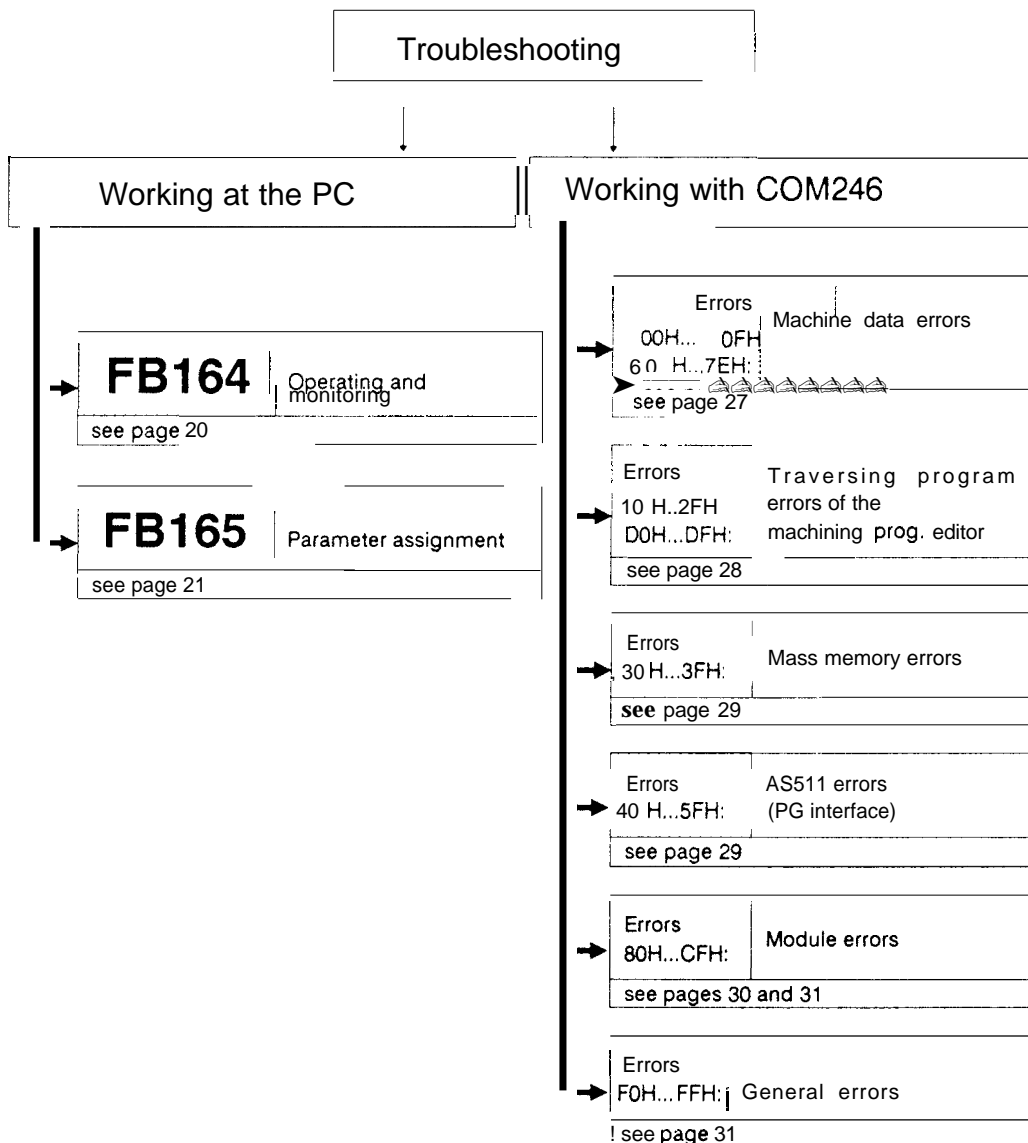
Once you have tested the interplay between the IP246 and your drive, you must test the positioning application in the STEP5 program.

If you have not yet written your own program, you can first work with the example programs supplied. Remember that this program was written for the page address "O" and refers to axis 1. Initially it is therefore advisable to set the module appropriately, otherwise errors can easily occur when matching the program to other page numbers or axis 2. All the information required can be found in the description of the example (= > "Standard Function Blocks **FB164** and **FB165**, User's Guide", Section 4 "Examples"). If you wish to base your new program on the example, it is advisable to print out the whole example program.



## 2 Troubleshooting

The following diagrams provide you with a routine which you can use for troubleshooting. The machine data errors and messages are explained in detail in Sections 2.1, 2.2 and 2.3.

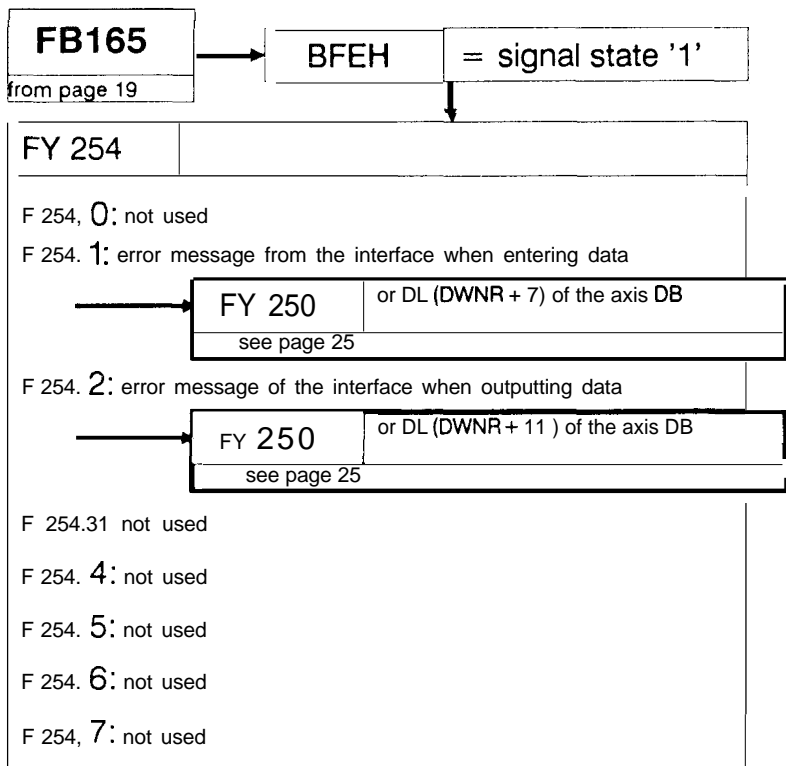
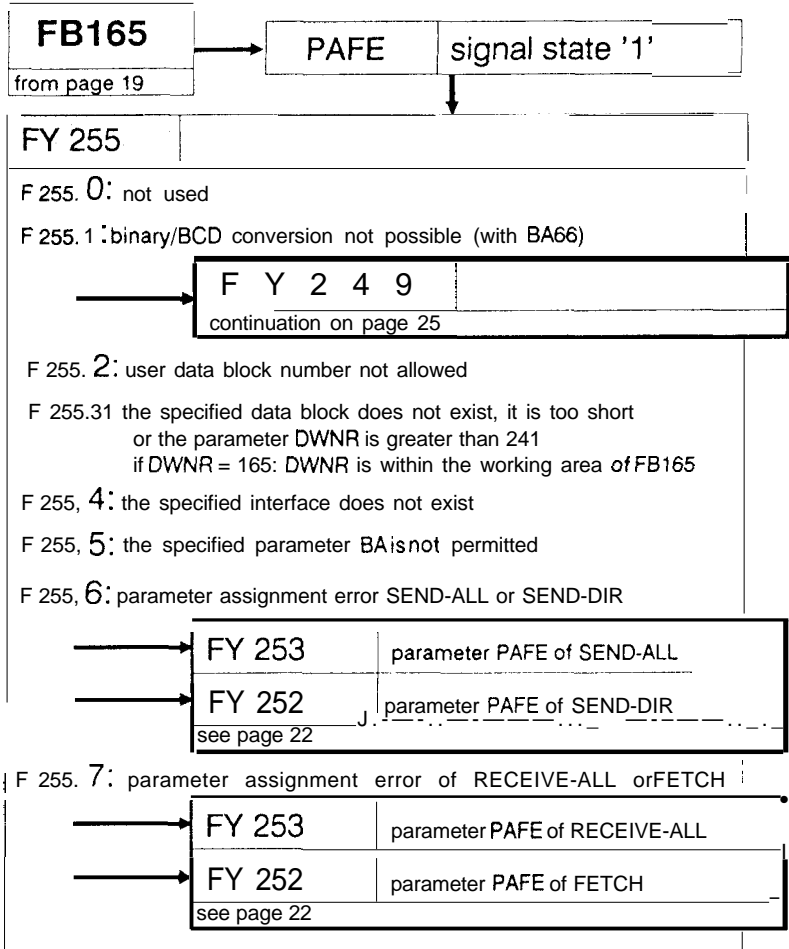


