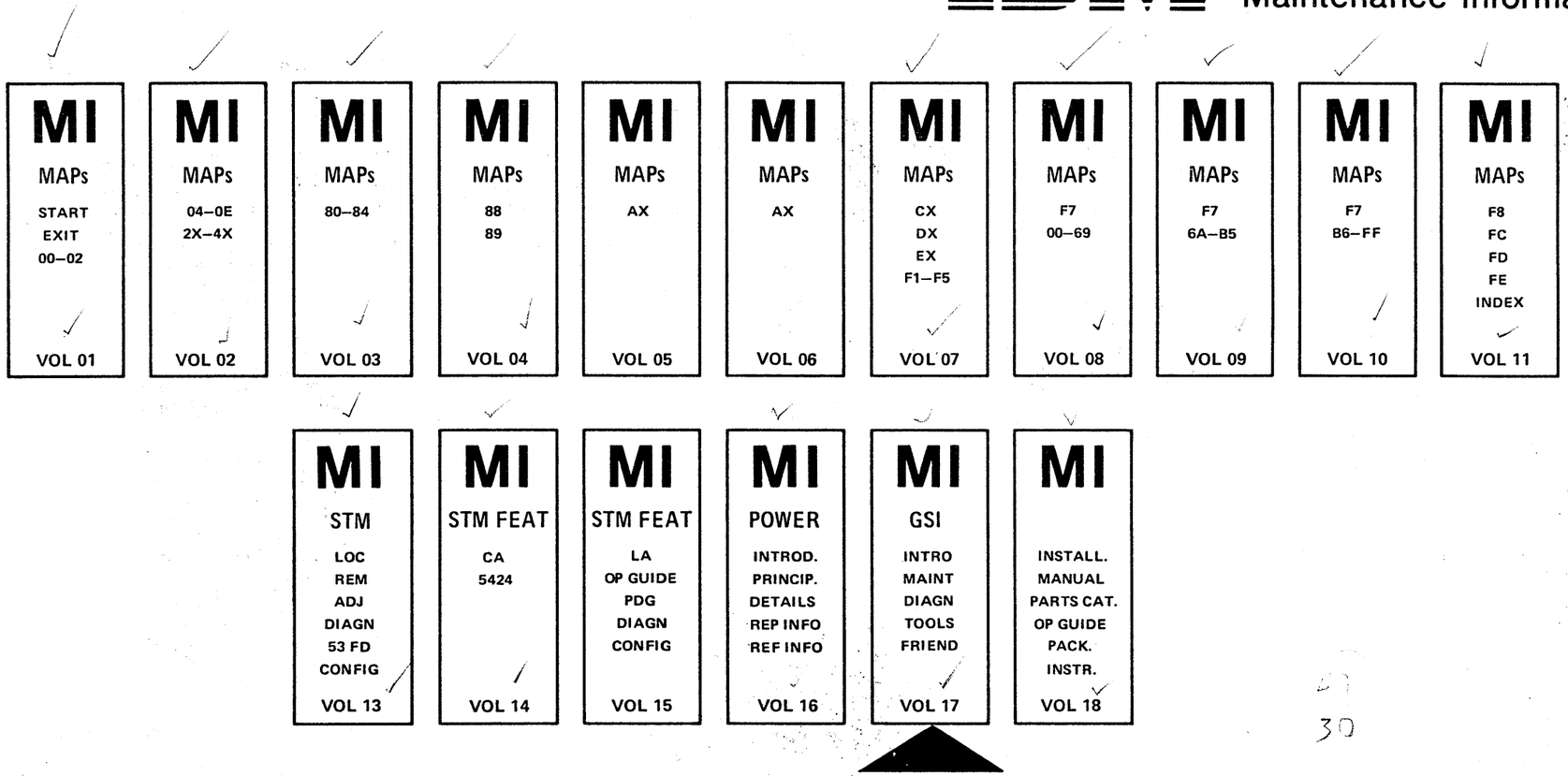
IBM Maintenance Information



IBM 4321/4331 Processors General System Information

AAG0110

Preface

This manual provides general information to the IBM 4321/4331 Processors. The manual contains the following major items.

- Section 1 contains an overview of the system documentation, a high level description of the system and the support subsystem.
- Section 2 describes the maintenance concept of the system, and how to use the MAPs.
- Section 3 contains information about error logging.
- Section 4 describes tools.
- Abbreviation List (page 9970).

Each section has its own table of contents.

The reader is assumed to have a good basic understanding of IBM system concepts.

The manual is not intended as a self-study course but as a recall document. It may also be used as an introduction to the system by people interested in the philosophy and concepts of the system but not in detailed maintenance or how-it-works information.

Volume Table of Contents

Volume:	**17**
Title:	**MI GSI, FRIEND**
Machine Type:	**4321/4331**
Power Design Level:	**4/5**
B/M Number 4321:	**4687158**
B/M Number 4331-1:	**8488405**
B/M Number 4331-2:	**5683367**
B/M Number 4331-11:	**4687145**

Safety Guidelines

If you are aware of the guidelines for working with electrical and mechanical equipment and practice these guidelines, you can work safely with this equipment.

You need not fear electricity, but you must respect it.

You should take every safety precaution possible and observe the following safety practices while maintaining IBM equipment.

1. You should not work alone under hazardous conditions or around equipment with dangerous voltage. Always advise your manager if this is a potential problem.
2. Remove all power before removing or assembling major components, working in the immediate area of power supplies, performing mechanical inspection of power supplies, or installing changes in machine circuitry.
3. Power supplies, pumps, blowers, motor generators, and other units with voltages which exceed 30V ac or 42.4V dc must not be serviced with power on when the unit is removed from its normal installed position within the machine, unless maintenance documentation clearly states otherwise. (This is done to ensure that proper grounding is maintained.)
4. Unplug the power supply cord whenever possible before working on the machine. The wall box switch when turned off should be locked in the off position or tagged with a DO NOT OPERATE tag (form Z229-0237). Be aware that a non-IBM attachment to an IBM machine may be powered from another source and be controlled by a different disconnect or circuit breaker.
5. When it is absolutely necessary to work on equipment having exposed live electrical circuitry, observe the following precautions:
   a. Another person familiar with power off controls must be in immediate vicinity. (Someone must be there to turn off power if it should become necessary.)
   b. Do not wear any jewelry, chains, metallic frame eyeglasses, or metal cuff links. (In the event of contact, there will be more current flowing because of the greater contact area afforded by the metal.)
   c. Use only insulated pliers, screwdrivers, and appropriate probe tibs/ extenders. (Remember, worn or cracked insulation is unsafe.)
   d. Use only one hand when working on energized equipment. Keep the other hand in your pocket or behind your back. (Remember there must be a complete circuit for electrical shock. This procedure helps eliminate a path that could complete a circuit through you!)
   e. When using test equipment, be certain that controls are set correctly and that insulated probes of proper capacity are used.
   f. Avoid contacting ground potential (metal floor strips, machine frames, etc.), use suitable rubber mats purchased locally if necessary.
6. Follow special safety instructions when working with extremely high voltages. These instructions are outlined in CEMs and the safety portion of maintenance documentation. Use extreme care when checking high voltage.
7. Avoid use of tools and test equipment that have not been approved by IBM. (Electrical hand tools [wire wrap guns, drills, etc.] should be inspected periodically.)
8. Replace worn or broken tools and test equipment.
9. After maintenance, restore all safety devices, such as guards, shields, signs, and ground leads. Replace any safety device that is worn or defective. (These safety devices are there to protect you from a hazard. Don't defeat their purpose by not replacing them at the completion of the service call.)
10. Safety glasses must be worn when:
    - Using a hammer to drive pins, etc.
    - Power hand drilling.
    - Using spring hooks, attaching springs.
    - Soldering, wire cutting, removing steel bands.
    - Parts cleaning, using solvents, chemicals, and cleaners.
    - All other conditions which might be hazardous to your eyes.
11. Never assume that a circuit is deenergized. (Check it first.)
12. Always be alert to potential hazards in your working environment (i.e., damp floors, nongrounded extension cords, power surges, missing safety grounds, etc.)
13. Do not touch live electrical circuits with the surface of the plastic dental mirrors. The surface of the dental mirror is conductive and can result in machine damage and personal injury.
14. Four steps that should be taken in the event of an electrical accident:
    a. USE CAUTION - DON'T BE A VICTIM YOURSELF.
    b. TURN POWER OFF.
    c. HAVE SOMEONE ELSE GET MEDICAL HELP.
    d. ADMINISTER RESCUE BREATHING IF VICTIM IS NOT BREATHING.
15. Do not use solvents, cleaners, or oils that have not been approved by IBM.
16. Lift by standing or pushing up with stronger leg muscles. This takes strain off back muscles. Do not lift any equipment or parts which you feel uncomfortable with.
17. Each customer engineer is responsible to be certain that no action on his/her part renders the product unsafe or exposes hazards to customer personnel.
18. Place removed machine covers in a safe out-of-the-way location while servicing the machine. These covers must be in place on the machine before the machine is returned to the customer.
19. Always place CE tool kit away from walk areas where no one can trip over it (i.e., under desk to table.)
20. Avoid wearing loose clothing that may be caught in machinery. Shirt sleeves must be left buttoned or rolled up above the elbow. Long hair and scarves must be secured.
21. Ties must be tucked in shirt or have a tie clasp (preferably non- conductive) approximately three inches from the end when servicing a machine.
22. Before starting equipment, make sure that fellow CEs and customer personnel are not in a hazardous position.
23. Maintain good housekeeping in the area of the machines while performing and after completing maintenance.
24. Avoid touching moving mechanical parts when lubricating, checking for play, etc.

Prevention is the key to electrical safety. You should always be conscious of electrical safety. Follow the Safety Guidelines and practice good habits such as:

- Making certain that the customer's power receptacle meets IBM equipment requirements.
- Inspect line cords and plugs. Check for loose, damaged or worn parts.
- Before removing a component which can retain a charge from the machine, review the procedure in the maintenance documentation. CAREFULLY discharge the necessary component exactly as directed by the service procedure.
- Do not use an ordinary lamp as an extension trouble light.

Safety Guidelines (continued)

Never assume anything about a machine or circuit. No machine is completely safe all the time. The exact condition of a machine may be unknown. Here are some of the reasons why:

- The power receptacle could be incorrectly wired.
- Safety devices or features could be missing or defective.
- The maintenance and/or modification history may be uncertain or unclear.
- A possible design deficiency could exist.
- The machine may have suffered transportation damage.
- The machine might have an unsafe alteration or attachment.
- An EC or sales change may have been improperly installed.
- The machine may have deteriorated due to age or environmental extremes.
- A component could be defective, creating a hazard.
- Some component of the machine may have been incorrectly assembled.

Relating to safety, these are some of the ways the condition of the machine can be affected. Before you begin a service call or procedure, exercise good judgement and proceed with caution.

Electrical Accidents

Administering First Aid

In implementing rescue procedures in an electrical accident, one must:

- *Use Caution* - If the victim is still in contact with the electrical current source, it may be necessary to use the room EPO (Emergency Power Off) or disconnect switch to remove the electrical current. If the EPO or disconnect switch cannot be located, use a dry stick or another nonconducting object to pull or push the victim away from contact with the electrical equipment.
- *Act Quickly* - If the victim is unconscious, he/she may need rescue breathing and possibly external cardiac compression if the heart is not beating.
- *Call Fire Rescue* (Rescue Squad, Emergency, Ambulance, Hospital, etc.) - Have someone summon medical aid.

Determine if the victim needs rescue breathing.

1. Make certain that the victim's airway is open and that it is not obstructed. Check the mouth for objects that may be blocking the airway such as gum, food, dentures or even the tongue. Position the victim on his back and place one hand beneath the victim's neck and the other hand on his forehead. Then lift the neck with one hand and tilt the head backward with pressure on the forehead from the other hand as shown in Figure 1.
2. Now you must *look, listen, and feel* to determine if the victim is breathing freely. Place your cheek close to the victim's mouth and nose to listen and feel for the exhaling of air.

Figure 1

At the same time, look at the chest and upper abdomen to see if they rise and fall. If the victim is not breathing properly, you should:

a. With the head in a backward tilt as shown in Figure 1, continue to exert pressure on the victim's forehead with your hand while rotating this same hand so that you can pinch the victim's nostrils together with the thumb and index finger (Figure 2).

CAUTION: Use extreme care when administering rescue breathing to a victim that may have breathed in toxic fumes. DO NOT INHALE AIR EXHAUSTED BY THE VICTIM.

Figure 2

b. Open your mouth and take a deep breath. Make a tight seal with your mouth around the victim's mouth and blow into the victim's mouth (Figure 3).

