MNS *i*S Motor Control Center
Interface Manual Modbus
System Release V7.0

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Table of content

General

Target Group

This document describes communication and control interfaces used in MNS *i*S.

The manual is primarily intended for those requiring information on accessing information and data provided from MNS *i*S. Furthermore the document provides information for integration of MNS *i*S as Fieldbus component into PLC or higher level Process Control Systems to control system and application engineers.

It is assumed that the reader of this manual is familiar with basic terms of Fieldbus and control communication (e.g. basic knowledge about PROFIBUS, Modbus etc.).

Use of Warning, Caution, Information and Tip icon

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The electrical warning icon indicates the presence of a hazard that could result in *electrical shock.*

The warning icon indicates the presence of a hazard that could result in *personal injury.*

The caution icon indicates important information or warnings related to the concept discussed in the text. It might indicate the presence of a hazard that could result in *corruption of software or damage to equipment/property.*

The information icon alerts the reader to pertinent facts and conditions.

The tip icon indicates advice on, for example, how to design your project or how to use a certain function

Although **Warning** notices are related to personal injury, and **Caution** notices are associated with equipment or property damage, it should be understood that the operation of damaged equipment could, under certain operational conditions, result in impaired process performance leading to personal injury or death. It is, therefore, imperative that you comply fully with all **Warning** and **Caution** notices.

Terminology

List of the terms, acronyms, abbreviations and definitions that the document uses.

Abbreviation	Term	Description
	Aspect Object	ABB technology. An Aspect Object is a computer representation of a real object such as a pump, a valve, an order or a virtual object such as a service or an object type. An Aspect Object is described by its aspects and is organized in structures.
	Alarm	Alarm is defined as status transition from any state to abnormal state. Status transition to abnormal state can be data crossing over the pre-defined alarm limit.
	Bus Local	A Control Access term describing that the M*Control* accepts its commands from a device on the switchgear control network, e.g. the Web Interface, M*View*.
COTS	Commercial off the shelf	Commercial off the shelf product, term to describe products available on the market, ready to use
DCS	Distributed Control System	See also PCS
DTM	Device Type Manager	Software module used to manage devices via Fieldbus (e.g. PROFIBUS) using frame application environment (e.g. PactWare, ABB Fieldbus Builder etc.)
Eth.	Ethernet	Ethernet is a local area network (LAN) technology. The Ethernet standard specifies the physical medium, access control rules and the message frames.
	Event	An event is a status transition from one state to another. It can be defined as alarm, if the state is defined as abnormal or as warning as a pre-alarm state.
FD	Field Device	Term for devices connected to the Fieldbus (e.g. motor control units or circuit breaker protection)
GSD file	Geräte Stamm Datei (German abbreviation)	A hardware description file for a PROFIBUS-DP or PROFIBUS-DP/V1 slave type
GPS	Global Positioning System	System to detect local position, universal time and time zone, GPS technology provides accurate time to a system
	Hardware Local	A Control Access term describing that the M*Control* accepts its commands from the Hardwired inputs, when the respective Local control input is set to true.

Abbreviation	Term	Description
HMI	Human Machine Interface	Generic expression
LVS	Low voltage switchgear	A factory built assembly built to conform with IEC 60439-1
MCC	Motor Control Centre	Common term for switchgear used for motor control and protection.
MNS		Modular Low Voltage Switchgear family from ABB
MNS *i*S		The integrated intelligent switchgear solution from ABB
	M*Start* M*Feed* M*Control* M*Link* M*View* M*Navigate*	MNS *i*S components integrated in the switchgear, see the MNS *i*S System Guide for technical details
	MODBUS	Fieldbus communication protocol
	MODBUS RTU	Fieldbus communication protocol
	Motor Starter	Consists of motor controller and electrical components to control and protect a motor, part of Motor Control Center
NLS	Native Language Support	Providing the ability to change the language of software tools in order to support native languages (English is basis, others are optional)
OPC		OLE for Process Control, an industrial standard for exchange of information between components and process control application
PCS	Process Control System	High level process control system
PLC	Programmable Logic Controller	Low level control unit
	PROFIBUS-DP	Fieldbus communication protocol with cyclic data transfer (V0).
	PROFIBUS-DP/V1	Fieldbus communication protocol, extension of PROFIBUS-DP allowing acyclic data transfer and multi master (V1).

Abbreviation	Term	Description
	PROFIBUS-DP/V2	Fieldbus communication protocol, extension of PROFIBUS-DP allowing time stamp and communication between master and slave (V2).
	PROFINET	PROFINET is an open standard for Industrial Ethernet and standardized in IEC 61158 and IEC 61784.
PNIO	PROFINET IO	PROFINET for decentralized periphery and distributed automation
RCU	Remote Control Unit	Local control unit with pushbutton and indicator to operate a device (e.g. motor) from field level.
RS232		Standard No. 232 for PC communication, established by EIA (Electronics Industries Association, USA)
RS485		Communication interface standard from EIA (Electronics Industries Association, USA), operating on voltages between 0V and +5V. RS-485 is more noise resistant than RS-232C, handles data transmission over longer distances, and can drive more receivers.
RTC	Real Time Clock	Integrated clock function in devices used to generate time and date information if a remote clock system is not present
	Software Local	A Control Access term describing that the M*Control* accepts its commands from the hardwired inputs as a result of either the PCS or M*View* passing the Control Access Authority to Soft-Local. Note: Does not require the hardwired local input to be set to true.
SNTP	Simple Network Time Protocol	a protocol used for time synchronization in Control Network through Ethernet
	Switchgear Bus Network	Term used to describe the internal switchgear communication network, between M*Link* and M*Control*.
TCP/IP	Transmission Control Protocol / Internet Protocol	TCP/IP is a high-level connection oriented , reliable, full duplex communication protocol developed for integration of the heterogenous systems.
	Trip	A consequence of an alarm activated or an external trip command from another device to stop the motor or trip the circuit breaker.