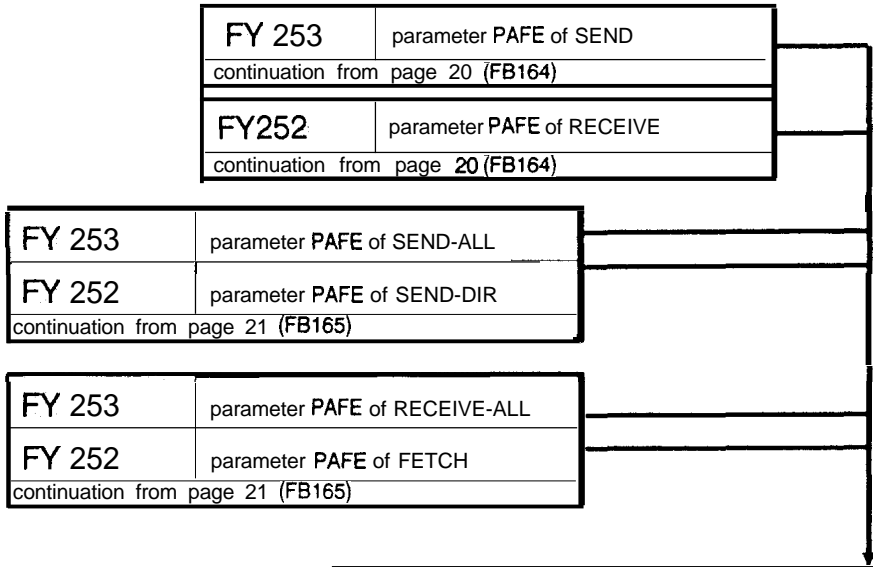


|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                    |               |                           |             |             |  |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|---------------------------|-------------|-------------|--|--|
| <b>FY 255</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                    |               |                           |             |             |  |  |
| <p>F 255. <b>0</b>: simultaneous signal change at the command inputs. Only the highest priority command is transferred, the others are lost.</p> <p>Commands in decreasing priority:<br/>STOP --&gt; STAR --&gt; VORW --&gt; RUCK --&gt; UEBN</p> <p>F 255.1: <b>binary/BCD</b> conversion not possible (in BA71 ..., BA73)</p> <p>F 255. <b>2</b>: user data block number not permitted,</p> <p>F 255. <b>3</b>: the specified data block does not exist, is too short or the parameter <b>DWNR</b> is greater than 236.<br/>If DWNR = 164; DWNR is within the working area of FB164.</p> <p>F 255. <b>4</b>: the specified interface does not exist,</p> <p>F 255. <b>5</b>: the specified parameter BA is not permitted or the command is not allowed for the mode to be executed.</p> <p>F 255. <b>6</b>: parameter assignment error SEND (FB120,FB180,FB244)</p> |                                                                                                                                                                                                                                                                    |               |                           |             |             |  |  |
| →                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <table border="1"> <tr> <td style="text-align: center;"><b>FY 253</b></td> <td style="text-align: center;">Parameter PAFE of SEND</td> <td style="text-align: center;">1</td> </tr> <tr> <td colspan="3" style="font-size: small;">see page 22</td> </tr> </table> | <b>FY 253</b> | Parameter PAFE of SEND    | 1           | see page 22 |  |  |
| <b>FY 253</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Parameter PAFE of SEND                                                                                                                                                                                                                                             | 1             |                           |             |             |  |  |
| see page 22                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                    |               |                           |             |             |  |  |
| <p>F 255. <b>7</b>: parameter assignment error RECEIVE (FB121,FB181, FB245)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                    |               |                           |             |             |  |  |
| →                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <table border="1"> <tr> <td style="text-align: center;"><b>FY 252</b></td> <td style="text-align: center;">Parameter PAFE of RECEIVE</td> </tr> <tr> <td colspan="2" style="font-size: small;">see page 22</td> </tr> </table>                                     | <b>FY 252</b> | Parameter PAFE of RECEIVE | see page 22 |             |  |  |
| <b>FY 252</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Parameter PAFE of RECEIVE                                                                                                                                                                                                                                          |               |                           |             |             |  |  |
| see page 22                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                    |               |                           |             |             |  |  |



|                                                                                                                                                             |                                                                                                                                                                                                                                               |               |                                  |                     |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------------------------------|---------------------|--|
| <b>FY 254</b>                                                                                                                                               |                                                                                                                                                                                                                                               |               |                                  |                     |  |
| <p>F 254. <b>0</b>: error message of the interface with operation</p>                                                                                       |                                                                                                                                                                                                                                               |               |                                  |                     |  |
| →                                                                                                                                                           | <table border="1"> <tr> <td style="text-align: center;"><b>FY 251</b></td> <td style="text-align: center;">or DR (DWNR + 16) of the axis DB</td> </tr> <tr> <td colspan="2" style="font-size: small;">see pages 24 and 25</td> </tr> </table> | <b>FY 251</b> | or DR (DWNR + 16) of the axis DB | see pages 24 and 25 |  |
| <b>FY 251</b>                                                                                                                                               | or DR (DWNR + 16) of the axis DB                                                                                                                                                                                                              |               |                                  |                     |  |
| see pages 24 and 25                                                                                                                                         |                                                                                                                                                                                                                                               |               |                                  |                     |  |
| <p>F 254. 1: module error caused by modes 1...19</p>                                                                                                        |                                                                                                                                                                                                                                               |               |                                  |                     |  |
| →                                                                                                                                                           | <table border="1"> <tr> <td style="text-align: center;"><b>FY 250</b></td> <td style="text-align: center;">1</td> </tr> <tr> <td colspan="2" style="font-size: small;">see page 25</td> </tr> </table>                                        | <b>FY 250</b> | 1                                | see page 25         |  |
| <b>FY 250</b>                                                                                                                                               | 1                                                                                                                                                                                                                                             |               |                                  |                     |  |
| see page 25                                                                                                                                                 |                                                                                                                                                                                                                                               |               |                                  |                     |  |
| <p>F 254. 2: not used</p> <p>F 254. 3: not used</p> <p>F 254. 4: not used</p> <p>F 254. 5: not used</p> <p>F 254. 6: not used</p> <p>F 254. 7: not used</p> |                                                                                                                                                                                                                                               |               |                                  |                     |  |





| PAFE byte of the HDBs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |   |   |   |   |   |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|-----|
| bit:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 7 | 6 | 5 | 4 | 3 | 2 | 1 0 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |   |   |   |   |   |     |
| <p><b>0:</b> no error</p> <p><b>1 :</b> QTYP/ZTYP wrong</p> <p><b>2:</b> memory area does not exist</p> <p><b>3:</b> memory areatoo small</p> <p><b>4:</b> timeout QVZ (area does not exist)</p> <p><b>5:</b> wrong condition codeword</p> <p><b>6:</b> no source or destination parameter present</p> <p><b>7:</b> interface does not exist</p> <p><b>8:</b> interface not ready</p> <p><b>9:</b> interface overloaded</p> <p><b>A:</b> inter-face <b>occupied</b> bya different CPU<br/>(multiprocessor operation)</p> <p><b>B:</b> illegaljob number</p> <p><b>C:</b> error in handshaking</p> <p><b>D:</b> other interface errors<br/>(e.g. block size illegal)</p> <p><b>E:</b> other errors<br/>(e.g. no DB open when using indirect parameter assignment)</p> <p><b>F:</b> HDB call illegal (double call by interrupts)</p> |   |   |   |   |   |   |     |