Figure 3

c. Remove your mouth and allow the victim to exhale while watching for the victim's chest to fall (Figure 4).

Figure 4

d. Repeat this cycle once every five seconds until the victim breathes for himself or medical help arrives.

Reporting Accidents

It is a CE's responsibility to report all electrical accidents, potential hazards, and "near miss" accidents to your field manager. Remember, a near miss accident might be the result of a design deficiency and prompt reporting will assure that the situation will be resolved quickly.
It's important to report even a minor shock since the conditions which caused it need only be varied slightly to cause serious injury.

General System Information, Section 1: Introduction

Table of Contents

Table of Contents - Section 1

Documentation Organization

The documentation for the system consists of two categories:

System Library

(available to customers)

- Processor Summary and I/O Configuration
- I/O Device Summary
- Data Communications Device Summary
- Functional Characteristics and System Configurator
- Channel Characteristics / Channel Load Sum Worksheet
- Principles of Operation
- Processor IM-PP / Templates
- I/O Equipment IM-PP / Templates
- Data Communication IM-PP / Templates
- Compatibility Features
- TP Configurator
- Operator's Guide

Maintenance Information (MI)

For use by IBM and customer service personnel. Prerequisite is that the user is familiar with IBM system concepts and has attended an IBM course or equivalent.

MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI
MAPs	MAPs	MAPs	MAPs	MAPs	MAPs	MAPs	MAPs	MAPs	MAPs	MAPs
START EXIT 00–02	04–0E 2X–4X	80–84	88 89	AX	AX	CX DX EX F1–F5	F7 00–69	F7 6A–B5	F7 B6–FF	F8 FC FD FE INDEX
VOL 01	VOL 02	VOL 03	VOL 04	VOL 05	VOL 06	VOL 07	VOL 08	VOL 09	VOL 10	VOL 11

MI	MI	MI	MI	MI	MI	MI	MI
STM	STM FEAT	STM FEAT	POWER	GSI		ITC	POWER
LOC REM ADJ DIAGN 53 FD CONFIG	CA 5424	LA OP GUIDE PDG DIAGN CONFIG	INTROD. PRINCIP. DETAILS REP INFO REF INFO	INTRO MAINT DIAGN TOOLS FRIEND	INSTALL. MANUAL PARTS CAT. OP GUIDE PACK. INSTR.	M HISTORY CARD REF CBL INST TIE DOWN PLUG LIST	-YA -YB -YC
VOL 13	VOL 14	VOL 15	VOL 16	VOL 17	VOL 18	VOL 30	VOL 40

MICROPROGRAM LINK–LISTING VOL 50

(WT only)

Description of the System

The system consists of the processor unit, one operator console (display station, keyboard, and control panel), and the attached input/output devices.

Operator Console

The operator console consists of the following units:

- The display unit.
- The keyboard.
- The operator control panel (OCP), with keys and indicator ligths to control and check the basic functions.
  For details of the OCP refer to 'Keys, Switches and Indicator Lights' in this section.

Processor

The processor includes:

- The processing unit (PU).
- The basic storage module (BSM).
- One or two integrated channels (IC-Bus 0, IC-Bus 1). Up to six I/O-adapters can be connected to an integrated channel.

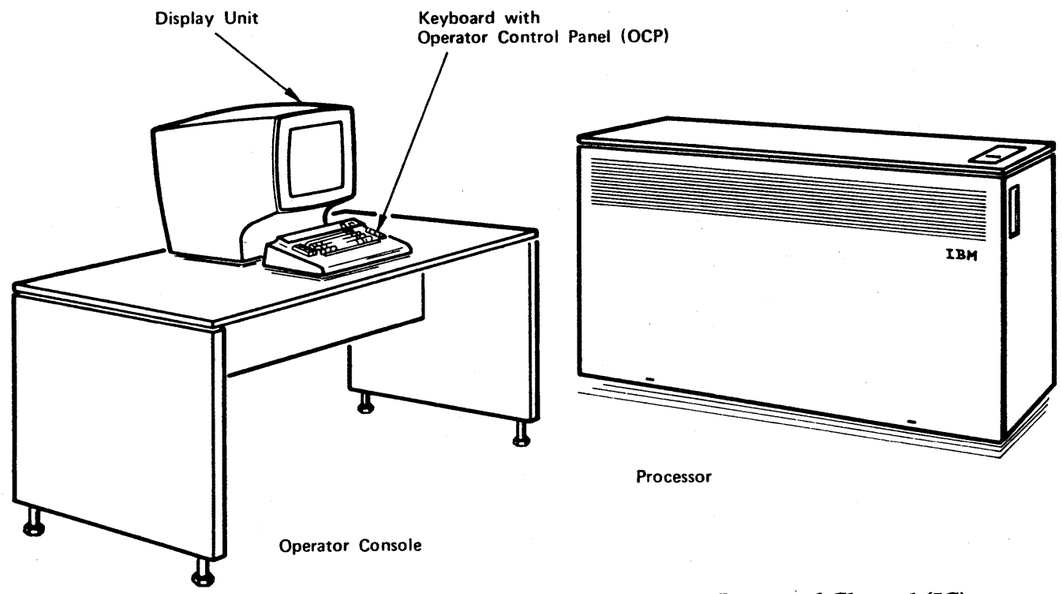
Processing Unit (PU)

The data flow in the PU is four bytes wide. The PU executes the entire system /370 instruction set, which includes:

- Control instructions
- Fixed point arithmetic instructions
- Floating point arithmetic instructions
- Decimal arithmetic instructions
- Logical instructions
- I/O instructions

In addition, a number of new control instructions are provided to support DOS/VSE (DOS Virtual Storage Extended).

Because all instructions and operand addresses are treated as virtual addresses, the PU uses a DLAT (Directory Look Aside Table) for fast address translation (Virtual Addresses to Real Addresses). The execution time for the instructions depends upon their complexity.



Basic Storage Module (BSM)

The BSM is the main storage of the processor. It may be considered as having two sections:

- The storage section
- The control section

Data transfers from or to the storage take place on a full word basis (4 bytes) via the fullword BSM register.

The BSM can perform the following operations:

- Fetch 64 bytes
- Store 1...64 bytes
- Store zeros in an address range of 1K bytes

To improve reliability of the storage, the storage is equipped with single bit error corrections logic. Special spare bits (redundant bits) are available on systems 4321 and 4331 Model 1. These spare bits are used to replace certain damaged storage bits.

Integrated Channel (IC)

The logic consists of four data buffers for each adapter. Each of these four buffers has a capacity of 64 bytes. A maximum of 32 buffers may be installed. The buffers are controlled via two control arrays, one is used for bus control, the other is used for storage control. The bus control array contains two fullwords per adapter, storage control array contains four words per adapter. The arrays allow for the collection of 64 bytes and subsequent transfer to main storage automatically when an adapter buffer has been filled (and vice versa).

Up to three adapters may be connected to each IC-Bus. These adapters are the link between the different I/O Interfaces and the IC-Buses.

I/O Interfaces are:

- Standard I/O Interface (used by the Byte and Block Multiplexer channels).
- Controller Interface (used for the attachment of disk drive units and tape drive units).
- Internal Processor Buses (used to attach the Support Subsystem, which includes the operator's console, and the I/O subsystem to the IC-Bus).

System Data Flow Description

①PU-BSM Bus

The PU-BSM bus is a four-byte-wide bidirectional data bus. It connects the processing unit (PU) with the basic storage module (BSM). Data transfer on the PU-BSM bus is controlled by the BSM control logic in the PU and the run control logic in the BSM. Both, the BSM control logic and the run control logic, are connected by the BSM control lines.

②Integrated Channel Bus

The integrated channel bus (IC-Bus) is basically a ring bus system consisting of a two-byte data bus and a number of control lines. It connects the I/O adapters with the integrated channel and is used for data transfer between the BSM and the I/O devices. Most of the data transfer on the IC-Bus is done in cycle-steal mode.
The systems 4321 and 4331 Model 1 use only one integrated channel bus (IC-Bus 0). To reach a higher performance the systems 4331 Model 2 and Model 11 are equipped with two integrated channel buses (IC-Bus 0 and 1).

The IC-Bus consists of different line groups, such as:

- Ring Lines
  These are the two-byte-wide 'IC-Bus Out' lines and 'IC-Bus In' lines with the transfer control lines. These lines run from the PU to the first adapter, through all adapters, and from the last adapter back to the PU.
- Star Lines
  These are adapter specific (unique) lines, such as request and check lines. Each adapter has its own group of lines.
- Stub Lines
  These are the control lines, such as clock pulses and strobe lines, which connect all adapters in parallel.

Note:
The following list contains all adapters that can be connected to the IC-Bus. Depending on the machine type and/or the model number some of the adapters are not available.

For more detailed information about attachable I/O devices refer to 'IBM 4300 Processors Summary and Input/Output & Data Communications Configurator', GA33-1523.

③Communications Adapter

The communications adapter (CA) supports up to eight communication lines (common communications adapters (CCA) and up to two auto call adapters (ACA).

For more detailed information about the communcations adapter feature refer to Vol. 14, 'STM FEAT, CA'.

④Byte Multiplexer Channel

The byte multiplexer channel (MPX) provides conventional bus and tag interface (standard I/O interface), to which I/O devices with their control units can be connected.

The byte multiplexer channel can operate in either byte-interleave mode or in burst mode. In byte-interleave mode (multiplexer mode) more than one device may operate concurrently. In burst mode only one device on the channel may be transferring data. The mode of operation is determined by the I/O device. The byte multiplexer channel is intended for the attachment of low-speed devices.

⑤Block Multiplexer Channel

The block multiplexer channel (BMPX) provides conventional bus and tag interface (standard I/O interface), to which I/O devices with their control units can be connected.

Unlike the MPX channel, the BMPX channel permits interleaving (multiplexing) of data records in block form. This mode of operation allows the attachment of high-speed I/O devices.

⑥High Speed Channel

The high speed channel (HSC) provides conventional bus and tag interface (standard I/O interface), to which I/O devices with their control units can be connected.

The HSC is a special type of block multiplexer channel that enables the fast chaining times required by some high-speed direct access storage devices (DASD).

⑦File/Tape Adapter

The file tape adapter (FTA) allows the direct attachment of disk drive units and tape drive units. A maximum of three FTAs (FTA 1, FTA 2, and FTA 3) are available.

Tape/disk drives are connected to an FTA through the control interface (CTLI).

FTA 1 and FTA 3 can attach disk drive units IBM 3310, 3340, 3344, and 3370.
FTA 2 can attach tape drive units IBM 8809.

For more detailed information about attachable tape/disk drives refer to 'IBM 4300 Processors Summary and Input/Output & Data Communications Configurator', GA33-1523.

⑧Support Subsystem

The support subsystem consists of a processor with its own bus and attachments for the operator's console, power control, console diskette drive, support bus, and a teleprocessing remote link. This subsystem is connected to the IC-Bus via a bus switching unit (BSU), which in turn consists of an ACC card and one or two BBA cards.

⑨I/O Subsystem

The I/O Subsystem consists of a processor that is identical to the processor of the Support Subsystem. It has its own storage and bus system, and is connected to the IC-Bus through a bus switching unit (BSU), which in turn is made of an ACC card and a BBA card.

One out of two different I/O adapters can be attached to the I/O subsystem:

1. 5424 Adapter
   The 5424 adapter allows to attach one IBM 5424 Multi Function Card Unit.

   For more detailed information about the 5424 Adapter Feature refer to Vol. 14, 'STM FEAT 5424'.