Abbreviation	Term	Description
UTC	Coordinated Universal Time	Coordinated Universal Time is the international time standard. It is the current term for what was commonly referred to as Greenwich Meridian Time (GMT). Zero (0) hours UTC is midnight in Greenwich England, which lies on the zero longitudinal meridian. Universal time is based on a 24 hour clock.
	Warning	A warning is defined as status transition from any state to pre-alarm state to inform in advance before an alarm level is reached.

Related Documentation

MNS *i*S

1TGC910211 M0201 MNS *i*S Interface Manual M*Link*, Release 7.0

1TGC910111 M0201 MNS *i*S M*Link* Upgrade Kit Manual

1TGC910221 M0201 MNS *i*S Interface Manual Web Interface, Release 7.0

1TGC910231 M0201 MNS *i*S Interface Manual OPC Server, Release 7.0

1TGC910241 M0201 MNS *i*S Interface Manual Profibus, Release 7.0

1TGC910291 M0201 MNS *i*S Interface Manual PROFINET IO, Release 7.0

1TGC910281 M0201 MNS *i*S M*Control* Interface Manual Profibus Direct, Release 7.0

1TGC910261 M0201 MNS *i*S Interface Manual Redundancy, Release 7.0

1TGC910271 M0201 MNS iS M*Connect* Interface Manual, Release 7.0

1TGC910001 B0204 MNS *i*S System Guide

1TGC910201 M0201 MNS *i*S Quick Guide Installation and System Setup, Release 7.0

1TGC910090 M0201 M*Navigate* Help file V7.0

1TGC910018 M0208 MNS *i*S ATEX – Enhancements for Safety

Modbus additional specifications

[1] Modbus Application Protocol Specification V1.1b – Modbus-IDA 28th December 2006

[2] Modbus Messaging on TCP/IP Implementation Guide 1.0a - Modbus-IDA 4th June 2004

Related System Version

The content of this document is related to MNS *i*S System Release 7.0.

The described functions are designed but may not be fully implemented in all details. Please refer to the current system guides and release notes regarding possible restrictions.

Document Revision History

Rev.	Page	Chapter	Description of change	Date
M0201			Initial document for Release V7.0	July 2012
M0202	29 36	Restrictions Monitoring Funct. code 03/04	Modbus RTU restrictions added Format of “Thermal image” edited	July 2012

Introduction

MODBUS Standard

MODBUS is a serial data communication protocol and was originally developed as a communication language for MODICON programmable controllers, its rights now reside with the Modbus-IDA organization.

The software on the M*Link* supports the pure Master-Slave operation as defined in the MODBUS RTU specification. This manual describes the M*Link* communication with MODBUS protocol in RTU and TCP modes.

The MODBUS communication protocol is implemented within the M*Link* to enable MNS *i*S to provide interface possibilities to process control systems or any other external systems that supports MODBUS RTU / TCP protocol handling.

The MODBUS configuration can be used in point to point configuration or in multidrop mode. In Master-Slave MODBUS architecture, the M*Link* is always used in a slave mode. The master station controls the traffic on the bus, in this case, by PCS or PLC system. The M*Link* responds to the queries received from master station as per the MODBUS specification.

MNS iS Software Requirements

For full support of MNS *i*S V7.0 functionality the Modbus interface requires:

- M*Link* image 1TGE131013R0001 or higher
- M*Navigate* Version 7.0 or higher

Basics

MODBUS RTU

Master Slave Query Response Cycle

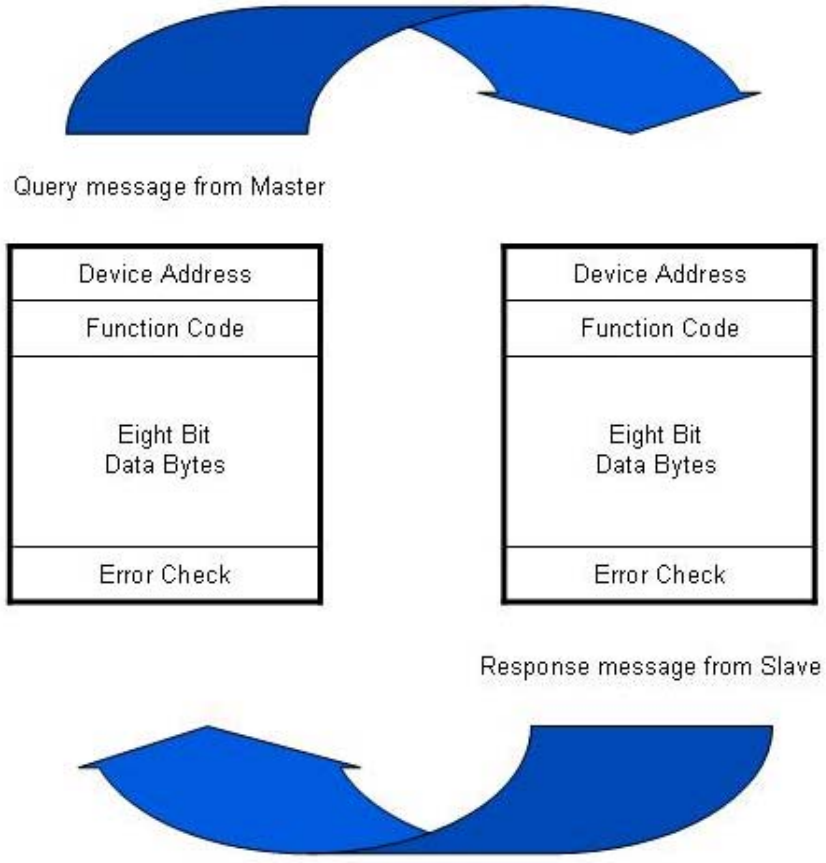


Fig. 1 Query Response Cycle

The Query

The function code (FC) in the query tells the addressed slave device what kind of action to perform. The data bytes contain any additional information that the slave will need to perform the function. For example, function code 03 will query the slave to read holding registers and respond with their contents. The data field must contain the information telling the slave which register to start at and how many registers to read. The error check field provides a method for the slave to validate the integrity of the message contents.

The Response

If the slave makes a normal response, the function code in the response is an echo of the function code in the query. The data bytes contain the data collected by the slave, such as register values or status. If an error occurs, the function code is modified to indicate that the response is an error response, and the data bytes contain a code that describes the error. The error check field allows the master to confirm that the message contents are valid.