FY 251 or DR (DWNR + 16) of the axis DB  
 continuation from page 20 (FB164)

FY 251 module error triggered by BA1...BA19

- 0: no error
- 1: PG job list full \*)
- 2: illegal job \*)
- 3: statement stored
- 4: axis in operation = = > input not possible
- 5: PC job list is full \*)
- 6: axis waiting for external start \*)
- 7: speed range exceeded \*)
- 8: status after power down on module
- 9:
- 10: reference/home point missing
- 11: max. following error exceeded \*)
- 12: correct MD module number cannot be changed \*)
- 13: data block missing
- 14: wrong or no machine data
- 15: error in machine data

Mach. data record machine data error

see page 26

- 16
- 17 overwrite machine data?
- 18: program no, limit reached
- 19: data block missing
- 20: overwrite machining program?
- 21: automatic prohibited
- 22: multi-machining program processing prohibited \*)
- 23: traversing range exceeded
- 24: not enough space for machining program
- 25: start limit switch tripped
- 26: end limit switch tripped
- 27: external STOP occurred
- 28: software start switch tripped
- 29: software end switch tripped
- 30: operating mode prohibited in teach-in \*)
- 31: wrong operating mode processed
- 32: standstill monitor responding
- 33: watchdog
- 34: watchdog
- 35: error at start of statement
- 36: subroutine DB no. too high
- 37: **G** function prohibited
- 38: continuous loop only as outer loop
- 39: nesting depth exceeded
- 40: wrong X function
- 41: wrong F function
- 42: traversing distance too long

continued on page 24

possible causes of module errors marked  
 with \*)  
 are listed from page 35 onwards,

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                      |                            |               |             |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|----------------------------|---------------|-------------|--|
| continued from page 23                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                      |                            |               |             |  |
| <b>FY 251</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | module errors tripped by BA1 ...BA19 |                            |               |             |  |
| <p>43: traversing speed too high<br/> 44: error at end of statement<br/> 45: program end before loop end<br/> 46: statement not allowed after flying change<br/> 47:<br/> 48: machining program error</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                      |                            |               |             |  |
| <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 70%; padding: 2px;"><b>Machining programDB</b></td> <td style="width: 30%; padding: 2px;">syntax errors</td> </tr> <tr> <td colspan="2" style="padding: 2px;">see page 27</td> </tr> </table>                                                                                                                                                                                                                                                                                                                                                                                            |                                      | <b>Machining programDB</b> | syntax errors | see page 27 |  |
| <b>Machining programDB</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | syntax errors                        |                            |               |             |  |
| see page 27                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                      |                            |               |             |  |
| <p>49: machining program already exists! change prog. no?<br/> 50: DB no. already exists on other axis<br/> 51: machining program is active<br/> 52: machining program only cleared from directory<br/> 53: target position not reached ● )<br/> 54: position loop interrupted ● )<br/> 55:<br/> 56: illegal dist. spec.<br/> 57: illegal tool offset<br/> 58: illegal G function with degrees<br/> 59: distance not in BCD<br/> 60: illegal absolute encoder reading ● )<br/> 61: wrong home point in machine data record ● )<br/> 62: actual value not clear *)<br/> 63: illegal change of absolute encoder value *)<br/> 64:<br/> 65: machining program waiting to continue</p> |                                      |                            |               |             |  |
| <p>possible causes of module errors marked<br/> with ● )<br/> are listed from page 35 onwards</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                      |                            |               |             |  |

|                                                   |                                   |
|---------------------------------------------------|-----------------------------------|
| <b>FY 250</b>                                     | error messages from the interface |
| continuation of page 20 (FB164) & page 21 (FB165) |                                   |



|               |                                                      |
|---------------|------------------------------------------------------|
| <b>FY 250</b> | error message from the interface                     |
| bit:          | 7 6 5 4 3 2 1 0                                      |
|               |                                                      |
| <b>0:</b>     | no error                                             |
| <b>1:</b>     | error entered in PAFE byte of the HDBs (FY252/FY253) |
| <b>2:</b>     | error in module error byte (FY251)                   |
| <b>3:</b>     | free                                                 |
| <b>4:</b>     | free                                                 |
| <b>5:</b>     | offset too great                                     |
| <b>6:</b>     | execution not possible at present                    |
| <b>7:</b>     | DB already exists                                    |
| <b>8:</b>     | DB missing                                           |
| <b>9:</b>     | wrong ORG identifier                                 |
| <b>A:</b>     | destination DB too small                             |
| <b>B:</b>     | source DB too small                                  |
| <b>C:</b>     | source DB too large                                  |
| <b>D:</b>     | area in PC too small                                 |
| <b>E:</b>     | area blocked for output/input                        |
| <b>F:</b>     | wrong checkback signal                               |

|                                   |                                    |
|-----------------------------------|------------------------------------|
| <b>FY 249</b>                     | binary/BCD conversion not possible |
| continuation from page 21 (FB165) |                                    |



|                   |                                                                      |
|-------------------|----------------------------------------------------------------------|
| <b>F Y 2 4 9</b>  | binary/BCD conversion not possible                                   |
| <b>F 249. 0:</b>  | binary/BCD conversion of actual value (actual position) not possible |
| <b>F 249. 1 :</b> | binary/BCD conversion of dist. to go not possible                    |
| <b>F 249. 2:</b>  | binary/BCD conversion of following error (or speed) not possible     |
| <b>F 249. 3:</b>  | FB164 missing (only S5 15U)                                          |
| <b>F 249. 4:</b>  | not used                                                             |
| <b>F 249. 5:</b>  | not used                                                             |
| <b>F 249, 6:</b>  | not used                                                             |
| <b>F 249, 7:</b>  | not used                                                             |

|                           |                     |
|---------------------------|---------------------|
| Mach. data record         | machine data errors |
| continuation from page 23 |                     |



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| Mach. data record                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | in machine data DB DRn + 4 |
| <p>0: no error in machine data</p> <p>1: machine data not yet checked</p> <p>2: wrong resolution ● )</p> <p>3: wrong maximum speed *)</p> <p>4: wrong JOG/INC speed *)</p> <p>5: wrong reference speed *)</p> <p>6: wrong acceleration *)</p> <p>7: wrong software limit switch *)</p> <p>8: wrong reference point *)</p> <p>9: Vmax is too low *)</p> <p>10: gain (kv) factor too low *)</p> <p>11: gain (kv) factor too high ● )</p> <p>12: wrong axis/module number *)</p> <p>13: zero offset too large ● )</p> <p>14: wrong tool offset *)</p> <p>15: wrong standstill monitoring *)</p> <p>16: wrong pulse evaluation ● )</p> <p>17: wrong polarity hardware limit switch *)</p> <p>18: maximum speed too high for this resolution *)</p> <p>19: traversing range too high for position encoder *)</p> <p>20: distance covered by encoder does not match traversing range ● )</p> <p>21: wrong encoder data ● )</p> <p>22: wrong end of range ● )</p> <p>23: wrong home point ● )</p> <p>24: wrong dimensional unit *)</p> <p>25: wrong backlash compensation value ● )</p> <p>26: wrong following error ● )</p> |                            |

|                      |              |
|----------------------|--------------|
| Machining prog. DB   | syntax error |
| continuation from 24 |              |