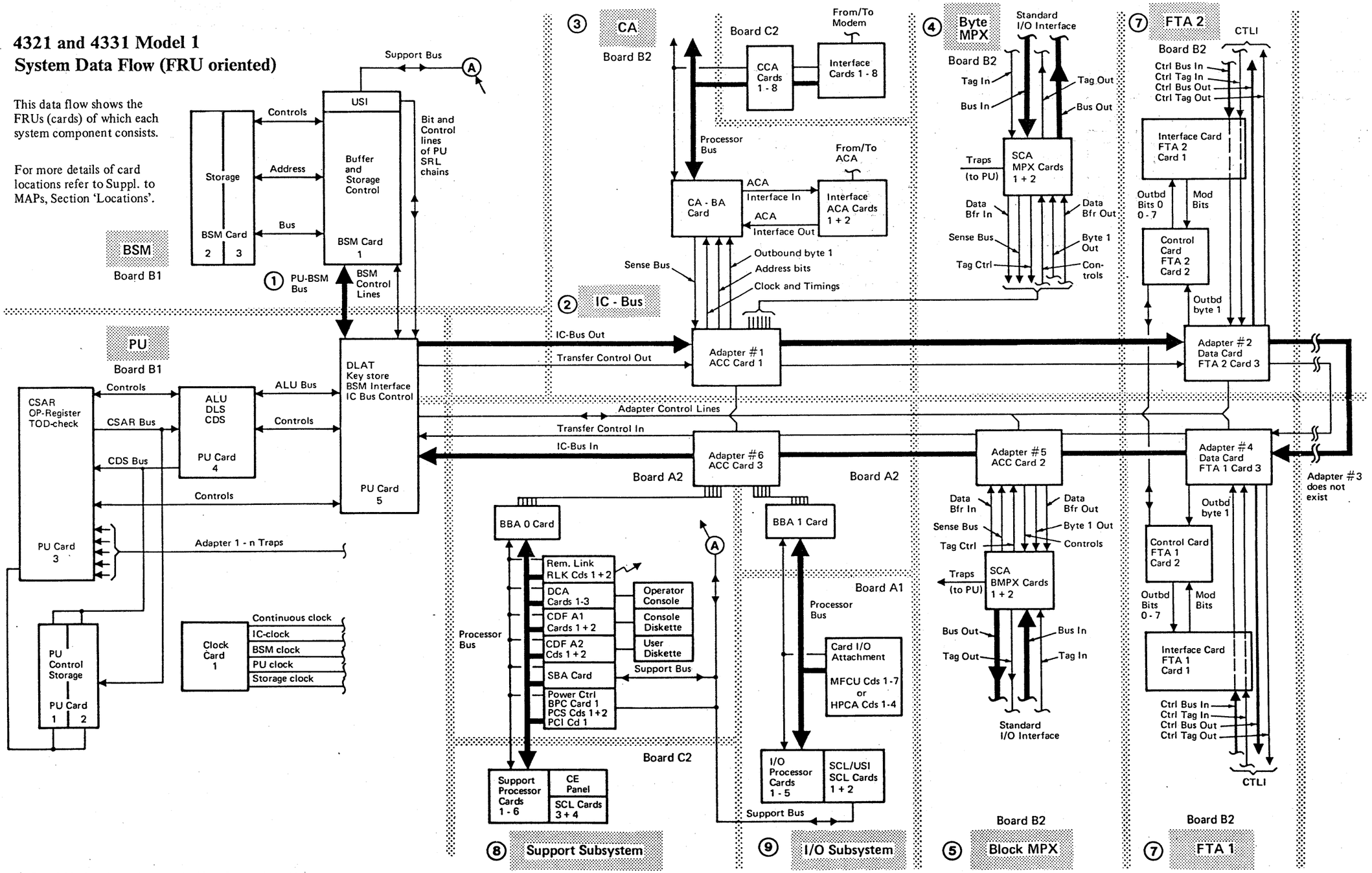
2. Loop Adapter
   The loop adapter permits the attachment of up to four multiuse communications loops which can be directly attached or data-link attached.

   For more detailed information about the loop adapter feature refer to Vol. 15, 'STM FEAT LA'.

4321 and 4331 Model 1
System Data Flow (FRU oriented)

This data flow shows the FRUs (cards) of which each system component consists.

For more details of card locations refer to Suppl. to MAPs, Section 'Locations'.



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4331 Model 2 and 11

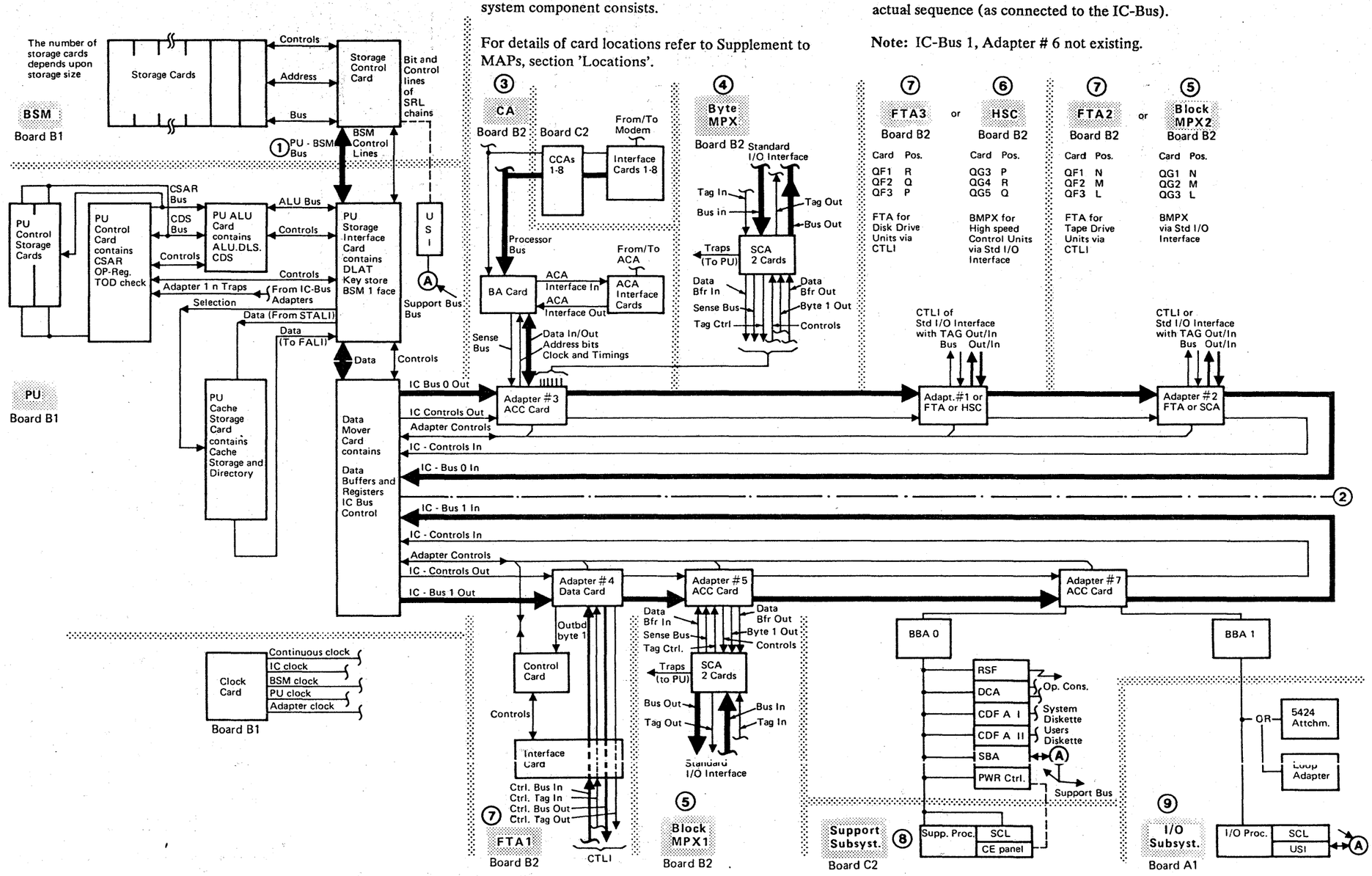
System Data Flow (FRU oriented)

This data flow shows the FRUs (cards) of which each system component consists.

For details of card locations refer to Supplement to MAPs, section 'Locations'.

IC-Bus Adapters in this data flow are shown in their actual sequence (as connected to the IC-Bus).

Note: IC-Bus 1, Adapter # 6 not existing.



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Concepts of the Support Subsystem

The support subsystem contains the hardware and provides the control logic for the following functions:

1. System initialization
2. Monitoring of the system hardware
3. Maintenance (See Section 2: 'Maintenance Concept')

At system initialization, the support subsystem loads the control information from the control diskette into the PU, the I/0 processor, and the processor of the support subsystem.

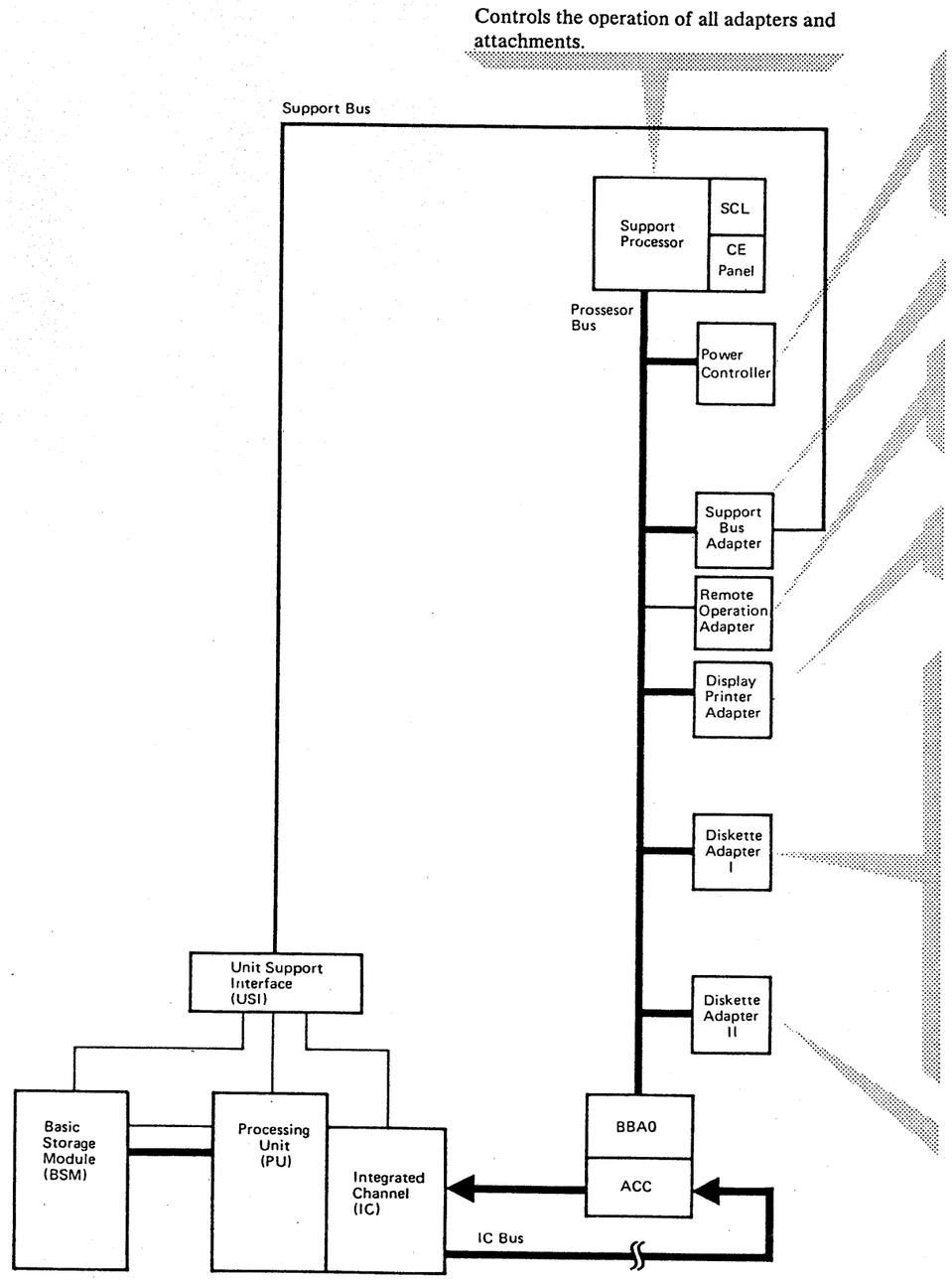
System Initialization Procedure

Place the required control diskette in the system diskette drive unit and switch power on. This raises the power-on-reset for the support processor (SP) and starts the system oscillator and SP clock. A bootstrap program is initiated automatically to control the following functions:

1. Tests the support processor, including the control store, using the basic assurance test (BAT).
2. Tests the path to the system diskette drive.
3. Verifies correct reading of the first record of the control diskette.

The basic assurance test takes about three seconds to run, indicated by LED 7 on the CE panel, see page 1400. If a failure occurs, the LED is not turned off at the end of the test. Other errors detected during the (IML) program can be displayed on the CE panel.

(For details refer to Supplement to MAPs, Section 4: Support Processor Display.)



Controls the power on/off sequence for the system, but the support subsystem is controlled by a hardwired sequence.

Monitors voltages and temperatures while the system is running.

Connects the support processor to the support bus.

The remote operation adapter is a communications adapter that provides a link either to the remote support facility (RSF), or a host system for operation of the 4321/4331 as a satellite processor from a remote console (Remote Operator Console Feature (ROCF)).

The display/printer adapter controls the operator console (consisting of a video display and keyboard) and up to 15 display/printer devices.

Controls the system diskette drive. This drive is used for the control diskettes and the diagnostic diskettes.