Characteristics

Certain characteristics of the MODBUS protocol, as specified by the reference document [1], are fixed such as the frame format, frame sequences, handling of communication errors and exception conditions, and the functions performed. In case of the M*Link*, the transmission mode is also limited to RTU or TCP.

Other characteristics are user selectable. These include a choice of transmission medium, baud rate and character parity, number of stop bits. These parameters can not be changed while the communication interface is active.

The OSI layers 1, 2, and 7 are implemented in the M*Link*

Layer 1, 2:

In these layers the physical sending and receiving of bytes, i.e. triggering of the interface hardware including monitoring of timeouts and CRC-Check generation as well as processing of addresses is realized. Upon receipt, the fault states, time-out and CRC-Error are being detected and treated according to the MODBUS RTU specification.

Layer 7:

In this layer the analysis and treatment of the function codes (FC) is implemented. This includes processing the received commands (read and write of MODBUS-registers) and generation of the response-message together with the addressed data.

Mode of Transmission

The mode of transmission is the structure of the individual units of information within a message, and the numbering system used to transmit the data. Two modes of transmission are available for use in a standard MODBUS communication, ASCII (American Standard Code for Information Interchange), and RTU (Remote Terminal Unit). Both modes provide the same capabilities for communication. Selecting ASCII or RTU mode defines the bit contents of message fields, and how information is packed and decoded.

M*Link* does not support ASCII transmission.

Characteristic	RTU (8-bit)
Coding System	8-bit
<u>Number of bits per character:</u> Start bits Data bits (least significant first) Parity Stop bits	 1 8 1 (1 bit set for even or odd parity, no bits for no parity) 1 or 2
Error Checking	CRC (Cyclical Redundancy Check)

Error Detection

There are two types of errors, which may occur in a communication system:

- Transmission error and
- Programming or Communication error

The M*Link* deals with either type of error as specified in MODBUS specification [1].

The most frequent cause of communication error is noise, unwanted electrical signals in a communication channel. These signals occur because of electrical interference from machinery, damage to the communication channel, impulse noise (spikes), etc. Character framing, a parity check, and a redundancy check detect these errors. When the error occurs, the message is unreliable and the processing of the last received erroneous message stops.

Programming or operational errors are those involving illegal data in a message or difficulty in communicating with a slave. These errors result in an exception response either from Master or Slave station.

Interfaces

MLink Connections

M*Link* provides the facility to connect MNS *iS* on a single entry point to a Process Control System via MODBUS protocol. Depending on the PCS or PLC application M*Link* can support either MODBUS RTU or MODBUS TCP. M*Link* acts always as a standard MODBUS Slave device.

For details see corresponding MNS iS Interface Manual MLink, see section References hereunder.

MLink Redundancy

The M*Link* is available for both single and redundant configurations. The MODBUS communication protocol is the same in both configurations.

In a redundant configuration two M*Link*s are used. They are connected together via port Serial 1 for internal data exchange / synchronization. One M*Link* is configured as 'Primary' M*Link* and the second M*Link* is configured as 'Backup' M*Link*. In case of a system disturbance where communication is lost to the 'Primary', the M*Links* will automatically initiate a transfer from Primary to Backup.

Refer to the manual MNS i*S* Interface Manuals Redundancy, see section References hereunder.

References

Hardware ID numbers	1TGE1020x9Rxxxx	1TGE120021R0010
MLink Types		
Hardware available for MNS iS Versions	up to V6.0	from V6.1 onwards
MNS iS Interface Manual **MLink**	1TGC 910120 M020x	1TGC 91021x M020x
MNS iS Interface Manual **Dual Redundancy**	1TGC 910260 M020x	

MODBUS RTU Topology

There are three options for MODBUS RTU available from the M*Link*, RS 232, RS 422 and RS 485. All connections on M*Link* are made available via the same standard Sub-D plug (Serial 2).

Cable length may vary from 80-1200 m depending on transmission speed and repeater type in use. Cable length can be extended using fiber optic modems (yielding a more robust network).

The serial port interface of the M*Link* is not galvanically isolated. To achieve this it is recommended to use 3rd party products.

Serial Link connections

RS 232

Allows only a simple point to point topology between Master and Slave. The maximum distance according to the standard is 15 meters.