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| Machining prog. DB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | in machining prog. DW n + 3 |
| <p>0: no error</p> <p>1: text too long or &lt;LF&gt; missing</p> <p>2: statement type wrong or N function missing</p> <p>3: statement number too high</p> <p>4: subroutine number too high</p> <p>5: function not allowed after G function</p> <p>6: function not allowed after X function</p> <p>7: free</p> <p>8: &lt;LF&gt; missing after final statement</p> <p>9: statement end: &lt;LF&gt; missing or wrong function</p> <p>10: traversing distance too great</p> <p>11: value of F function too high</p> <p>12: too many decimal places</p> <p>13: end of loop missing</p> <p>14: start of loop missing</p> <p>15: end of program missing</p> <p>16: function not known</p> <p>17: value of M function too high</p> <p>18: new statement after final statement</p> <p>19: the statement is too long</p> <p>37: G function not implemented</p> |                             |

possible causes of machine data errors marked with \*) are listed on pages 32, 33 and 34



|                                    |                        |
|------------------------------------|------------------------|
| Errors<br>00H...0FH<br>60H...7EH:  | machine data<br>errors |
| continuation from page 19 (COM246) |                        |

| Error message line | machine data errors                                               |
|--------------------|-------------------------------------------------------------------|
| 0:                 |                                                                   |
| 1:                 |                                                                   |
| 2:                 | wrong resolution *)                                               |
| 3:                 | wrong maximum speed *)                                            |
| 4:                 | wrong JOG/INC speed *)                                            |
| 5:                 | wrong reference speed *)                                          |
| 6:                 | wrong acceleration *)                                             |
| 7:                 | wrong software limit switch *)                                    |
| 8:                 | wrong reference point *)                                          |
| 9:                 | Vmax is too low *)                                                |
| A:                 | gain (kv) factor too low *)                                       |
| B:                 | gain (kv) factor too high *)                                      |
| C:                 | wrong axis/module number *)                                       |
| D:                 | zero offset too large *)                                          |
| E:                 | wrong tool offset *)                                              |
| F:                 | wrong standstill monitoring *)                                    |
| 60:                | wrong pulse evaluation *)                                         |
| 61:                | wrong polarity hardware limit switch *)                           |
| 62:                | maximum speed too high for this resolution *)                     |
| 63:                | traversing range too high for position encoder *)                 |
| 64:                | distance covered by encoder does not match<br>traversing range *) |
| 65:                | wrong encoder data ● )                                            |
| 66:                | wrong end of range *)                                             |
| 67:                | wrong home point *)                                               |
| 68:                | wrong dimensional unit *)                                         |
| 69:                | wrong backlash compensation value ● )                             |
| 6A:                | wrong following error *)                                          |

possible causes of machine data errors marked  
with \*)  
are listed on pages 32, 33 and 34

|                                    |                                                             |
|------------------------------------|-------------------------------------------------------------|
| Errors<br>10H...2FH<br>DOH...DFH   | machining program<br>errors of the<br>reach. program editor |
| continuation from page 19 (COM246) |                                                             |

| Error message line                                    | machining program errors of the<br>machining program editor |
|-------------------------------------------------------|-------------------------------------------------------------|
| 10: illegal input                                     |                                                             |
| 11: memory overflow                                   |                                                             |
| 12: separate functions with blanks                    |                                                             |
| 13: program exists already                            |                                                             |
| 14: statement syntax incorrect                        |                                                             |
| 15: field cannot be exited                            |                                                             |
| 16: terminate processing?                             |                                                             |
| 17: final function already present                    |                                                             |
| 18: input after L function prohibited                 |                                                             |
| 19: X function not present                            |                                                             |
| 1A: input after last entry prohibited                 |                                                             |
| 1B: value outside permitted range                     |                                                             |
| 1C: X function incorrect -> correction                |                                                             |
| 1 D: insert prohibited                                |                                                             |
| 1 E: not stored -> machining program incomplete       |                                                             |
| 1 F: output impossible ->DB no. not identical         |                                                             |
| 20: statement type not permitted                      |                                                             |
| 21: function key blocked -> statement incomplete      |                                                             |
| 22: G function -> prohibited input                    |                                                             |
| 23: no other fcts. with L function. Delete?           |                                                             |
| 24: error in F function                               |                                                             |
| 25: statement type missing                            |                                                             |
| 26: statement number missing                          |                                                             |
| 27: statement complete -> function key                |                                                             |
| 28: current G function needs entry                    |                                                             |
| 29: X function must be followed by F function         |                                                             |
| 2A: X function missing -> entry prohibited            |                                                             |
| 26: final statement present -> function key inhibited |                                                             |
| 2C: error in L function                               |                                                             |
| 2D: error in M function                               |                                                             |
| 2E: statement number wrong                            |                                                             |
| 2F: error in G function                               |                                                             |
| DO: only continuous loop allowed                      |                                                             |
| D1: loop end missing                                  |                                                             |

|                                    |                    |
|------------------------------------|--------------------|
| Errors<br>30H...3FH:               | Mass memory errors |
| continuation from page 19 (COM246) |                    |

| Error message line | mass memory errors                   |
|--------------------|--------------------------------------|
| 30:                |                                      |
| 31:                | drive not defined                    |
| 32:                | extern. memory defect                |
| 33:                | element list missing                 |
| 34:                | data block missing                   |
| 35:                | DB or file exists already            |
| 36:                | file type not defined                |
| 37:                | identification headers not identical |
| 38:                | external memory read-only            |
| 39:                | file read-only                       |
| 3A:                | not enough buffer length             |
| 3B:                | number of allowed elements too large |
| 3C:                | file missing                         |
| 3D:                | directory full                       |
| 3E:                | diskette full                        |
| 3F:                | file not interpretable               |

|                                    |                                |
|------------------------------------|--------------------------------|
| Errors<br>40H...5FH:               | AS511 errors<br>(PG interface) |
| continuation from page 19 (COM246) |                                |

| Error message line | AS511 errors                |
|--------------------|-----------------------------|
| 40:                | syntax error /name wrong    |
| 41:                | not allowed                 |
| 42:                | data block missing          |
| 43:                | overwrite data block?       |
| 44:                | data block missing          |
| 45:                | delete data block?          |
| 4a:                | illegal value               |
| 4C:                | cable not connected         |
| 50:                | data block missing          |
| 51:                | cable not corm. at PG       |
| 52:                | not enough memory on module |
| 53:                | watchdog error module       |
| 54:                | transfer error              |
| 55:                | error in data transfer      |
| 56:                | error in data transfer      |
| 57:                | BREAK received              |
| 5a:                | mod, not answering          |
| 5A:                | wrong baud rate             |
| 5D:                | parity error                |
| 5E:                | overflow error              |
| 5F:                | frame error                 |

|                                     |               |
|-------------------------------------|---------------|
| Errors<br>80H...CFH:                | Module errors |
| continuation from page 19 (COM 246) |               |

↓

| Error message line                                            | module errors |
|---------------------------------------------------------------|---------------|
| 80:                                                           |               |
| 81: PG job list is full *)                                    |               |
| 82: illegal job *)                                            |               |
| 83: statement stored                                          |               |
| 84: axis in operation = = > input not possible                |               |
| 85: PC job list is full                                       |               |
| 86: axis waiting for external start *)                        |               |
| 87: speed range exceeded                                      |               |
| 66: status after power down on module                         |               |
| 89:                                                           |               |
| 8A: reference/home point missing                              |               |
| 8B: max. following error exceeded *)                          |               |
| 8C: correct MD module number cannot be changed *)             |               |
| 8D: data block missing                                        |               |
| 8E: wrong or no machine data                                  |               |
| 8F: error in machine data                                     |               |
| 90: PG is offline                                             |               |
| 91: overwrite machine data?                                   |               |
| 92: program no. limit reached                                 |               |
| 93: data block missing                                        |               |
| 94: overwrite machining program?                              |               |
| 95: automatic prohibited                                      |               |
| 96: multi-machining program processing prohibited *)          |               |
| 97: traversing range exceeded                                 |               |
| 98: not enough space for machining program                    |               |
| 99 start limit switch tripped                                 |               |
| 9A: end limit switch tripped                                  |               |
| 9B: external STOP occurred                                    |               |
| 9C: software start limit switch tripped                       |               |
| 9D: software end limit switch tripped                         |               |
| 9E: operating mode prohibited in teach-in *)                  |               |
| 9F: wrong operating mode processed                            |               |
| AO: standstill monitor responding                             |               |
| A1: watchdog                                                  |               |
| A2: watchdog                                                  |               |
| A3: error at start of statement                               |               |
| A4: subroutine DB no. too large                               |               |
| A5: G function prohibited                                     |               |
| A6: continuous loop only as outer loop                        |               |
| A7: nesting depth <b>exceeded</b>                             |               |
| A8: wrong <b>X</b> function                                   |               |
| A9: wrong F function                                          |               |
| AA: traversing distance too long                              |               |
| AB: traversing speed too high                                 |               |
| AC: error at statement end                                    |               |
| AD: program end before loop end                               |               |
| AE: statement not allowed after flying change                 |               |
| AF:                                                           |               |
| BO: machining program error                                   |               |
| BI: machining program already exists! Change <b>prog. no?</b> |               |
| continued on page 31                                          |               |