The control diskette holds:

- System initialization program
- Interpreter programs
- Control information
- I/0 device control programs
- Power controller programs
- Maintenance programs
- Error logs for maintenance and service
- Disk/Tape inline tests

The diagnostic diskette holds:

- Test and tool programs
- IRECA
- FRIEND

Controls the user diskette drive.

Concepts of the Support Subsystem (continued)

Monitoring

The support subsystem monitors the system by continually and sequentially checking all system components for errors that may occur during normal system operation, and by checking all voltage levels and currents in the power supply.

If an error is detected, the support subsystem uses all of the information that is available about the failing component and analyzes it. The result is logged on the control diskette and, at the same time, a reference code is displayed on the screen.

Each component has a separate area assigned to it on the control diskette for error logging. Each component area has two parts:

One is a record of the most recently logged item on the component, and provides some information about it.

The second part is the reference code that was displayed on the screen. A counter for each error type records the number of times each error occurred. Use these records as a starting point when intermittent errors are affecting the normal operation of the system. First work through the MAP called out by the reference code that occurs most frequently.

Manual Controls

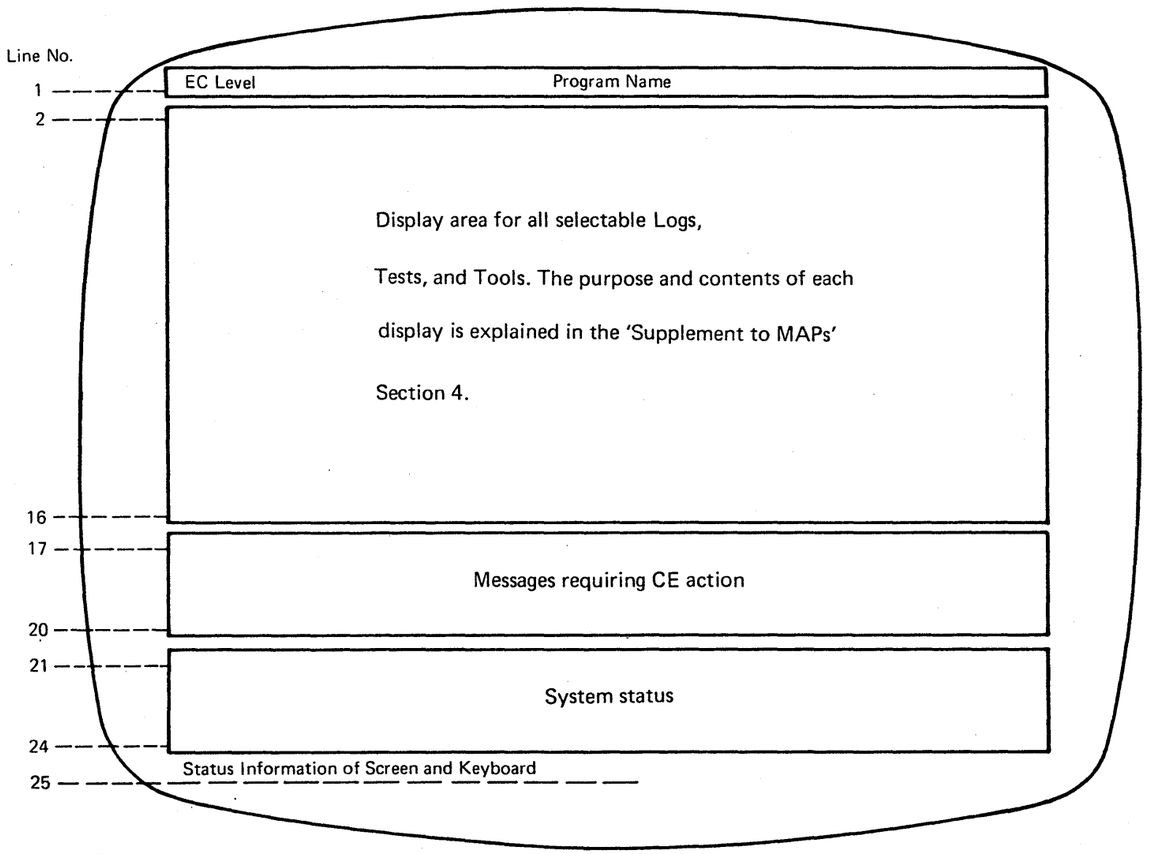
Manual operations are provided for the operator and for the CE. A brief explanation of the manual controls is given in 'Running the System' in this section.

Verification

There are no programs provided specifically for verification. To verify correct FRU installation or EC installation, perform IML. Errors may be indicated on the CE panel. For details, see Supplement to MAPs, Section 4: 'Support Processor Display'. In general, errors are indicated on the display console in the form of a reference code referring to the map chart applicable to the error.

Basic Display Format

The following display format is used during execution of diagnostic programs:



For details of line 25 refer to 'IBM 4321/4331 Processors Operating Procedures and Problem Determination Guide', GA33-1525.

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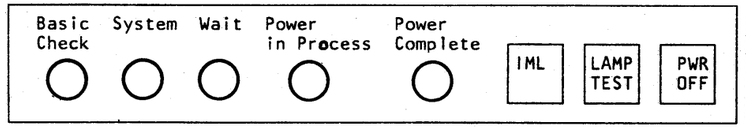
Keys, Switches and Indicator Lights

Operator Control Panel (OCP)



Indicator lights and keys to check and control basic machine functions.

Indicator Lights

Basic Check: Indicates a malfunction in the power section that requires CE activity. It is always on, as long as the CE Mode switch is on.

System: Indicates that instructions are being processed.

Wait: Indicates that the 'wait' bit in the current PSW is set. This means that the processor is idling while an I/O activity is being completed.

Power in Process: Indicates a power-on or power-off sequence in process.

Power Complete: Indicates that the power-on sequence is completed.

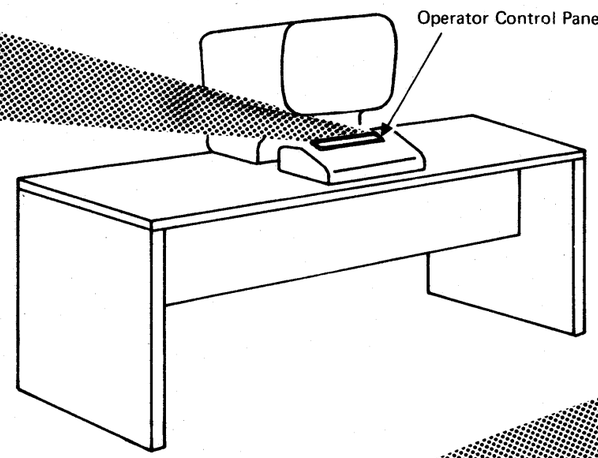
Keys

IML: Pressing this key while power is on, starts an IML sequence.

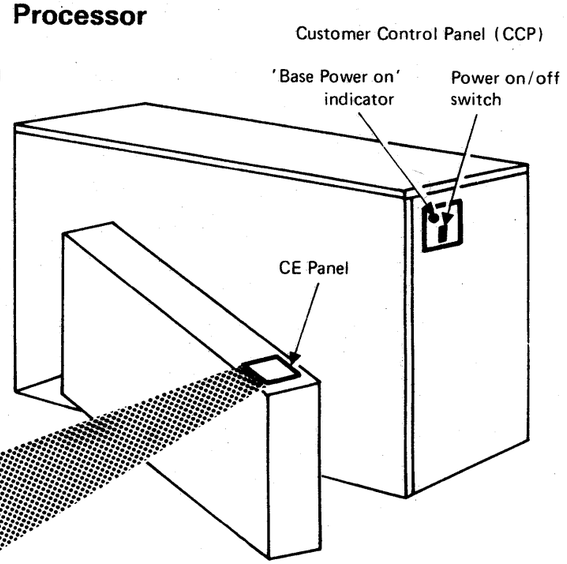
Lamp Test: As long as this key is pressed the indicator lights on the OCP must be on and, in addition, the indicator lights of all I/O devices which have no lamp test switch. The LEDs on the CE-panel are not checked by Lamp Test.

Power off: Pressing this key starts a power-off sequence.

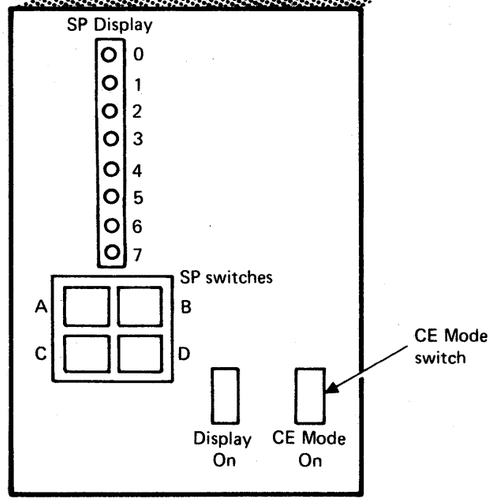
Operator Console



Processor



CE Panel



For details refer to STM, section 4: 'Support Processor Display'.

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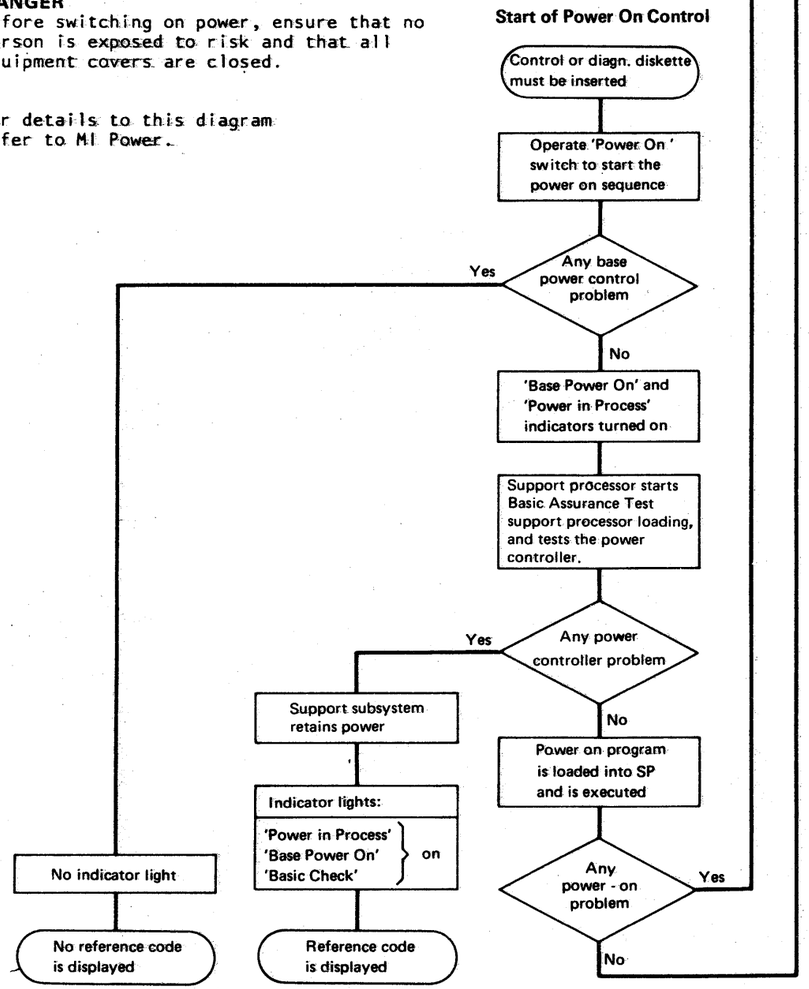
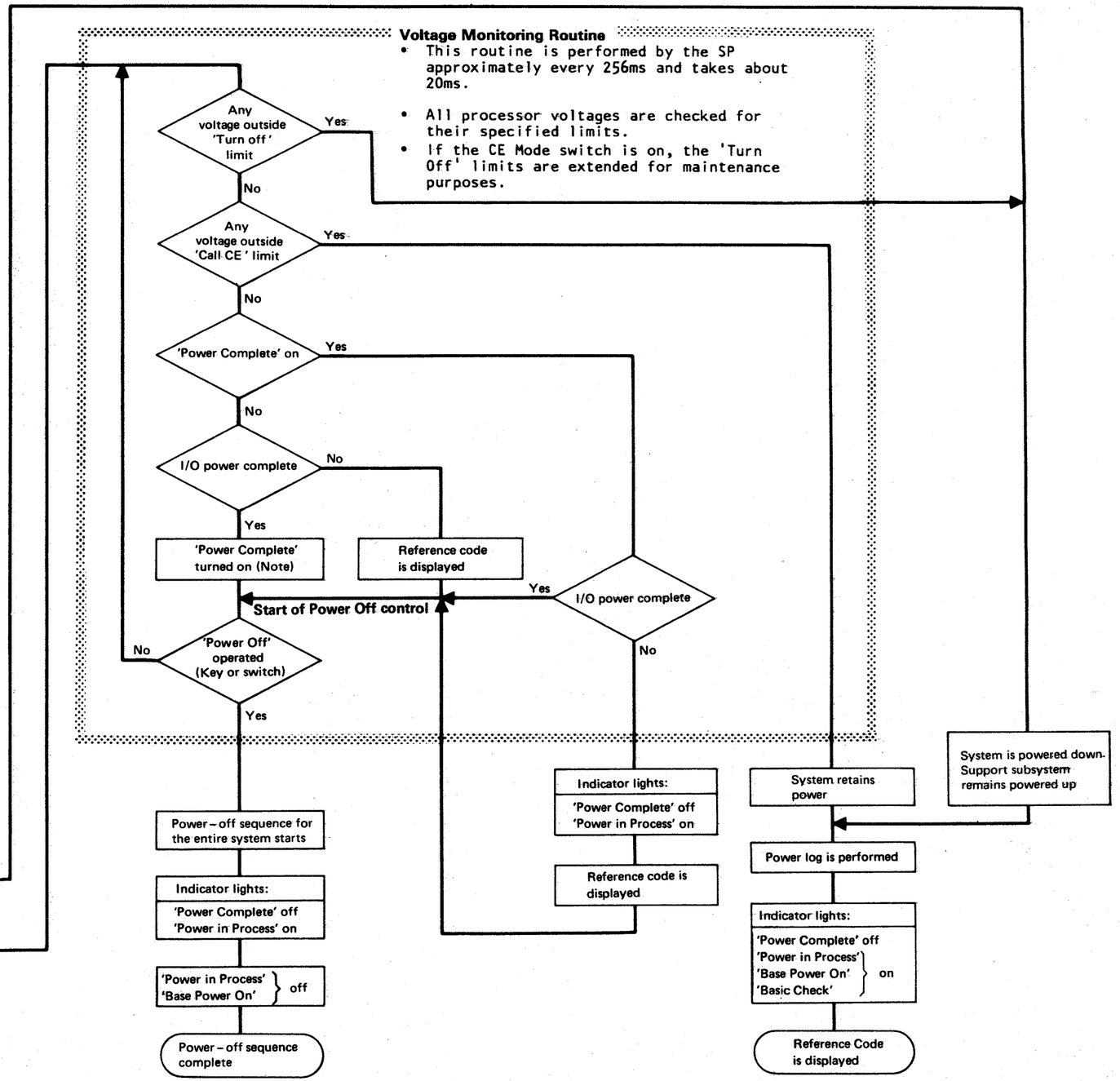
Running the System (Principle)