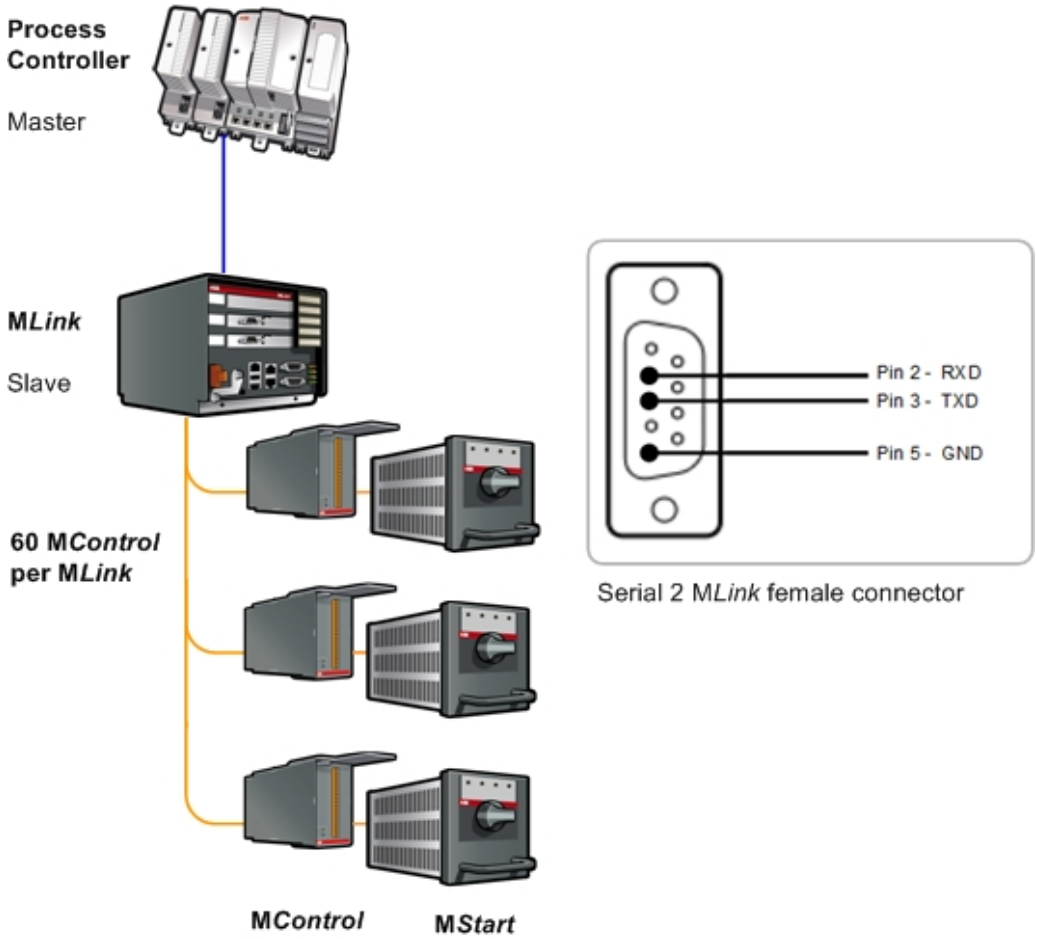


Fig. 2 RTU Topology with RS 232

RS 422

Allows only a simple point to point topology between Master and Slave. The maximum distance according to the standard is 1200 meters.

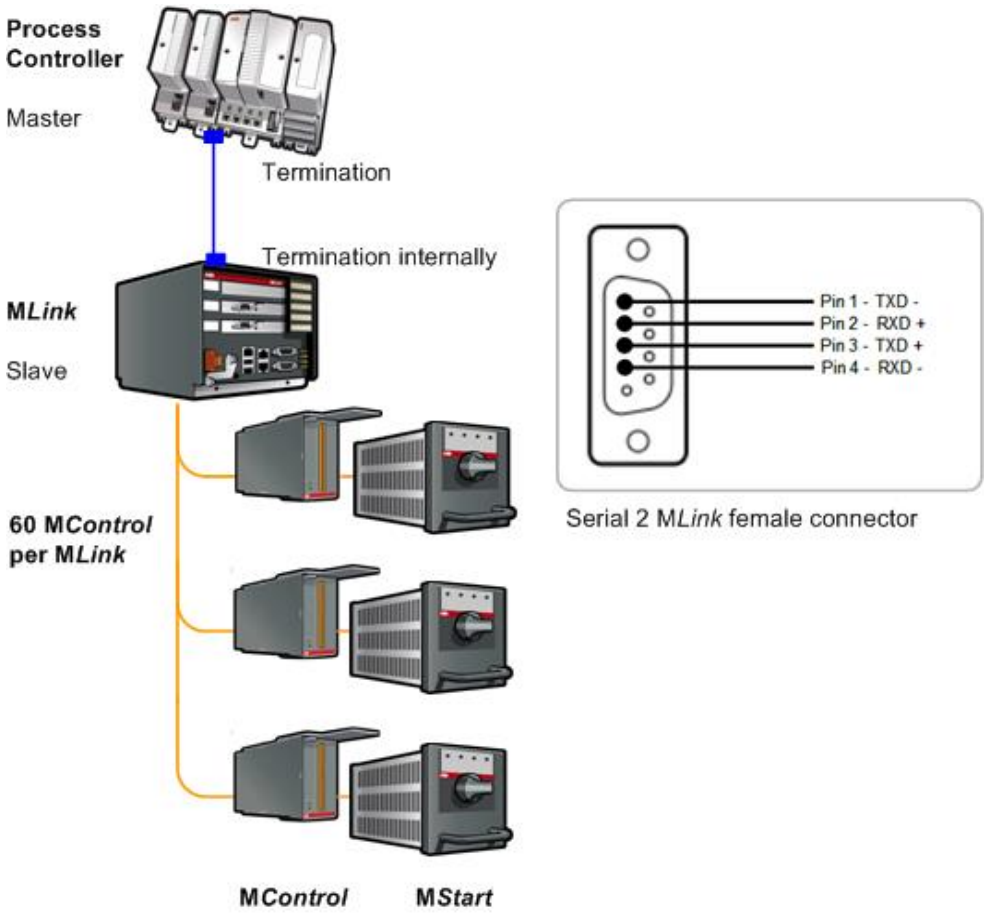


Fig. 3 RTU Topology with RS 422

RS 485

Allows multidrop topology with a maximum of 31 devices on the link. The total distance according to the standard is 1200 meters.