possible causes of module errors marked  
with \*)  
are listed from page 35 onwards.

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**Error message line** continued from page 30
 

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B2: DB no. already exists on other axis  
 B3: machining program is active  
 B4: machining program only cleared from directory  
 B5: target position not reached \*)  
 B6: position loop interrupted \*)  
 B7: PC failure  
 B8: illegal dist. spec.  
 B9: illegal tool offset  
 BA: illegal G function with degrees  
 BB: distance not in BCD  
 BC: illegal absolute encoder reading \*)  
 BD: wrong home point in machine data record \*)  
 BE: actual value not clear \*)  
 BF: illegal change of absolute encoder value \*)  
 CO:   
 CI: machining program waiting to continue

possible causes of module errors marked  
 with \*)  
 are listed from page 35 onwards.

|                                    |                |
|------------------------------------|----------------|
| Errors                             |                |
| F0H...FFH:                         | general errors |
| continuation from page 19 (COM246) |                |

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**Error message line** general errors
 

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F0:  
 F1: error mess. does not match this COM  
 F2: printer not assigned paras  
 F3: delete everything?  
 F4: only machining programs  
 F5: tilde stands for power 2  
 F6: illegal mode  
 F7: wrong time entered  
 F8: no plant designation entered  
 F9: no file name entered  
 FA: DB transferred  
 FB: last page reached  
 FC: key prohibited  
 FD: HELP key not allowed  
 FE: exit COM246?  
 FF: input prohibited

---

## 2.1 Machine Data Errors and their Causes

When machine data are transferred to the module, they are checked on the module. If a machine data error is recognized, the error "error in machine data" is set and the machine data record is marked as containing errors by entering the number of the machine data error in the data record. The COM246 software package evaluates this error number and displays the error in plain text in the error message line on the PG. When transferring data with FB165 (= > "Standard Function Blocks FB164 and FB165, User's Guide") the number must be read out of the data record when an error was recognized in the machine data record.

- Error 2 (COM246: F02H; PC: 2) **"wrong resolution"**  
The resolution resulting by dividing the "distance per encoder revolution" by "pulses/steps per encoder revolution" must be within the limits 0.1...99.9  $\mu\text{m}/\text{pul}$  (incremental version) or 0.1...100  $\mu\text{m}/\text{step}$  (absolute version). The parameter "distance per encoder revolution" [1 ...400000  $\mu\text{m}$ ], and with the incremental version, the range of values of the parameter "pulses per encoder revolution" [1...65000  $\mu\text{m}$ ] is also monitored. The selected traversing range must always be greater than twice the resolution.
- Error 3 (COM246: F03H; PC: 3) **Wrong maximum speed"**  
The specified speed must be in the range 1...65000.
- Error 4 (COM246: F04H; PC: 4) **"wrong JOG/INC speed"**  
Each of the speeds must be greater than or equal to 1 and less than or equal to the assigned maximum speed.
- Error 5 (CC) 246: F05H; PC: 5) **Wrong reference speed"**  
With the IP246 (incremental version), the reference speed 1 must be greater than or equal to 1 and less than or equal to the assigned maximum speed. The reference speed 2 must also be greater than 1, however, less than or equal to reference speed 1.
- Error 6 (COM246: F06H; PC: 6) **"wrong acceleration"**  
The maximum acceleration must be greater than or equal to 10 and less than or equal to 9999  $\text{mm}/\text{sec}^2$  (0.1  $\text{inch}/\text{sec}^2$ ,  $\text{degrees}/\text{sec}^2$ ). The other acceleration or deceleration rates must also be greater than or equal to 10, however, less than or equal to the maximum acceleration.
- Error 7 (COM246: F07H; PC: 7) **"wrong software limit switch"**  
The traversing range of a linear axis is fixed by the coordinates of the "software start limit switch" and "software end limit switch". The coordinates of the software limit switches must be different - the start always less than the end - and within the range +/-40 m (+/- 4000 inches, +/- 40000 degrees).
- Error 8 (COM246: F08H; PC: 8) **"wrong reference point"**  
The coordinate of the reference point for the incremental version must be less than or equal to the coordinate of the "software end limit switch" and greater than or equal to the coordinate of the "software start limit switch".
- Error 9 (CC) 246: F09H; PC: 9) **" $v_{\text{max}}$  is too low"**  
The lower value of the programmed maximum speed depends on the resolution R [ $\mu\text{m}/\text{pul}$ ] ("distance per encoder revolution" / "pulses per encoder revolution").  $v_{\text{max}}$  [ $\text{mm}/\text{min}$ ] must be greater than 4. R [ $\mu\text{m}/\text{puls}$ ].
- Error 10 (COM246: F0AH; PC: 10) **"gain (kv) factor too low"**  
The lower limit of the gain factor is 0.1 [1/sec].

- Error 11 (COM246: FOBH; PC: 11) **“gain (kv) factor too high”**  
The kv factor must be less than 100 [l/see] and must not be so high that a voltage corresponding to the maximum speed is output when there is a control error of 1 pulse; i.e. the gain factor in l/see must be less than  
  
 $V_{max} [\text{mm/min}] \cdot 1000$   
  
 $R [\text{urn/pulse}] \cdot 60$
- Error 12 (COM246: FOCH; PC: 12) **“Wrong axis/module number”**  
In mode 24 (“enter SYSID”), the IP246 is assigned a module number. COM246 executes mode 24 when F1(BEGIN) is pressed in the presetting mask (= > “Functions, Reference Manual”, Section 3.18 “Enter SYSID”). When entering a machine data record to the IP246, this number is compared with the module number entered in the machine data record. The machine data record must contain the same module number.
- Error 13 (COM246:F0DH; PC: 13) **“zero offset too large”**  
Each zero point offset can have values in the total range of +/-40 m. When a zero point offset is executed, the coordinates of the software limit switches are corrected accordingly, Following such a correction, the coordinates of the software limit switches must still be within the permitted range of +/-40 m ( +/-4000 inches, +/-40000 degrees).
- Error 14 (COM246: FOEH; PC: 14) **“wrong tool offset”**  
The tool offset is limited to a value of +/-40 m. The coordinates of the software end limit switch plus the tool offset and the coordinate of the software start limit switch plus the tool offset must remain in the range +/-40 m (+/-4000 inches, +/-40000 degrees). Remember that tool offsets have a sign. If a rotary axis is being used, the tool offset must also be less than the traversing range fixed by the range limits.
- Error 15 (COM246: FOFH; PC: 15) **“wrong standstill monitoring”**  
The range of values for the standstill monitoring is between 0.001 and 64.999 mm. It must also be less than the maximum following error.
- Error 16 (COM246: F60H; PC: 16) **“wrong pulse evaluation”**  
Only single, double or quadruple evaluation of the signal of an incremental encoder is permitted (= > “Fundamentals of Positioning, Reference Manual”, Section 4.2 “Position Decoding and Travel Resolution”).
- Error 17 (COM246:F61H; PC: 17) **“wrong polarity hardware limit switch”**  
The values “O” (NO, **positive**) and “I” (NC, **negative**) are permitted. The IP246 can only recognize incorrect parameter assignment when neither hardware limit switch is tripped when the machine data are entered. The hardware limit switches are also evaluated for a rotary axis. If no hardware limit switches are connected, you must program NO switches.
- e Error 18 (COM246:F62H; PC: 18) **“maximum speed too high for this resolution”**  
The counter chip on the incremental version can count pulse trains from encoders with 5 V differential signals up to a maximum rate of 500 kHz. At the maximum speed and selected resolution [urn/pulse], this value is exceeded.
- Error 19 (COM246:F63H; PC: 19) **“traversing range too high for position encoder”**  
If a linear axis is being used with the absolute version, you must make sure that the absolute position encoder can cover every coordinate which can be reached during operation. (= > “Fundamentals of Positioning, Reference Manual”; Section 4.3 “The Traversing Range” and Part 4 “Functions”; Section 3.4.2 “Set Reference Point”).