This chart shows how power is turned on and how it is monitored. The chart also shows power removal and symptoms in case of power failure.

DANGER
Before switching on power, ensure that no person is exposed to risk and that all equipment covers are closed.

For details to this diagram refer to MI Power.





Note: PROGRAM LOAD is displayed.
To get the 'Maintenance/Service Program Selection' picture, hold ALT key pressed while pressing DIAG key.

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Program Execution and Interruption

The execution of machine language programs is controlled by program status words (PSWs). There are old, current, and new PSWs. With program load, these PSWs are also loaded. After loading is complete, a 'current' PSW points with its instruction address field to the first instruction to be executed. During execution of the program the instruction address in the PSW is continuously updated, so that it points always to the next instruction to be executed.

There may be different reasons to interrupt the execution of a program:

Machine check interrupt
Supervisor-call interrupt
Program check interrupt
External interrupt
I/O interrupt
Restart

With any of these interruptions the current PSW becomes an old PSW and is set into a predetermined storage location. The cause of the interruption is identified by an interruption code and/or information stored during the interruption. A new PSW from a defined storage location becomes the current PSW and this PSW controls now the 'handling' of the interruption. Upon completion of this interrupt-handling the PSW now being current becomes an old PSW and is restored in its pre-determined storage location. If no other reason for an interruption became active, the previously stored PSW becomes again the current PSW which allows the PU to continue processing of the interrupted program. This PSW hierarchy allows the PU to execute different programs.

Operation Modes

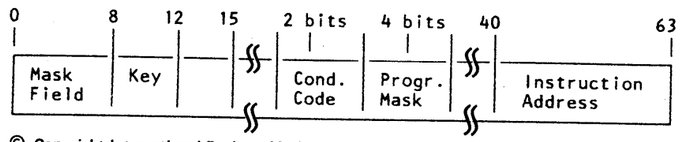
The PU may run in two operation modes:

- BC mode (basic control)
- EC mode (extended control)

which is indicated in the PSW, bit 12. The PSW format for both operating modes is different.

PSW Format

The picture shows a simplified format which is valid for either mode.



AAG1500

- The mask field in BC mode contains the channel mask; in EC mode the system mask.
- The key field contains the protection key. This key is compared with the key in the key storage. Upon compare equal BSM store operations are allowed. Upon compare equal or an all zero key BSM fetch operations are allowed.
- The 4 bits following the key field define:

  EC/BC mode
  Machine check
  Wait state
  Problem state

- The condition code field indicates four different conditions (00,01,10,11) used for branching. The setting of this condition code depends on the type of instruction.
- The program mask field contains:

  Fixed point overflow mask
  Decimal overflow mask
  Exponent underflow mask
  Significance mask

- The last three bytes of either PSW contain the instruction address, which points always to the next instruction to be executed.

Other Control Words

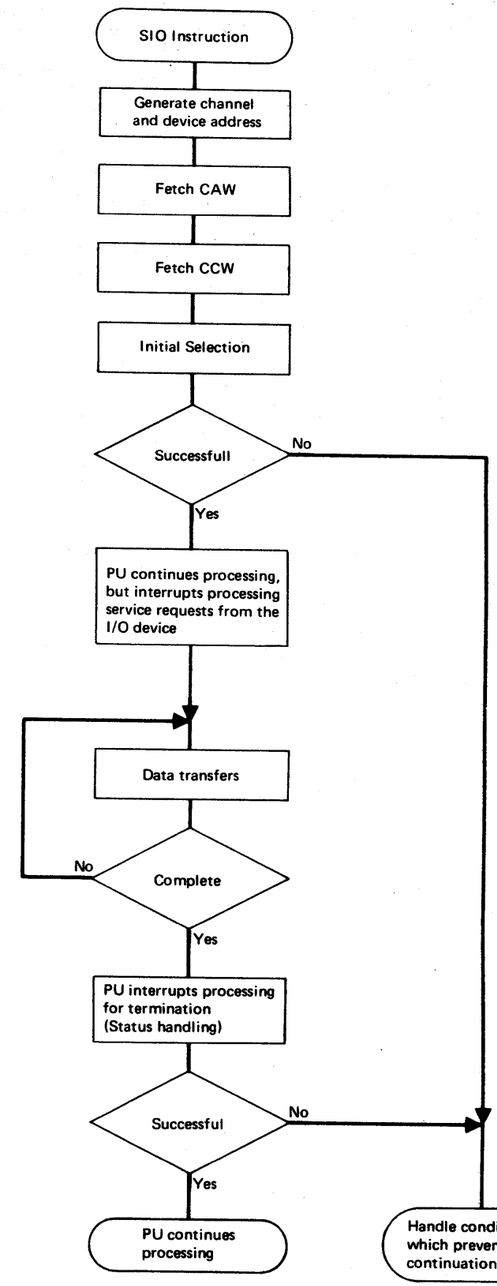
In addition to the PSW, there are some more control words used in connection with I/O operations:

- Channel Address Word (CAW) which points to a command which in turn is to be executed by the addressed I/O device.
- Channel Command Word (CCW) which contains the command and the I/O (data) address for the I/O operation to be executed by the addressed I/O device.
- Channel Status Word (CSW) which contains status information on the execution of an I/O operation.

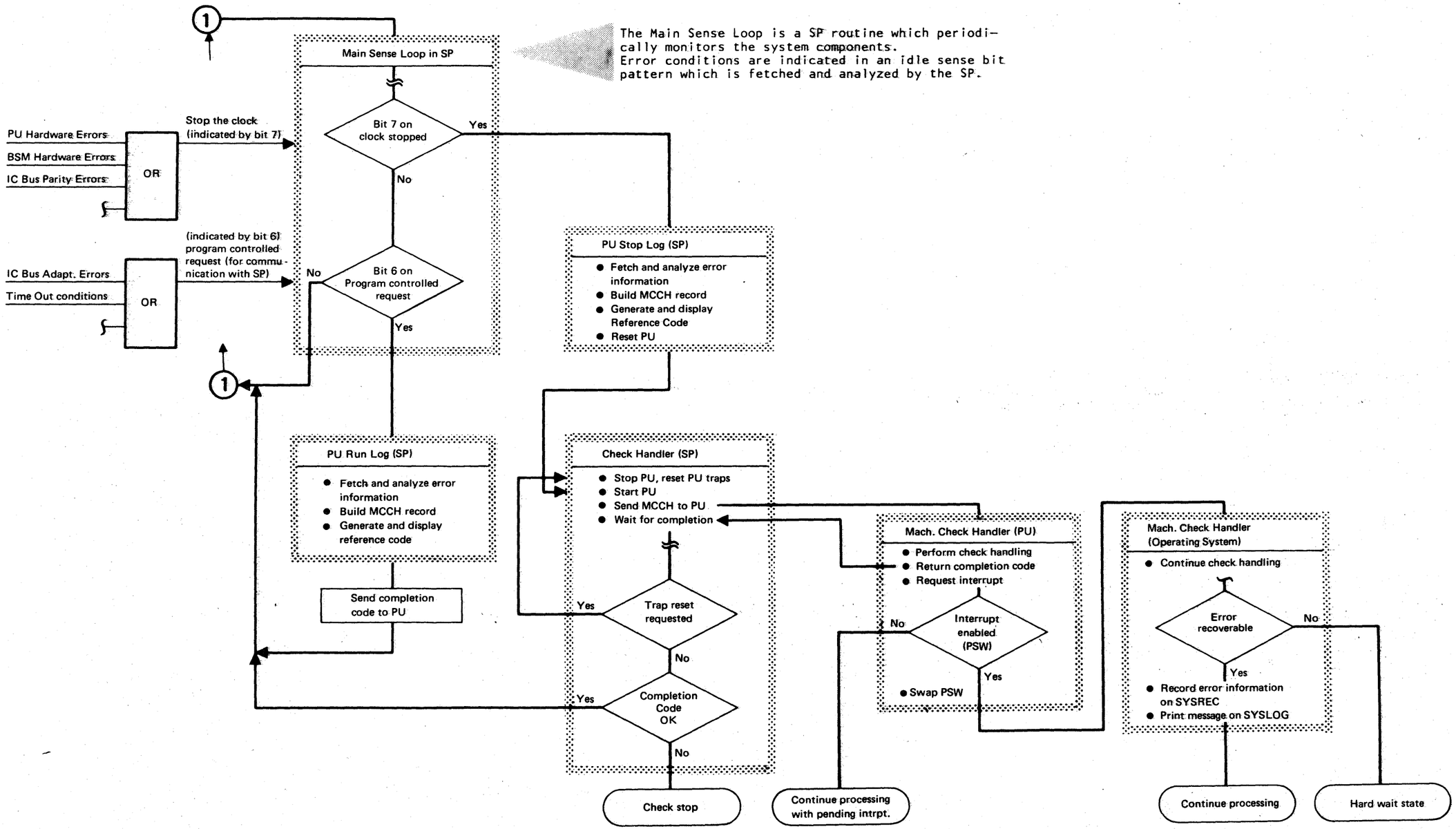
Refer to the System Reference Summary for more information on:

Instruction Formats and Types
PSW Formats
CAW, CCW, CSW Formats
Condition code setting

Principles of an I/O Operation



PU to SP Communication in Case of Errors



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General System Information, Section 2: Maintenance Concepts

Table of Contents

Maintenance Concept

- Maintenance of the system is based on continuous monitoring by the support processor.
- When an error is detected, the failure symptoms are analyzed automatically and a reference code is generated. This reference code is used as MAP entry. Troubleshooting is guided by MAPs.
- Preventive Maintenance (see page 2170)

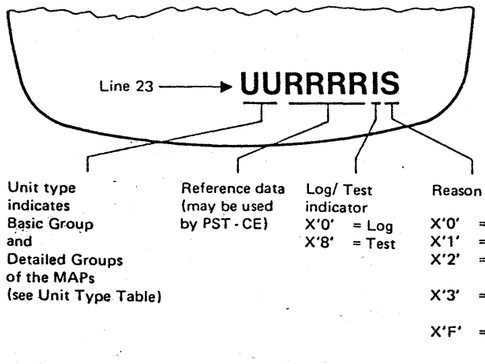
Reference Code

- The reference code is displayed on the screen, and is also logged onto the control diskette.
- The reference code provides:
  The entry to the MAPs, or IRECA,
  Reference data, and feedback to
  the development laboratory.