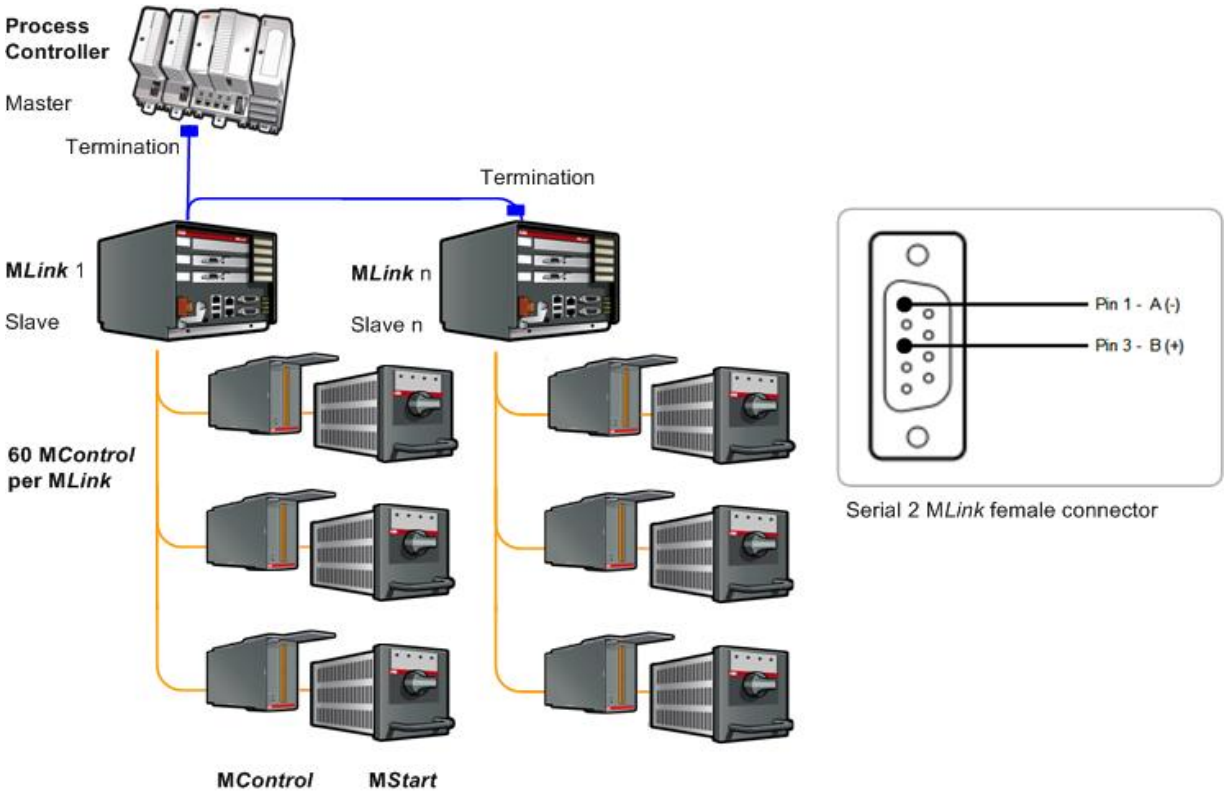


Fig. 4 RTU Topology with RS 485 multidrop

Termination

The M*Link* does not provide in-built MODBUS RTU termination for RS485 communication; therefore correct measures must be taken to connect termination to both ends of the segment.

Example for RS485 bus termination and biasing

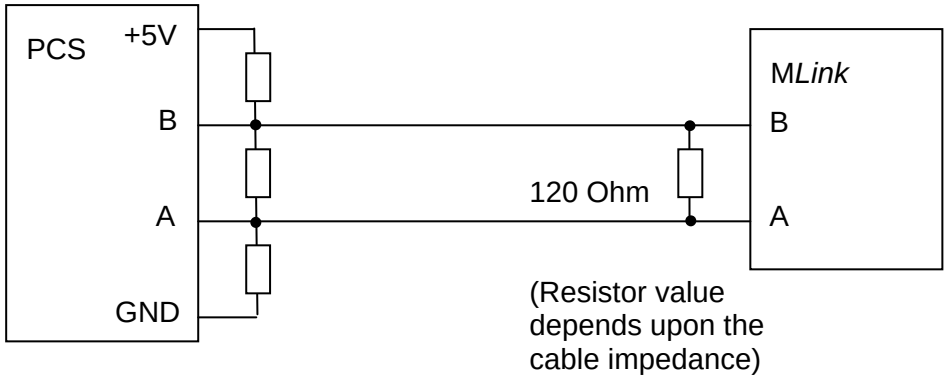


Fig. 5 Termination example for RS 485

MODBUS RTU Communication Settings

Variable Name	Default Parameter	Allowed Ranges	Remarks
Slave address	**247**	1 . . . 247	RTU Slave Address
Baud rate	**19200**	9600, 19200, 38400, 115200	Data Transmission Speed
Parity bit	**Even**	None, Even, Odd	Used for Error checking
Stop bit	**1**	1 or 2	Required if no Parity check is used
PLC Time Out enable	**No**	Yes / No	Activates PLC time out
PLC Failsafe Time Out	**10**	1 . . . 100	Delay until Failsafe is activated
Modbus Interface *	**RS232**	RS232, RS485, RS422	Type of serial interface
* only valid for MLink hardware 1TGE120021R0010			

Table 1 MODBUS parameter and initial values

Configuration of the parameters is done via M*Navigate.* The parameters must then be downloaded to the M*Link*. After restart of the M*Link* the settings are taken into effect.

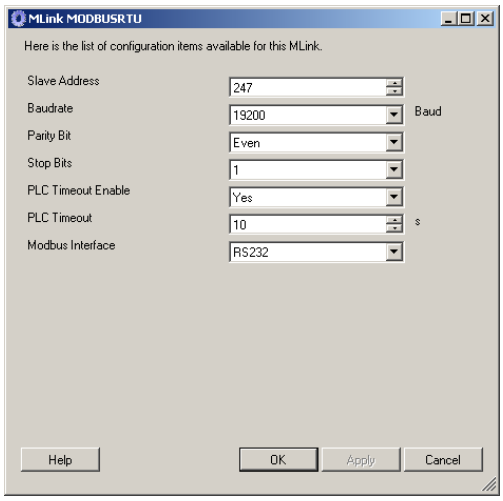


Fig. 6 Parameter Window for MODBUS RTU parameters in M*Navigate*

MODBUS TCP Topology

MODBUS TCP connection is available via the standard RJ45 LAN 1 connector on the M*Link*. For a direct connection a CAT 5 cross-over cable is to be used. For a network with multiple slaves via a network switch the standard CAT 5 patch cables are used. Maximum cable length for CAT 5 Ethernet cable is 100m.