- Error 20 (CC) 246:F64H; PC: 20) **“distance covered by encoder does not match traversing range”**  
If a rotary axis is being used with the absolute version, you must make sure that the range covered by the absolute encoder exactly matches the traversing range (= > “Fundamentals of Positioning, Reference Manual”; Section 4.3 “The Traversing Range”).
- Error 21 (COM246:F65H; PC: 21) **Wrong encoder data”**  
The range of values of the parameter “number of revolutions” is 1...65000. The range of values of the parameter “steps per encoder revolution” for the absolute version is 2...65000, and only even numbers are allowed. The multiplication of the two values must not result in a value greater than  $2^{20}$ . If the product is not equal to a power of 2, the module assumes that you are using an absolute encoder supplying Gray excess-X code. This is, however, only permitted with a single turn encoder (= > “Fundamentals of Positioning, Reference Manual”, Section 4.2 “Position Decoding and Travel Resolution”).
- Error 22 (COM246:F66H; PC: 22) **“wrong end of range”**  
This error only occurs with a rotary axis. The cause of the error is identical to that of error 7.
- Error 23 (COM246:F67H; PC: 23) **“wrong home point”**  
This error only occurs with the absolute version. The cause of the error is identical to that of error 8.
- Error 24 (COM246:F68H; PC: 24) **Wrong dimensional unit”**  
The dimensional units available are metric (“1”), inches (“2”) and degrees (“3”) (= > “Fundamentals of Positioning, Reference Manual” Section 4.2 “Position Decoding and Travel Resolution”).
- Error 25 (COM246:F69H; PC: 25) **“wrong backlash compensation value”**  
The permitted range for the backlash compensation value is 0.001...64.999 mm.



## 2.2 Module Errors and Possible Causes

This section deals with module errors and errors specific to the axis. Module errors occurring on the positioning module IP246 are output both via the PC and via the PG interface. The messages displayed by COM246 have an offset, so that the error numbers at the PG differ from those at the PC by 80H.

The COM246 software package also displays an additional set of error messages resulting from communication between the COM246 software when operator input is made, from diskette/hard disk processing or from the interpretation of machine data and machining program errors.

The software of the IP246 generates two types of error messages for module errors:

- the actual axis errors which lead to a traversing movement being aborted and
- warnings or indications which are simply to inform the user (errors 1 to 9).

With the incremental version from firmware release A02.1 and with the absolute version, the axis errors must be further divided as follows:

- axis errors, which lead to the traversing movement being aborted and the axis status "finished" being set
- axis errors, which lead to the traversing movement being aborted but then automatically switch on the following error mode (mode 4).

If an axis error is displayed in COM246, not only the error number but also a message is displayed, so that the cause of the error can normally be recognized immediately.

There are, however, some error messages which require further explanation to allow you to find the cause of the error and to remedy it more quickly. Some error messages are therefore explained in more detail.

- Error 1 (PC: 1, COM246: 81 H) "**PG job list is full**"  
Owing to mechanical inertia, the module cannot execute the jobs as quickly as they are being entered. The last job entered from the PG has been lost and must be repeated.
- Error 2 (PC: 2, COM246: 82H) "**illegal job**"  
The last job sent from the PC or PG either has no defined mode or is not feasible at this point. Example: starting an axis which is already running. The job is ignored.
- Error 5 (PC: 5, COM246: 85H) "**PC job list is full**"  
Corresponds to error 81 from the point of view of the PC. The last job must be repeated.
- Error 6 (PC: 6, COM246: 86H) "**axis waiting for external start**"  
The execution of the selected mode is blocked by a signal "I" at the digital input "external start/stop" (= > "Fundamentals of Positioning, Reference Manual", Section 7.4 "External Start/Stop").
- Error 7 (PC: 7, COM246: 87H) "**speed range exceeded**"  
Either the specified override is outside the permitted range of values of 1...200%, or the speed resulting from the selected (permitted) override exceeds the maximum speed. This only occurs in the JOG modes and in incremental approach. The position module automatically prevents the limit values being exceeded.

- Error 11 (PC: 11, COM246: 8BH) "**max. following error exceeded**"  
The "maximum following error" selected in the machine data has been exceeded and the current job aborted with a deceleration ramp. The position control loop remains switched on and the axis stops after the existing following error has been eliminated. The following error monitoring only responds with the absolute version and incremental version from firmware version A02.1 when the maximum following error is exceeded, despite the movement of the axis or when the actual value no longer changes and the maximum following error is selected so that it is exceeded at an analog value below 5 V. Possible causes are as follows:
  - the load torque is too high,  
the acceleration is too high,
  - the gain (k<sub>v</sub>) factor is too low,
  - the maximum following error has been set too low.

In these four cases it is possible to move the axis in the open-loop JOG mode. The machine data must be suitably selected.

- The maximum speed and the resolution in the machine data are incorrectly selected, i.e. not matched to each other. Check by comparing the selected speed and the displayed speed in the open-loop JOG mode.

With the incremental version of the IP246 with a firmware release less than A02.1, the following error monitoring responds when

- the 24 V power supply is absent,
- a position encoder is not connected, incorrectly connected or is defect.

(You can check this by moving the axis manually in the following error mode (mode 4) and observing whether there is a change of actual value, or if the speed is zero when you traverse in mode 3 (JOG open-loop)).

- the analog output of the module is not connected,
  - the power unit is not switched on or not enabled, or
  - the axis is mechanically blocked by an obstacle or is jammed.
- Error 12 (PC: 12, COM246: 8CH) "**correct MD - module number cannot be changed**"  
As soon as the positioning module has at least one correct machine data record, the module number can no longer be changed. The number already stored can be read in the presetting mask of COM246 ( => "Functions, Reference Manual", Section 3.19 "Enter SYSID" and Part 2 "Fundamentals of Positioning", Section 4.8 "Other Parameters").
  - Error 22 (PC: 22, COM246: 96H) "**multi-machining program processing prohibited**"  
It is not possible to store several machining programs in the memory of the IP246 at the same time. This error occurs when an axis is creating a machining program in the teach-in mode and you attempt to transfer a second machining program to the other axis on the module.
  - Error 30 (PC: 30, COM246: 9EH) "**operating mode prohibited in teach-in**"  
When the teach-in mode is active, only the JOG modes BA1 to BA3 and incremental jobs BA6 and BA7 are permitted.