MAPs

- The MAPs contain either the name of the failing FRU (field replaceable unit), or procedures for further analysis down to the FRU.
- The MAPs also direct to diagnostic programs used for fault location, and to verify that the failing FRU was found and replaced correctly.
  A short description of the diagnostic programs and their handling procedures is provided in Section 4 of the Supplement to MAPs (STM).

Reference Code Layout

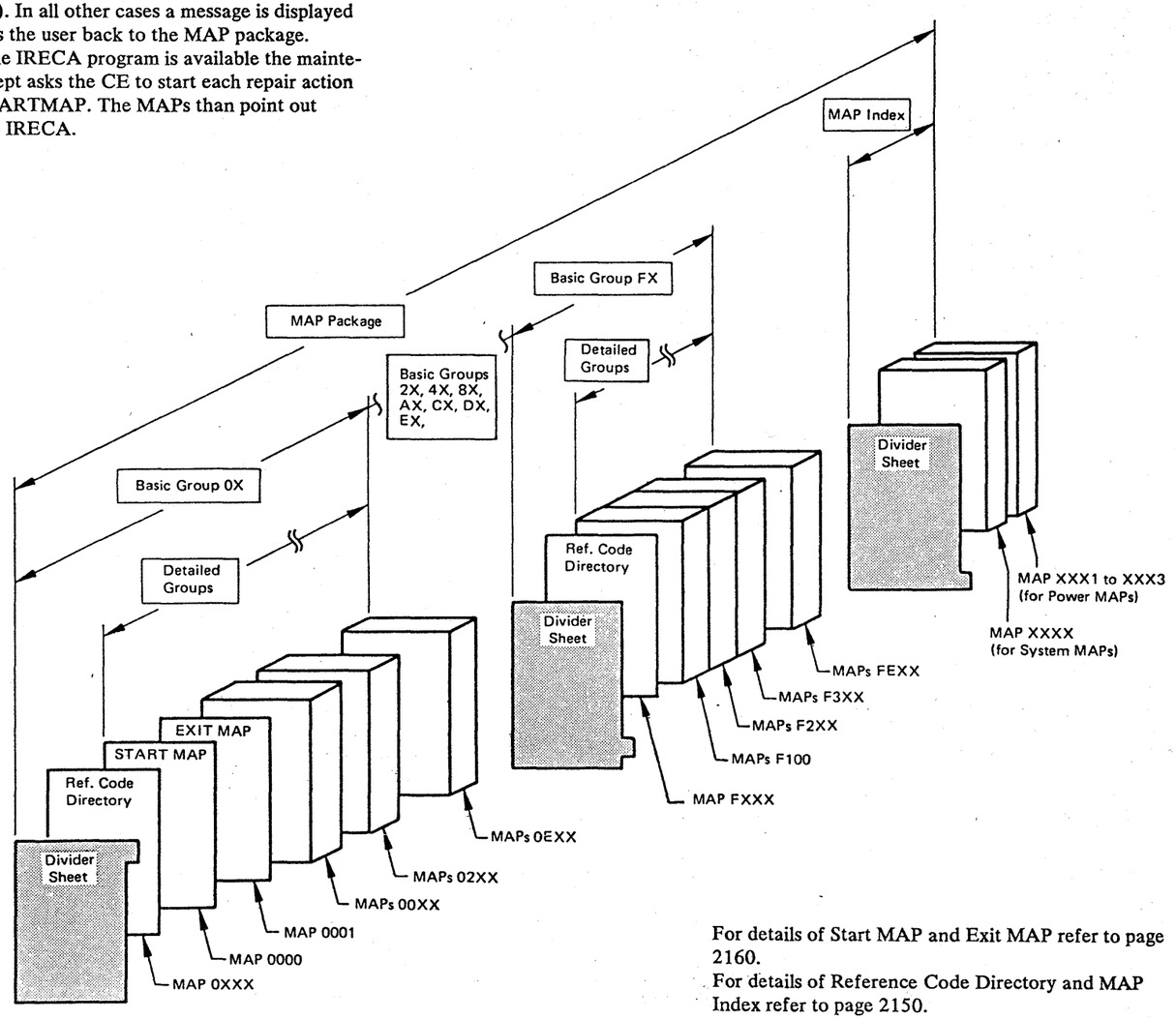


IRECA

The integrated reference code analysis program (IRECA) assist the CE on his way through the MAPs. The program should not be used as a stand alone tool. The IRECA program resides on the diagnostic diskette. After selection any reference code generated by the system can be entered for analysis. But only those reference codes lead to an analysis result which do not need further manual intervention (such as signal probing). In all other cases a message is displayed which refers the user back to the MAP package. Although the IRECA program is available the maintenance concept asks the CE to start each repair action with the STARTMAP. The MAPs than point out when to use IRECA.

Organization of the MAP Package

- The MAP package consists of a number of basic groups and the MAP Index. The basic groups are separated by divider sheets.
- Each basic group consists of several detailed groups (see Unit Type Table).
- Each detailed group contains the MAPs associated with the particular reference code.



For details of Start MAP and Exit MAP refer to page 2160.
For details of Reference Code Directory and MAP Index refer to page 2150.

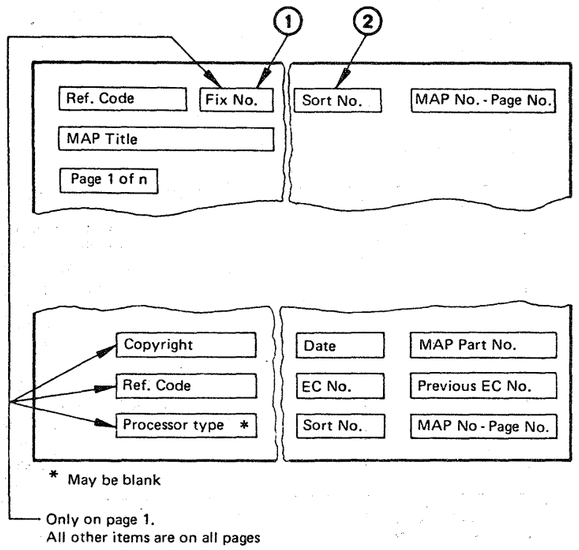
Unit Type Table

BASIC GROUP	DETAILED GROUPS	REMARKS
0X = No reference code on screen	00 = Introduction, Start MAP, Exit MAP, Call for Support MAP 01 = Procedures in STM 02 = Power problems 04 = IML problems 06 = Operator console failures 08 = Support subsystem 0C = Miscellaneous 0E = Operating system (DOS, EREP)	
2X = IC–Bus	None	4321 and 4331–1
3X = IC–Bus	None	4331–2 and 4331–11
4X = PU–BSM	49 = PU–BSM	4321 and 4331–1
	4B = PU–BMS	4331–2 and 4331–11
8X = Channels	80 = BMPX 1 81 = BMPX 2 82 = HSC 84 = MPX 88 = CA channel checks 89 = CA unit checks	
AX = I/O Subsystem	A0 = Processor bus and adapter interfaces A1 = Processor A2 = I/O BBA (1) A3 = SCL adapter A8 = Loop adapter AA = 5424 adapter	

BASIC GROUP	DETAILED GROUPS	REMARKS
CX = Disk/Tape adapters	C0 = CTLI and interface adapters C1 = FTA1–CTLI C2 = FTA2–CTLI C3 = FTA3–CTLI C4 = FTA1 C5 = FTA2 C6 = FTA3 C8 =) reserved C9 =) CA =)	
DX = Disk/Tape ILTs	D0 = ILT monitor D8 = 8809 D9 = 3330 DA = 3340 DB = 3344 DD = 3310 DE = 3370	
EX = System related problems	E0 = IML problems / power on reset E1 = Timer damage E4 = PU programmed clock stop E6 = Customer manual operations E8 = Ambient recording EA = Internal program checks (excluding SPIL)	
FX = Support Subsystem	F0 = Processor bus and adapter interfaces F1 = Support Processor F2 = SP BBA (0) F3 = SBA/SCL adapter F4 = Transmit/receive F5 = SPIL program checks F7 = Power system F8 = Remote support F9 = DCA I/O counter overflow FC = Log–in and idle programs FD = Diskette drive adapter FE = Utilities	

MAP Page Layout

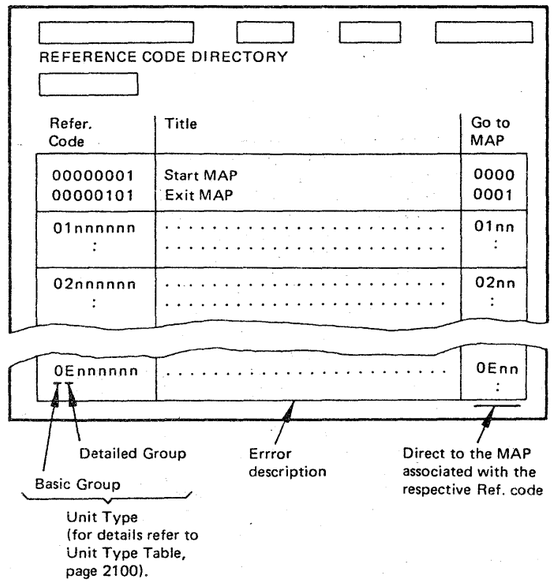
Common Parts



Reference Code Directory

The reference code directory in front of each basic group of the MAP package is used to find the appropriate MAP for troubleshooting.

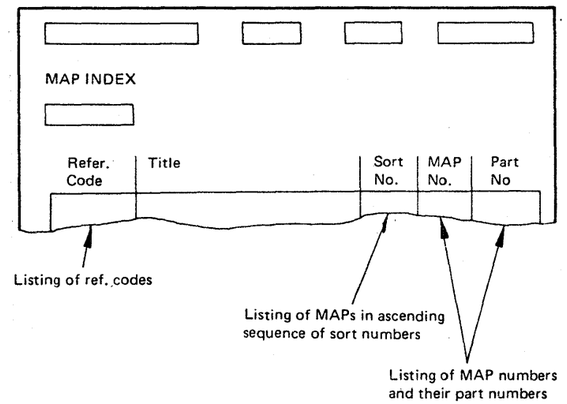
Example:



MAP Index

The MAP index is a table of contents of the entire MAP package. It is subdivided into two groups:

The first group is a listing of all system MAPs,
the second group is a listing of all power MAPs.



(1) Fix Number

- Shows the number of fixes of the MAP. The CE has to update this number, whenever he inserts a fix.
- The fix number of a MAP updated by an engineering change shows the latest fix.

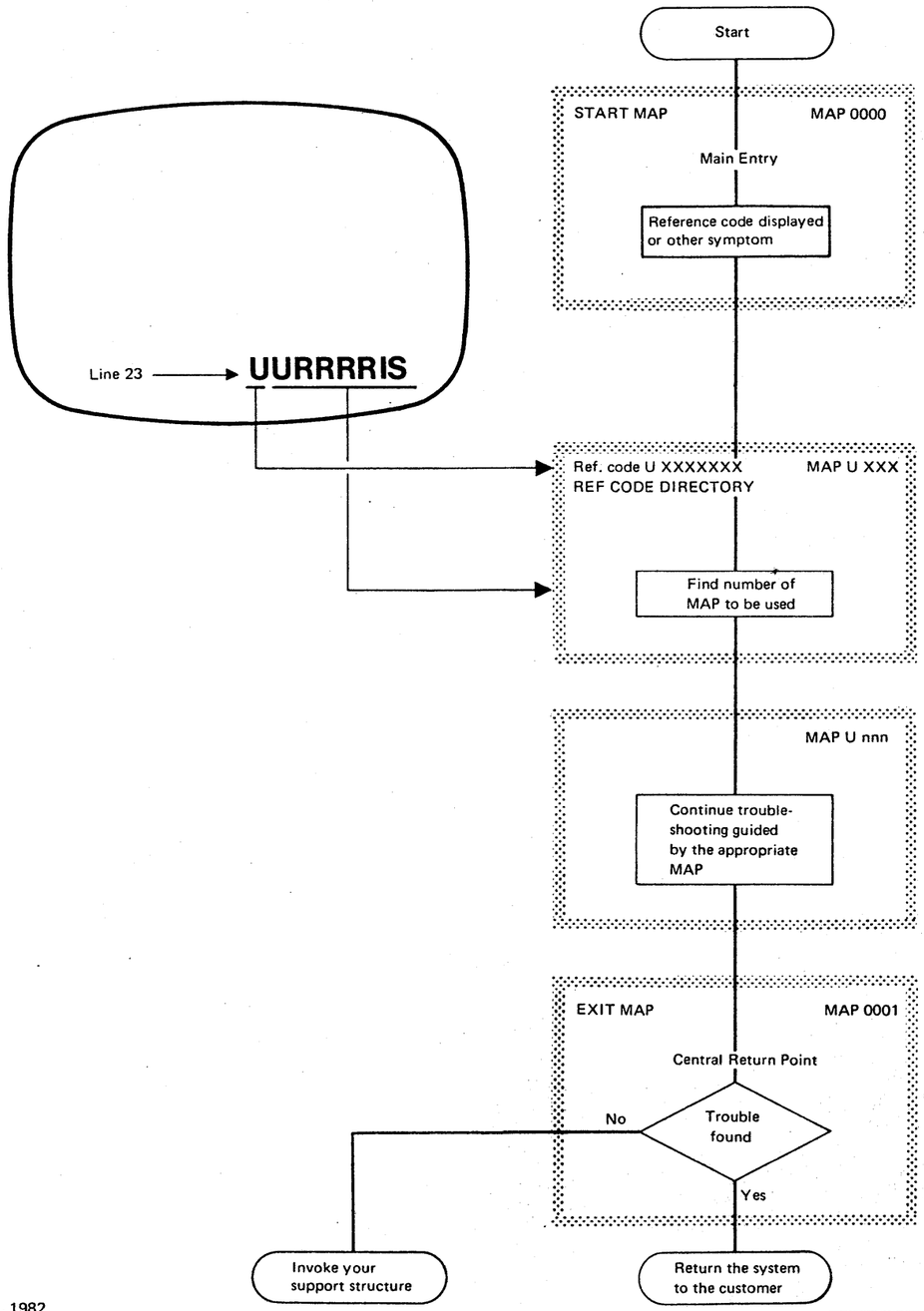
(2) Sort Number

- The sort number is used to insert additional MAPs in the correct sequence.