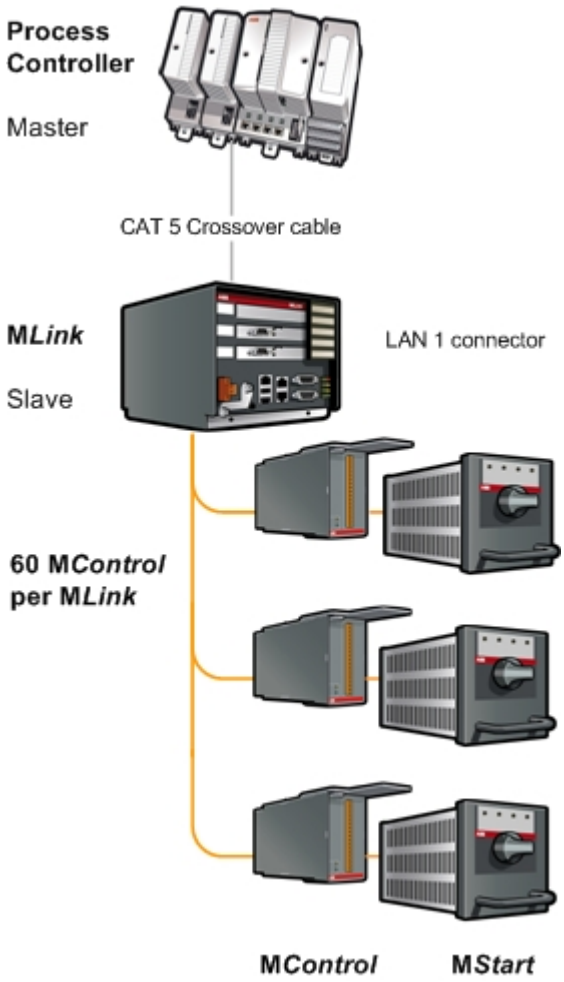


Fig. 7 TCP topology – direct connection

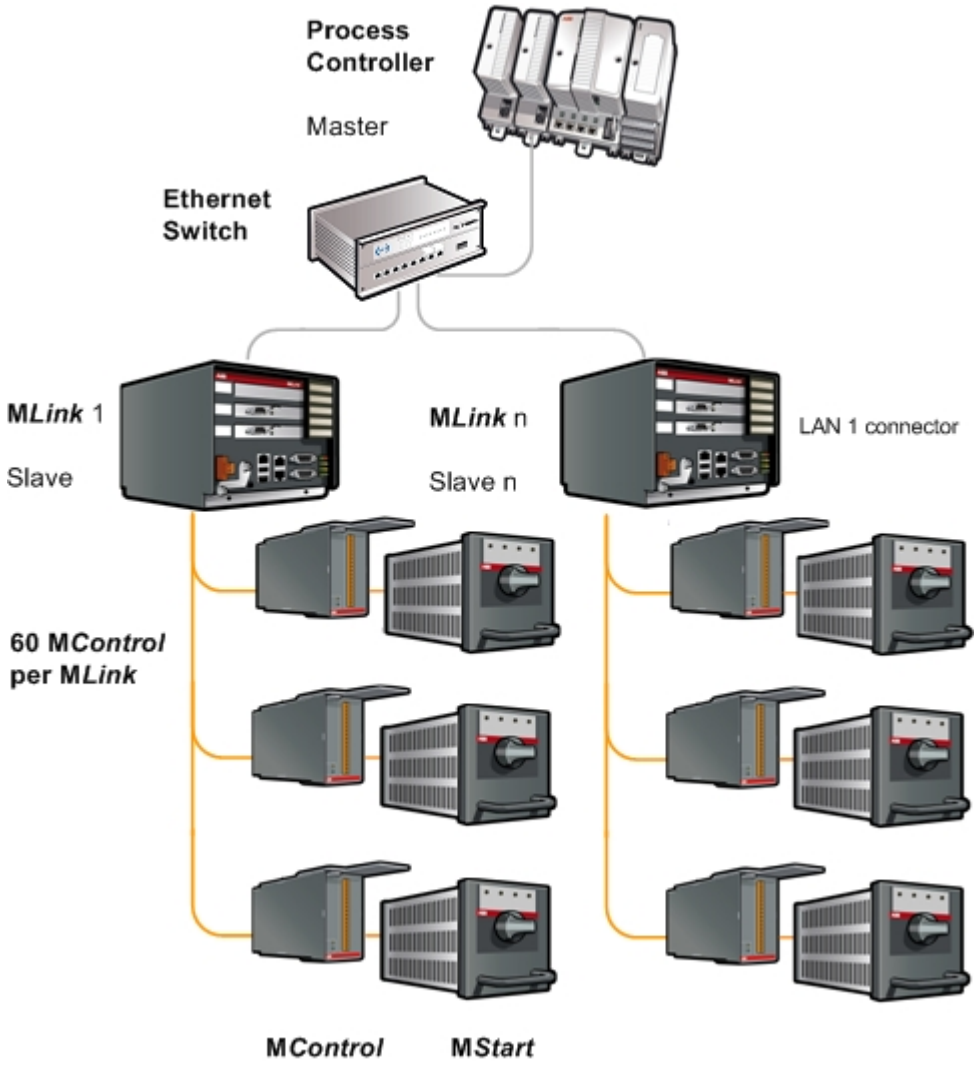


Fig. 8 TCP topology – utilizing network switches

It is recommended that a managed network switch is used to connect M*Link* to PCS or PLC via Modbus TCP. The switch is not an integral part of the MNS *i*S assembly but may be delivered together with the switchboard, depending on project scope definition.

MODBUS TCP Communication Settings

Variable Name	Default Parameter	Allowed Ranges	Remarks
Slave address	**247**	0 . . . 255	TCP Slave Address
Port	**502**	502	TCP Port Number
PLC Time Out enable	**No**	Yes / No	Activates PLC time out
PLC Failsafe Time Out	**10**	1 . . . 100	Delay until failsafe activated

Table 2 MODBUS parameter and initial values

Configuration of the parameters is via M*Navigate.* The parameters must then be downloaded to the M*Link*. After restart of the M*Link* the settings are taken into effect.