- Error 53 (PC: 53, COM246: B5H) **“target position not reached”**  
The position setpoint is already at the target. The actual position value is still outside the selected standstill monitoring value and is no longer approaching the target coordinate and the following error is less than the selected maximum following error. Possible causes are as follows:
  - the standstill monitoring value is too small,
  - the gain (kv) factor is too small or
  - the drift of the power unit is too great (drift compensation, mode 18)
  - during the execution of a traversing job, the positioning control loop was interrupted and the distance to go for the job is less than the maximum following error. If the distance to go is, however, greater than the maximum following error, the error message “maximum following error exceeded” is set,
  
- Error 54 (PC: 54, COM246: B6H) **“position loop interrupted”**  
The actual position value is not changing although the analog voltage (speed setpoint) has exceeded the 5 V limit. The current job is abandoned by applying 0 V or a voltage corresponding to a compensated drift to the analog output. The module then automatically switches to the following error mode (mode 4). The closed-loop position controller is switched off in the following error mode. The following error mode can be terminated at any time. The closed-loop position controller is then switched on again. The possible causes are as follows:
  - the 24 V power supply is absent,
  - the position encoder is not connected, incorrectly connected or is defect,
  - the analog output of the module is not connected,
  - the power unit is not switched on or not enabled,
  - the axis is blocked mechanically by an obstacle or is jammed.
  
- Error 60 (PC: 60, COM246: BC<sub>H</sub>) **“illegal absolute encoder reading”**  
The detected absolute encoder value is not permitted. Possible causes areas follows:
  - the total number of steps of the absolute encoder used does not match the total number of steps specified in the parameters,
  - jumper XI 7 ( => Part 3 “Hardware”, Section 3.4 “Connecting Absolute Position Encoders to the IP246-4UB “) is not correctly inserted,
  - the encoder cable is **subject to** interference, is defect or not connected,
  - the position encoder is defect,
  - the power supply to the position encoder has failed.

One of these causes either results in an absolute position encoder value which can never occur with the selected encoder parameters (e.g. total number of steps of the absolute encoder is greater than the specified total number of steps) or with a home point set, an absolute encoder reading is received which indicates a position outside the usable range (=> “Fundamentals of Positioning, Reference Manual”, Section 4.3 “The Traversing Range”). Closed-loop position control is no longer possible. The current job is abandoned, 0 V or a voltage corresponding to the compensated drift is applied to the analog output and the module switches automatically to the following error mode. The following error mode can (in this exceptional case) also be ended by changing the machine data. If the error occurs again after changing the machine data, the module switches immediately to the following error mode again.

- Error 61 (PC: 61, COM246:BDH) “**wrong home point in machine data record**”  
The relationship of the home point coordinate to the absolute encoder reading as entered in the machine data record is not permitted with this home point coordinate.
- Error 62 (PC: 62, COM246:BEH) “**actual value not clear**”  
When establishing the coordinate system, the current absolute encoder reading cannot be assigned a unique actual value, since this absolute encoder reading means a position outside the usable range ( => “Fundamentals of Positioning, Reference Manual”, Section 4.3 “The Traversing Range”).

The coordinate system is **re-established** with the absolute version of the **IP246** in the following situations::

- mode 5 (“set home point”) is executed
- the module starts up with valid machine data
- input (transfer) of valid machine data to the module.

If this error occurs, the home point is deleted on the module. In the machine data record itself a valid home point is nevertheless retained.

- Error 63 (PC: 63, COM246:BFH) “**illegal change of absolute encoder values**”  
The absolute encoder value has changed illegally. Possible causes are as follows:

- the total number of steps of the absolute encoder being used is less than the total number of steps selected in the parameters,
- there is feedback in the positioning control loop; i.e. with a positive analog voltage (speed setpoint) the encoder turns backwards and with a negative analog voltage it turns forwards,
- the encoder is not defect and is correctly connected. It turns when the 24 V power supply from the module is absent or when the analog output of the module is not connected, for example as a result of drift in the power unit,
- the encoder is defect, e.g. a track is missing,
- the power supply to the encoder has failed,
- the encoder cable is subject to interference, defector not connected.

Closed-loop position control is no longer possible, the current job is therefore interrupted, 0 V or a voltage corresponding to a compensated drift is applied to the **analog** output and the module changes automatically to the following error mode. The following error mode (in this exceptional case) also be ended by changing the machine data.

## 2.3 PG Interface Errors

- Error 53H “**watch dog error module**”  
This error only appears on the PG interface, i.e. in **COM246** and indicates situations in which there is no connection established to the positioning module. The possible causes are as follows:
  - the connecting cable is not inserted or there is a wire break
  - the positioning module has no power supply.

### 3 Supplementary Notes

When using the IP246 positioning module there are several characteristics of the **SIMATIC S5** system which must be taken into account. The following sections deal with these characteristics.

#### 3.1 Keyboard Character Buffer

The keyboards of the programmers have a buffer in which characters entered at the keyboard are temporarily stored when characters are entered more quickly than they can be processed. This can become apparent in the test mask of **COM246** when commands are entered, for example, a fast sequence of "forwards" and "reverse" commands is entered in the **JOG mode**. The execution then lags behind the input. A stop command can only be executed when all the commands previously stored in the character buffer have already been processed.

#### 3.2 Multiprocessor Operation

The S5 135U programmable controller is designed for multiprocessor operation. Several R processors could access the same positioning module independently, This is not permitted with the IP246 positioning module.

#### 3.3 Restarts

A reset pulse on the bus resets both the incremental and absolute versions of the **IP246**. A current job is then no longer active, just as if the power had been switched off and on again.

The start-up characteristics of function blocks **FB164** and **FB165** are discussed in "Programming Instructions IP246". The **IP246** positioning module reacts as follows when it is restarted:

##### **Incremental version of the IP246:**

Following each restart of the module, the reference point is deleted and the following error mode is active. If the battery back-up of the programmable controller was absent (the module was removed), all the machine data and machining programs on the **IP246** are lost, a compensated drift, zero point offsets and tool length offsets are also deleted. If the module was backed up by the battery, the machine data remain valid. The reference point coordinate is then signalled as the actual value.

Absolute version of the **IP246**:

A home point is only lost if the module is not backed up by the PC battery. If the battery back-up of the programmable controller was absent (the module was removed) as with the incremental version, all the machine data and machining programs on the **IP246 are lost, the home point, a compensated drift, zero point offsets and tool length offsets are also deleted. If the module was backed up by the battery, the machine data remain valid. If the home point was set, the absolute position of the axis is signalled immediately.**

**If no home point was set before the restart (module backed up by the battery), the home point coordinate is signalled as the actual value.**

## Troubleshooting Questionnaire

If, despite careful installation and programming, you still encounter problems with positioning operations and cannot localize the problem, please follow the routine outlined below:

Before calling **your branch representative**, please complete the questionnaire so that the **necessary information is readily available**. The more exact the description of the problem and the events leading up to it, the faster your representative will be able to help you.

### 1) Which module are you using?

IP246 order no: 6ES5 246- 4U \_\_\_\_\_

Version marked: \_\_\_\_\_

Firmware issue displayed by COM: \_\_\_\_\_

### 2) Which COM are you using?

Order no: 6ES5 8— 5\_\_

Version issue: A \_\_\_\_\_

### 3) Which PG are you using?

PG: \_\_\_\_\_

Version: \_\_\_\_\_

### 4) Which PG/EU are you using?

Pc: \_\_\_\_\_

EU: \_\_\_\_\_

Interface module: \_\_\_\_\_

Power supply: \_\_\_\_\_

**5) System components**

(please enter order numbers)

PC: \_\_\_\_\_

CC: \_\_\_\_\_

PS: \_\_\_\_\_

CPU: \_\_\_\_\_

**Slot number:**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |  |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|--|
|   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |  |

**Version**

EU: \_\_\_\_\_

PS: \_\_\_\_\_

**Interface module pair:** \_\_\_\_\_

**Slot number:**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |  |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|--|
|   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |  |

**Version**

**Have the drive specifications, machine data and any machining programs ready (see machine data planning or print out this data).**