The other items are self explanatory.

How to Use the MAPs

- Start troubleshooting always using the START MAP.
- Terminate troubleshooting always using the EXIT MAP.



The Start MAP contains:

- The main guidance and distribution to all other MAPs.
- The 'main entry' with information for troubleshooting.
- The start point for troubleshooting.

Whenever a signal has to be probed, use the General Logic Probe (GLP), described in Section 4 of this manual.

The Exit MAP contains:

- The 'central return point' after all CE activities.
- Procedures for final verification of all maintenance activities.
- Instructions to invoke support for a solution, if the MAPs fail.

Preventive Maintenance

The only preventive maintenance on the central electronic complex of the system has to be done on the air filters.
These filters are located in the front and back cover and should be maintained at least once a year. To do a proper maintenance the filters must be removed since dust and other particles which reduce air throughput collect on the inner side, see Figure B.
Clean or replace the filters.
In a very contaminated enviroment cleaning or replacement may be necessary more often.
After you have cleaned or replaced the filters make an entry in the inspection table, see Figure A.

Inspection Table

INSPECTION DATE	REPLACED	CLEANED
Air filter part no. 8483722		

Figure A

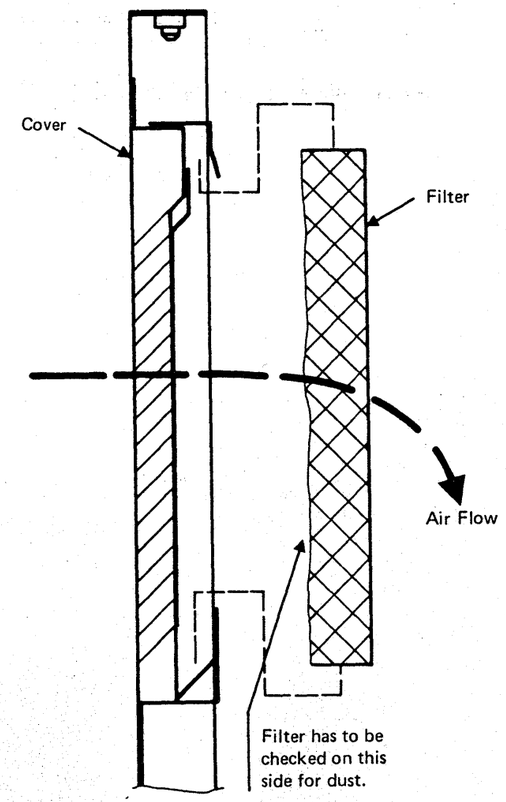


Figure B

General System Information, Section 3: Diagnostic Information

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Log

Principle

- Errors detected in the CPC (Central Processing Complex), and CA unit checks are logged on the control diskette. The control diskette contains two log areas:
  'Reference code log area' and 'detailed log area'.
  All logs are stored in the 'reference code log area'.
  A number of logs contain additional error information which is stored in the 'detailed log area'.
  Reference code logs and detailed logs can be displayed by the M/S Program Selection.

- Machine/ and channel-checks generated from CPC error data, and unit checks (except CA unit checks) are recorded by the operating system and can be fetched by EREP.

Logging of Errors in the Central Processing Complex

The CPC includes the PU, BSM, IC, IC bus, adapters, attachments, and all buses located within the processor.

Any error detected within the CPC is reported to the support processor. The support processor executes the corresponding log analysis program. As a result the following information is stored on the control diskette:

- Last detailed log per unit (last log raw data)
- Pointer to last detailed log
- Reference codes of all logged errors
- Total count per reference code entry
- Date of last error per unit
- Date of last erase per unit

Any date is displayed in the following format:
MM DD HH MM
(month/day/hour/minutes)

Reference Code Log Area

This area contains all reference code logs collected since the last erase date, representing a system log overview.

Up to 148 different log types can be stored in this area. If the same log type occurs several times (same reference code), no new entry is made, but only the fields for ADD INFO, COUNT, DATE, and TIME of the first entry are updated. The counter per log type may be 1 to 255.

If there is space left for only 10 entries or less in this log area, a warning REF CODE LOG AREA FULL is displayed on line 23. If the entire area is filled, the last position is always overloaded.

The reference code log area also contains the area for the 'Log Distribution Statistic'.

Reference Code LoG Display

The reference code log display consists of two parts:

Log distribution statistic,
Reference code log.

Log Distribution Statistic

Keeps tracks of the logging history. A reference code pre-analysis is performed to offer the correct reference code for entering the MAP.

(CA unit check logs do not update the log distribution statistic.)

Detailed Log Area

Each log type has its individual log area:

Header	last log raw data	compressed log area.

Header layout (common for all logs):

Name of log type e.g. PU, FTA etc.
Date of last log erase } contains zeros
Date of first log } if TOD was
Date of last log } not available
Total count of logs for this log type
Last reference code.

Last log raw data: error data from the failing unit during the last log-in

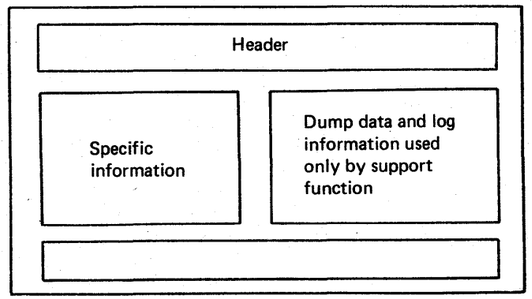
Compressed log area: collected data for the total number of logs for this log type.

Dump Type Logs

The following detailed logs are dump type logs:

BMPX= Block multiplexer channel
MPX = Multiplexer channel
IOC = I/O Controller
BBA0 = BBA0
BBA1 = BBA1
PUPR = PU Program check
SPIL = SP Interpreter check

Dump type log display



General System Information, Section 4: Tools

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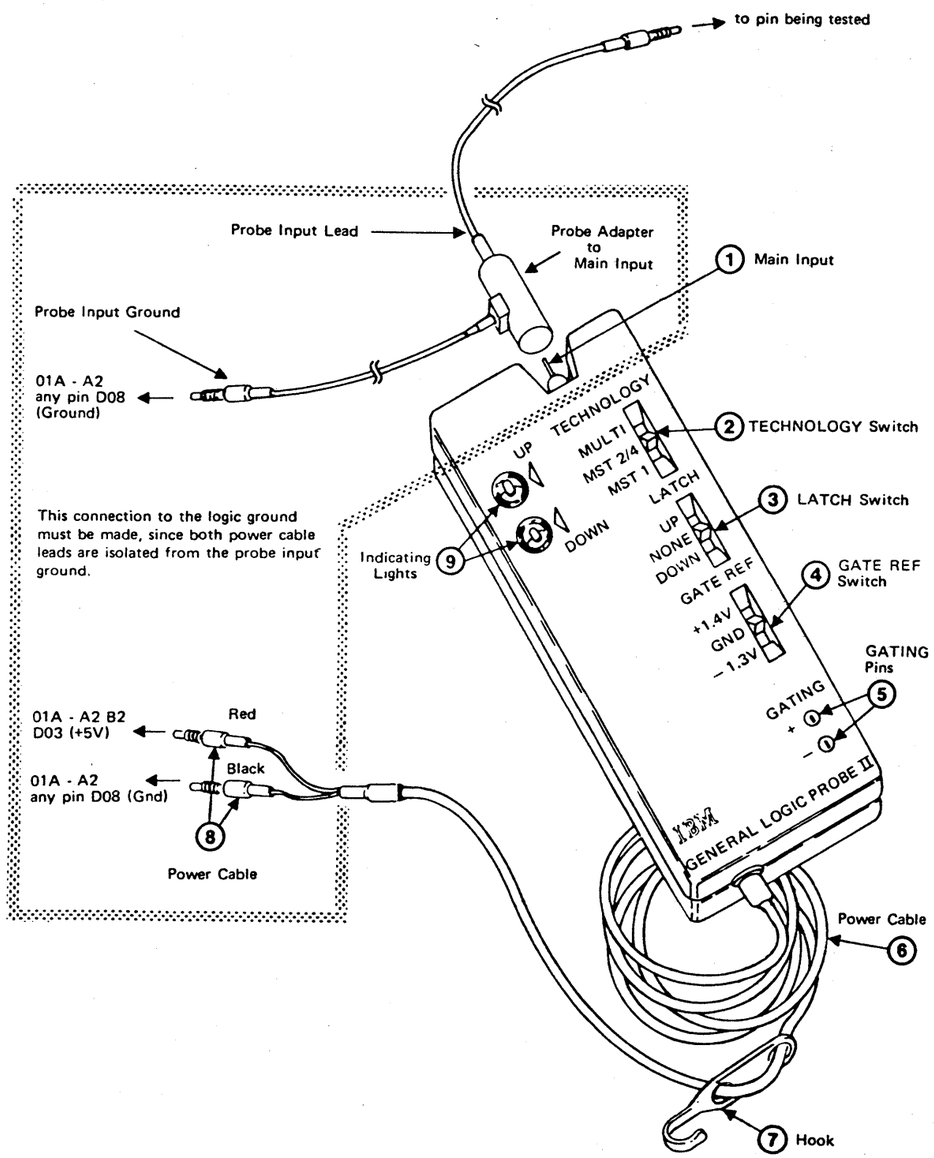
General Logic Probe II (GLPII)

The GLPII is a tool used to detect logic signals. Its operation and maintenance are described in detail in the 'General Logic Probe II Manual', SY27-0127.
The GLPII can be used to check signals of two technologies in the system (Dutches and VTL), which are compatible; therefore the following guide applies to both technologies. It does not replace or override the instructions in the GLPII manual.

Preliminary Setup with Checking for Correct Operation

1. Connect cables as shown.
2. Set TECHNOLOGY switch 2 to MULTI.
3. Connect probe input lead to 01A-C2 F2 U02 (+osc. out):
   Both indicating lights 9 have to be on.
4. Connect probe input lead to 01A-B2J03, or D03, or U03 (+5V). Up indicator should be on. If the down indicator is on, it usually indicates a failure of the probe input around lead.

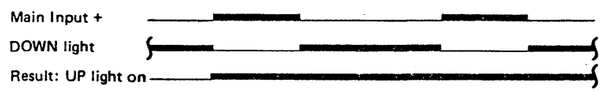


Latch Function

1. Perform preliminary setup with checking for correct operation.
2. Set TECHNOLOGY switch 2 to MULTI.
3. Set LATCH switch 3 to NONE.
4. Connect probe input lead to pin being tested.
5. If there is a valid static logic condition present, one of the indicator lights 9 is turned on:
   - If the UP light is on, set the LATCH switch to DOWN,
   - If the DOWN light is on, set the LATCH switch to UP.

   the light, which is off will be turned on, and both lights stay on.