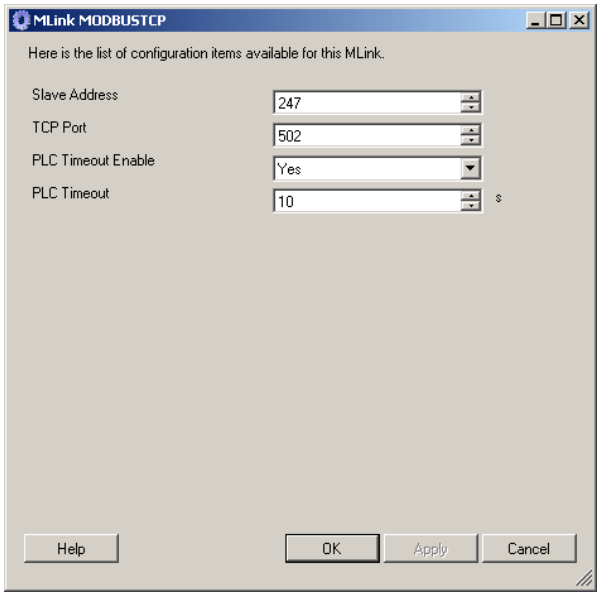


Fig. 9 Parameter Window for MODBUS TCP parameters in M*Navigate*

Default parameter setting for PlcTimeOut is No, in this case the PlcTimeOut value is not visible in the window, applicable for both RTU and TCP, please refer to the Failsafe description on the following page for more information.

Multiple Master in MODBUS TCP applications

The M*Link* offers the possibility to support up to 4 MODBUS TCP masters. This function can only be utilized if also the PCS or PLC MODBUS master supports such configuration.

An access control function can be enabled with M*Navigate* to define the addresses of the MODBUS master devices. In the following configuration example only a PLC or PCS master with IP address 192.168.100.80 is able to access data from M*Link*.

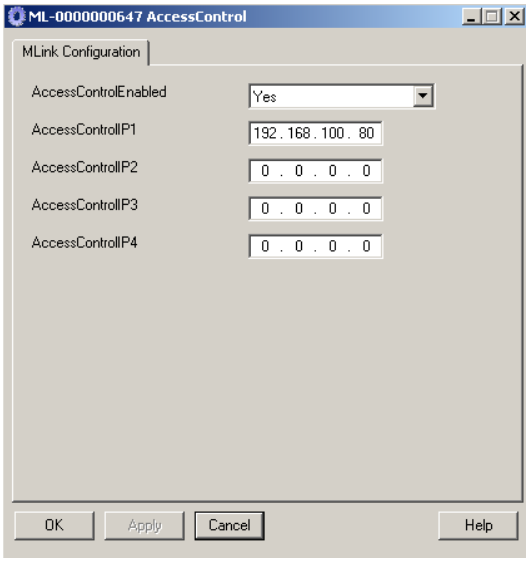


Fig. 10 Access Control Configuration

Failsafe

In circumstances where a disturbance in the MODBUS communication network needs to be monitored it is possible to select a 'Failsafe' state for each M*Control*. This state has to be defined as a parameter for each M*Control* separately. The M*Link* supervises the MODBUS communication to the PCS or PLC if the parameter PLCTimeOut is set to "YES". The timeout for this connection is set by using the parameter PLCTimeOut (see Table 1 and 2 for initial values).

The M*Control* must be operating in 'Remote' mode for the Failsafe function to be active.

When multiple masters are connected to the M*Link* (option for MODBUS TCP only) and parameter "Extended Failsafe" is disabled, loss of communication by all masters is required to activate this 'Failsafe'.

For more information please refer to the 'Extended Failsafe' section.

Function Codes

The MOBDUS protocol implemented in M*Link* is using the MODBUS standard function codes (FC). The standard function codes supported are as follows:

FC02	*Read Input Status*	Bit-orientated reading from register file
FC03	*Read Holding Registers*	Word-orientated reading from register file
FC04	*Read Input Registers*	Word-orientated reading from register file
FC06	*Preset Single Register*	Writing of a word into register file
FC08	*Diagnostics*	Check communication between master and slave, (loop back)
FC16	*Pre-set multiple Registers*	Write of several successive words into register file

Table 3 Function Codes

The M*Link* is a ‘standard MODBUS slave device. The PLC or PCS master initiates the communication by sending the 'Query Messages' and the M*Link* replies the requested information in 'Response Messages'.

Message Format

Query Messages

The MODBUS query messages have the standard query structure as below.

- The slave address
- Function code for Read or Write operation
- Start address of the desired information
- Register length or data code to be read
- CRC-Error checking field

Response Messages

The standard MODBUS response message structure is

- The slave address
- Applied function code
- Length of response (byte)
- Requested information/Action performed
- CRC-Error checking field

Function codes and their relevant address range are shown in the table below.

Function Codes	Address / Mapping Area	Starting Address used in Modbus Frame
FC02	10001-19999	0-9999
FC04	30001-39999	0-9999
FC03, 06, 16	40001-49999	0-9999

Table 4 Address ranges of function codes

Function Code 02 - Read Input Status

This function allows the control system to obtain the ON/OFF status of discrete inputs from the M*Link*. With function code 2 following information can be requested.

- Life Bits
- Status Information
- Control Access Information
- Alarms
- Trips

The valid address range: 10001-19999.

Function Code 03 - Read Output Registers

With function code 03, the control system can read the registers that can store the numerical data, which can be driven to external devices as mentioned below.

- Measuring Values
- Status as Word-oriented bits
- Alarm structure (Warnings/Trips)

The valid address range: 40001-49999

Function Code 04 - Read Input registers

Function code 04 obtains the contents of the input registers. These locations receive their values from devices connected to the I/O structure of field units and can only be referenced, not altered within the system or via MODBUS as mentioned below.

- Status as Word-oriented bits
- Alarm structure (Warnings/Trips)

The valid address range: 30001-39999

Data Presentation for Function Code 03 and 04

Function code 03 and 04 using a 16 bit modbus register. In the first byte of register is high part of data in second byte is the low data part.

Bit Number	15 - 8	7 - 0
Register n	Data High	Data Low

A float value has 4 bytes and uses two 16-bit Modbus registers. See following table:

Bit Number	15 - 8	7 - 0
Register n	Data High-High	Data High-Low
Register n+1	Data Low-High	Data Low-Low

In case Mapping Tool parameter “Float Register Big Endian” is set to “No” data presentation of float value is as follows:

Bit Number	15 - 8	7 - 0
Register n	Data Low-High	Data Low-Low
Register n+1	Data High-High	Data High-Low

Function Code 06 - Preset Single Register

Function code 06 allows control system to modify the contents of a single output register. Any output register that exists within the system can have its contents changed by this message i.e.