**Make sure you know the jumper and switch settings on the module.**



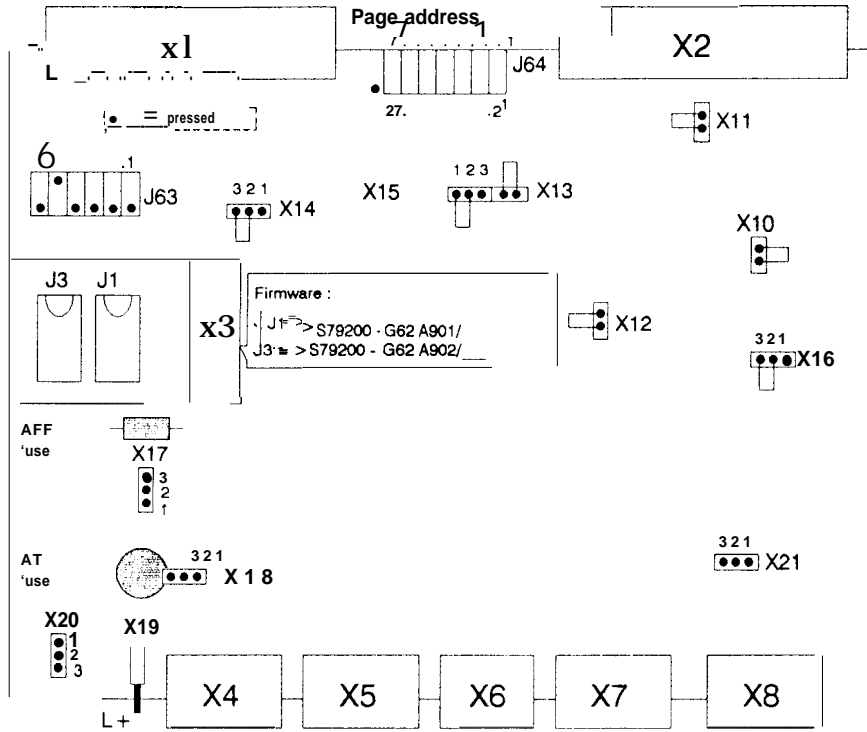


Fig. 4.1: Position of the switches, jumpers and fuses on the incremental version

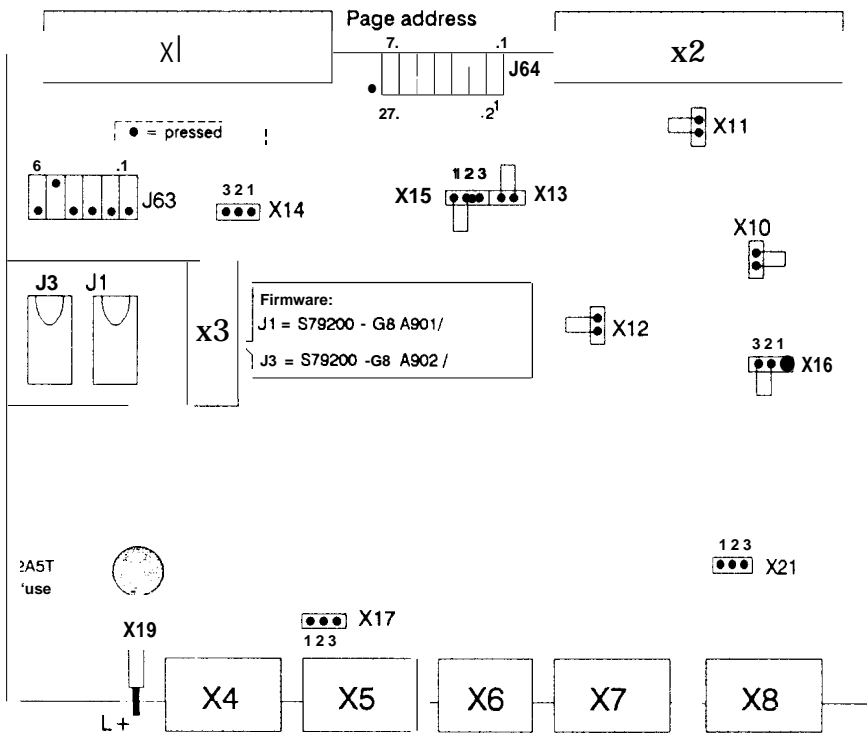


Fig. 4.2: Position of the switches, jumpers and fuses on the absolute version

**6) What is going wrong?**

---

**7) Which error messages were output by the COM software?**

---

**8) Which error message is set at the output of the standard function block?**

---

**9) Which error numbers are entered in the appropriate flag bytes?**

---

**10) Is the error reproducible?**

---

**11) Does the error occur sporadically?**

---

**12) Does the error occur when operating the module from the PG as well as from the PC?**

---

**13) Which modes are being used?**

---

**14) In which modes does the error occur?**

---

**15) When the positioning is incorrect, is the distance travelled**

- always too long \_\_\_\_\_
- (=> possibly loss of pulses on the encoder lines or the encoder coupling is loose),
- always too short, \_\_\_\_\_
- (=> possibly interference pulses coupled into the encoder lines),
- always wrong by the same amount? \_\_\_\_\_

**16) Does the error only occur with a particular sequence of jobs?**

\_\_\_\_\_

**17) What type of axis are you using?**

Rotary axis: \_\_\_\_\_ (0)

Linear axis:

Vertical axis: \_\_\_\_\_ (0)

Horizontal axis: \_\_\_\_\_ (0)

**18) What kind of drive are you using?**

DC drive: \_\_\_\_\_ (0)

AC drive: \_\_\_\_\_ (0)

Rated speed: \_\_\_\_\_ rpm

Adjusted to: \_\_\_\_\_ rpm

for 10 V signal input

Manufacturer: \_\_\_\_\_

Type: \_\_\_\_\_

**19) Is there transmission?**

Type of transmission

Belt \_\_\_\_\_ (0)

Gear wheel \_\_\_\_\_ (0)

Chain \_\_\_\_\_ (0)

Transmission ratio: \_\_\_\_\_

**20) Which power unit are you using?**

Manufacturer: \_\_\_\_\_

Type: \_\_\_\_\_

Is the power unit adjusted to the IP246?

(Yes (0) /No (0))

How great is the axis drift in BA4? \_\_\_\_\_ mV

Are the analog lines from the IP to the power unit shielded twisted pairs wired as shown in the manual?

(Yes (0) /No (0) )

**21) What type of position encoders are you using?**

Absolute position encoder

Manufacturer: \_\_\_\_\_

Type: \_\_\_\_\_

Single turn ( O ) / Multiturn ( O )

If multiturn, number of revolutions: \_\_\_\_\_

Steps per revolution: \_\_\_\_\_

Code used: \_\_\_\_\_

Incremental position encoder

Manufacturer \_\_\_\_\_

Type: \_\_\_\_\_

Resolver

Manufacturer: \_\_\_\_\_

Type: \_\_\_\_\_

Number of pulses per revolution: \_\_\_\_\_

Measuring multiplexer with multiplication factor: \_\_\_\_\_

Was the encoder mounted directly on drive?

(Yes (0) /No (0))

if not, brief description of the mounting

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Wiring shielded and in twisted pairs for symmetrical encoders?

(Yes (0) /No (0) )

Are there any sources of high-frequency interference (e.g. frequency converter) in the vicinity of the IP246 or its signal lines, or were the signal lines and power lines laid parallel and close together?

(Yes ( 0 ) /No(O))

**22) Is the module outputting an analog voltage although it has no traversing job?**

**(Yes (0) /No (0))**

**23) When using externally ventilated IP246 modules in the S5 115U is there an additional fan?**

**(Yes (0) /No (0))**

**24) Is FB164 called once per cycle and axis?**

**(Yes (0) /No (0))**

Jobs triggered by momentary pulse?

(Yes (0) /No (0))

Which error messages are displayed?

---

---

**25) Are the scratchpad flags being saved in the interrupting OBS?**

**(Yes (0) /No (0))**

# SIEMENS

## SIMATIC S5

IP 246 Positioning Module

Incremental 6ES5246-4UA31 / -4UA41

Absolute 6ES5246-4UB11 / -4UB21

List of Key Words

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C79000-B8576-C657-02

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