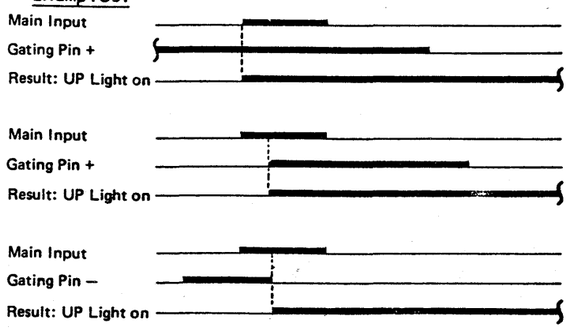
Example: The DOWN light was turned on in step 5, therefore the LATCH switch has been set to UP.



Latch Function with Gating

1. Perform preliminary setup with checking for correct operation.
2. Set TECHNOLOGY switch 2 to MULTI.
3. Set LATCH switch 3 to the expected level.
4. Set GATE REF switch 4 to +1.4 V.
5. Connect the board pin used for gating to the appropriate GATING pin 5 .
6. Connect probe input lead to the pin being tested.
7. If there is no signal on the gate, the probe operates in the normal way.
   If, however, a signal is on the gate at the same time, a signal is present on the main input, the appropriate indicator light 9 is turned on.

Examples:



Abbreviation List

Abbr.	Abbreviation
AC	Alternating Current
ACA	Auto Call Adapter
ACC	Adapter Common Card
ACO	Auto Call Originator
ACT	Action
ACU	Auto Call Unit
ADC	Adapter Card
Addr.	Address
ADI	Address In
adj.	adjust, adjustment
ADO	Address Out
Adpt.	Adapter
AFL	Automatic Field Length
ALD	Automated Logic Diagram
Aligner	allows selection of individual bytes in a full word
ALU	Arithmetic and Logic Unit
AMD	Air Moving Device
ANR	Alphanumeric Replacement
AR	Attention Routine
AR	Amplifier
AS	Analog Sense
ASC	Adapter Specific Card
ASCP	Automatic System Checkout Program
ASR	Adapter Status Register
Atchmt.	Attachment
BA	Bus Adapter
BAC	Buffer Address and Control
BACR	Buffer Address Compare Register
BAT	Basic Assurance Test
BBA	Bus to Bus Adapter
BC	Basic Control Mode
Bd	Board
Bfr.	Buffer
BIB	Bus In Buffer
BIR	Bus In Register
Bksp.	Backspace
BMPX	Block-Multiplexer Channel
BOB	Bus OUT Buffer
BOR	Bus-Out Register
BPC	Base Power Control
BSC	Binary-Synchronous Control
BSM	Basic-Storage Module
BSR	Basic-Status Register
BSU	Bus Switching Unit
Bwd.	Backward
C-Reg.	Control Register
CA	Communications Adapter
CAC	Common Adapter Code
Cap.	Capacitor
CAW	Channel Address Word
CB	Circuit Breaker
CBG	Check Bit Generator
CC	Chain Command
CC	Condition Code
CCA	Common Communications Adapter
CCP	Customer Control Panel
CCW	Channel Command Word
CD	Chain Data
Cd	Card
CDF	Console Disk File
CDFA	Console Disk File Attachment
CDR	Characteristic Difference Register (floating point)
CDS	Central Data Switch
CE	Customer Engineer
CE	Channel End
CET	Central European Time
Char.	Character
CHK CTRL	Check Control
CKD	Count, Key, Data
Ckt.	Circuitry, Circuit
Clk.	Clock
Cmd.	Command
CMO	Command Out
Comp.	Comparator, Compare
CNCL	Cancel
CNSL	Console
Cnt.	Count(er)
CNTLD	Controlled
COB	Card on board
COER	Correctable Error Request
Con.	Connector
Cont.	Contact
COS	Call originate status
CP	Circuit Protector
CPC	Central Processing Complex
CRC	Cyclic Redundancy Check
CRT	Cathode Ray Tube
CS	Cycle Steal
CS	Control Storage
CSAR	Control Storage Address Register
CSB	Control Storage Buffer
CSCB	Cycle Steal Control Buffer
CSCW	Cycle Steal Control Word
CSW	Channel Status Word
Ctrl.	Control
CTS	Clear to send
CU	Control Unit
DAA	Data Access Arrangement (non IBM equipment)
DAC	Digital Analog Converter
DAD	Device Adapter
DASD	Direct Access Storage Device
DAT	Dynamic Address Translation
Data Mover	Hardware-part of the integrated channel
DBR	Data Buffer Register
DC	Direct Current
DCA	Display (Device) Cluster Adapter
DCD	Data Carrier Detect
DCI	Director-Controller Interface
DDA	Direct Disk Attachment
DE	Device End
Dec.	Decoder, Decimal
Del.	Delay
Descr.	Description
Diagn.	Diagnostics
DIB	Data In Buffer
Dim.	Dimension
Dir.	Directory, Direction
Displ.	Display
Disc.	Disconnect
Div.	Division, Divide
DLAT	Directory Look-Aside Table
DLS	Data Local Storage
DM	Data Mover
DOB	Data Out Buffer
DOS	Disk Operating System
DOS/VS	Disk Operating System/Virtual Storage
DOS/VSE	... Extended
DR	Driver
DS	Digital Sense
DSR	Data Set Reading
DTE	Data Terminal Equipment
DTM	Data Transfer Mechanism
EC	Engineering Change
EC	Extended Control Mode
ECC	Error Correction Code
EIA	External Interface Adapter
El.	electrical, electronic
EM	EMC Monitor
EMC	Electromagnetic Compatibility
Emu.	Emulator
ENBL	Enable
EPO	Emergency Power Off
EREP	Environmental recording, editing, and printing
ERR	Error
ESD	Electrostatic Discharge
ESDM	Electrostatic Discharge Monitor
EXT	Extension
Ext.	External
Extr.	Extract(ion)

Abbreviation List (continued)

FA	Functional Adapter
FA	File Adapter
FALI	Fetch Aligner
FBA	FB-512 (All fixed block references)
FBF	FB-512 (All fixed block references)
FBM	Field Bill of Material
FCS	First Customer Shipment
FFBM	Feature Field Bill of Material
FFI	Field Feature Index
Fig.	Figure
FL	Field Length
FL	Flip Latch
FP	Floating Point
FSC	Field Support Center
FTA	File/Tape Adapter
FW	Fullword
Fwd.	Forward
Gen.	general
Gnd.	Ground
Grd.	Ground
GPR	General Purpose Register
GSI	General System Information
HEX	Hexadecimal
HO	Hold Out
HW	Halfword
I/O Disk.	Input/Output Diskette
IAR	Instruction Address Register
IC	Integrated Channel
ICA	See CA
Id.	Identifier
IFC	Interface Card
IFL	Initial Field Length
ILC	Instruction Length Count
ILI	Incorrect Length Indication
ILT	In Line Test(s)
IML	Initial Microcode Load
IMPL	See IML
Ins.	Insert(ion)
Inst.	Install(ation)
Instr.	Instruction
Int.	Interval, Internal
INT	Integrator
IOAR	Input/Output Address Register
IOC	I/O Controller (Proc. of I/O Subsystem)
IPL	Initial Program Load
IPO	Instant Power Off
IPS	Integrated Power System
INTR	Interrupt, Interruption
Irpt.	Interrupt, Interruption
I-Step	Instruction step (mode)
ITC	Individual Table of Contents
K	Contactor
KB	Keyboard
LA	Loop Adapter
LB	Latch Byte
LC	Length Count
LCA	Local Channel Adapter
LCL	Line Channel Logout
LE	Leading Edge
LED	Light Emitting Diode
LF	Line Filter
LM	Latch Module
Loc.	Location
LRC	Longitudinal Redundancy Check
LS	Local Storage
LSAR	Local Storage Address Register
Lt	Latch
M-Reg.	Modify Register
MA	Maintenance Adapter
MACR	Microinstr. Address Compare Register
Man.	Manual
Man.Ops.	Manual Operations
MAP	Maintenance Analysis Procedure
Max.	Maximum
MC	Machine Check
MCCH	Mchine Check Handler
MCIC	Machine Check IRPT Code
Mech.	mechanical
MFCU	Multifunction Card Unit
MFI	Machine Feature Index
MI	Maintenance Information
MI-OPC	Machine Instruction OP-Code Register
MIBU	Machine Instruction Buffer
Min.	Minimum, Minute
Mod.	Model
MPX	Multiplexer Channel
MS	Main Storage
ms	Millisecond
MSD	Main Storage Directory
MSSS	Maintenance/Service Sub-System
MSVP	Maintenance/Service Processor
MVS	Multiple Virtual Storage
N	Inverter
Nom.	Nominal
NPRO	Non Process Runout
NSAT	Non-Sequential Address Table
OC	Overcurrent
OCP	Operator Console Panel
Ofl.	Overflow
Op.	Operand, Operation, Operator
Oper.Ctrl.	Operation Control The operation control consists of two components, the hardware component and the microcode component. These two components (mainly the micro-code component) are needed to control the execution of the various operations.
Op.-Reg.	Operation Register
OPI	Operational In
OS	Operating System
Osc.	Oscillator
OTOCH	Original time out, count high
OV	Overvoltage
P/N	Part Number
PBC	Page Boundary Crossing
PC	Parts Catalogue
PC	Parity Check
PC	Power Controller or Power Complex
PCC	Power Control Compartment
Pch.	Punch
PCI	Program Controlled Interruption
PCR	Program Controlled Request
PCS	Power Controller Sense
PCUR	Program Controlled Unit Request
PER	Program Event recording
perm.	permanent
PG	Parity Generation, Parity Generator
Pgm.	Program
PLA	Programmable Logic Array
PM	Preventive Maintenance
PP	Peak to Peak
Prim.	Primary
Prod.	Product
Prtr.	Printer
PS	Power Supply
PS	Pico Store
PST-CE	Product Support Trained Customer Engineer
PS 0	Pico Store Left
PS 1	Pico Store Right
PSAR	Pico Storage Address Register
PSW	Program Status Word
PT-CE	Product Trained Customer Engineer
Pt.	Point
Ptr.	Pointer
Pty.	Parity
PU	Processing Unit
PUSIC	PU Support Interface Control
PV	Parity Valid
Pwr.	Power

Abbreviation List (continued)

RAM	Random Access Memory
Rd.	Read
Rec.	Record
Reg.	Register
Ref.	Reference
Rem.	Remote, removal
Rep.	Repair
Requ.	Request
Res.	Reset
Res.	Resistor
RLK	Remote Link
RLP	Remote Loop
RMS	Root Mean Square
ROM	Read Only Memory
ROS	Read Only Storage
RQI	Request In
RSP(L)	Recommended Spare Parts (List)
RTS	Request to Send
S-Reg.	Sense Register
SAT	Sequential Address Table
SB	Support Bus
SB	Sense Byte
SBA	Support Bus Adapter
SC	Sense Card
SCA	Standard Channel Adapter
SC-Reg.	Shift Control Register
SCL	Support Control Logic
SCR	Silicon Controlled Rectifier
SDLC	Synchronous Data Link Control
Sec.	Second(ary), Section
Sel.	Select(ion)
Sep.	Separator, separate
Sequ.	Sequence
SF	Support File
SI	Support Interface
Sig.	Signal
SL	System Library
SLI	Select In
SLO	Select Out
SM	Sense Module
SP	Support Processor
SPI	Standard Power Interface
SPIL	Support Processor Interpreter Language
SPO	Suppress Out
SPR	Support Processor Request
SRL	Shift Register Latch
SRL	(System Reference Library) see SL
SS	Single Shot
SSD	Support Subsystem Diskette
STALI	Store Aligner
Std.	Standard
Stg.	Storage
STI	Status In
STM	Supplement to MAP's
SU	Shift Unit
SVI	Service In
SVO	Service Out
SVS	Single Virtual Storage
SX	Selector Channel
SYNC	Synchronous
TA	Tape Adapter
TB	Terminal Block
TD	Time Delay
TE	Trailing Edge
Term.	Terminator
TH	Thermal
THSW	Thermal Switch
TIR	Tag In Register
TO	Time Out
TOC	Table of Contents
TOD	Time of Day
TOR	Tag Out Register
TP	Teleprocessing
TP	Testpoint
Tr.	Transformer
TRD	Trap Request Demand
Trap	Forced Microprogram Branch
UCS	Universal Character Set
UCW	Unit Control Word
UMC	Usemeter and Control
USI	Unit Support Interface
UV	Undervoltage
Var.	Variable
VD	Voltage Divider
VF	Voltage Failure
VFO	Variable Frequency Oscillator
VIRT	Virtual
VRC	Vertical Redundancy Check
VS	Virtual Storage
VTOC	Volume Table of Contents
Wr.	Write
Xfer	Transfer
Xlator	Translator

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