- Switching Commands, other commands

The valid address range: 40001-49999

Outgoing commands utilizing FC06 are always sent, regardless of any change to the command value.

Function Code 08 - Diagnostic Loop Back (Serial Line only)

The purpose of the loop back test is to test the communication between Master and Slave station. The data passed in the request data field is returned (looped back) in the response (Sub-function 0000). The entire response message should be identical to the request.

Function Code 16 - Preset Multiple Registers

Function code 16 performs the same function as FC06 but allows modifying the contents of multiple output registers. That means it is possible to send the switching commands to several M*Control* on a single write command.

The valid address range: 40001-49999

The M*Link* will only send outgoing commands via FC 16 if there is a change in value compared with the commands previously sent, thus decreasing bus load. If this does not comply with users' communication philosophy, FC 06 should be used for commands so that each single command will be passed without limitations.

When utilizing FC 16 it is good practice to, once the desired command has been sent and successfully acted upon, then change the command code to NOP. This will ensure that the M*Control* acts upon a 'change of state' from the command control.

Restrictions

General

To ensure optimal performance, a maximum of 60 modbus requests per second is allowed.

According Modbus standard MLink supports up to 16 simultaneous requests. Simultaneous means Modbus master don't wait until response of MLink, DCS could send more new requests. Please keep in mind: DCS has to count open requests and has to check that **never** more than 16 requests are open.

Modbus RTU

MLink with Modbus RTU in redundant configuration does not reply to Modbus requests (except FC08) if switchgear bus is not connected properly. Thus the DCS can easily detect a communication problem and use the redundant communication line.

The response time of a modbus slave depends on several parameters, for instance baudrate, number of registers in request and/or reply. Due to this the following procedure for DCS is recommended:

1. DCS sends modbus requests
2. DCS receives modbus reply from slave
3. After receiving of complete modbus reply DCS waits 100ms (or more if from DCS application required)
4. DCS sends next modbus request

Exception Code Handling

Handling of exception code is supported according to MODBUS specification. The following response telegrams will be sent if a query could not be served:

Exception code 1 (Illegal function)

A Function Code was received that is not supported.

Exception code 2 (Illegal data address)

A register address is out of the valid range.

Exception code 3 (Illegal data value)

The length of the telegram is not valid (start address + register counter > start address range + 1).

Exception code 8 (Memory parity error)

The CRC of the received telegrams is not correct.

Data Mapping

Two possibilities exist for data mapping, the default data map as described below and a user defined data map which can be created by the MNS *iS* Mapping Tool.

The default data map is a selection of data based on typical requirements. If this selection is not accepted in the project, a user data map has to be created.

User Data Map

All available data in a M*Control* application can be assigned to the corresponding register addresses by using the MNS *i*S Mapping Tool. This is a proprietary tool for ABB to program the MODBUS registers according to customer requirements.

Default Data Map

Monitoring (Inputs from MControl)

Monitoring of the M*Control* data handled by the M*Link* is possible utilizing the following function codes and address ranges.

FC 02	10001 …. 19999	Bit registers
FC 03	40001 …. 49999	Word registers
FC 04	30001 …. 39999	Word registers

Monitoring with Function Code 02

Monitoring of the life and status bits of each M*Control* via the M*Link* is detailed in the following tables.

Table 4 Default Modbus Map Life-Bit of M*Control*

Modbus Function Code	Modbus-Register	Device Number	Description	Remarks
2	10001	1	Life-Bit M*Control* 1 or MConnect 1	M*Control* 1 or MConnect 1 is available (comm. ok)
2	10002	2	Life-Bit M*Control* 2 or MConnect 2	M*Control* 2 or MConnect 2 is available (comm. ok)
2	10003	3	Life-Bit M*Control* 3 or MConnect 3	M*Control* 3 or MConnect 3 is available (comm. ok)
2	10004	4	Life-Bit M*Control* 4 or MConnect 4	M*Control* 4 or MConnect 4 is available (comm. ok)
2	10005	5	Life-Bit M*Control* 5 or MConnect 5	M*Control* 5 or MConnect 5 is available (comm. ok)
2	10006	6	Life-Bit M*Control* 6 or MConnect 6	M*Control* 6 or MConnect 6 is available (comm. ok)
2	10007	7	Life-Bit M*Control* 7 or MConnect 7	M*Control* 7 or MConnect 7 is available (comm. ok)
2	10008	8	Life-Bit M*Control* 8 or MConnect 8	M*Control* 8 or MConnect 8 is available (comm. ok)
:	:	:	:	:
:	:	:	:	:
:	:	:	:	:
2	10060	60	Life-Bit M*Control* 60 or MConnect 60	M*Control* 60 or MConnect 60 is available (comm. ok)

Table 5 Default Modbus Map Bit Status of M*Control*

Modbus Function Code	Modbus-Register	Device Number	Description	Remarks
2	11001	1	Stopped	1 = Motor Stopped or Tripped or Feeder open
2	11002	1	Runs	1 = Motor Runs or Feeder closed
2	11003	1	CW or K1	1 = Motor Runs Clockwise or K1 energised in Transparent mode
2	11004	1	CCW or K2	1 = Motor Runs Counter Clockwise or K2 energised in Transparent mode
2	11005	1	K3	1 = K3 energised in Transparent mode
2	11006	1	GPI 1	1 = General Purpose Input 1 set
2	11007	1	GPI 2	1 = General Purpose Input 2 set
2	11008	1	Ready	1 = M*Start* in correct location, & main switch on, & no trip, & no start inhibit.
2	11009	1	Alarm	1 = Any Alarm condition of protection or supervision functions.
2	11010	1	New Trip	1 = Any Trip condition of the protection or supervision functions
2	11011	1	Trip Ack	1 = Current Trip Acknowledged
2	11012	1	Failsafe	1 = Set when M*Start* runs, after loss off communication.
2	11013	1	Test	1 = M*Start* with main switch set to test position. (Motor cannot start)
2	11014	1	HW local	1 = Control Access is selected to hardwired I/O from Local / Remote input on M*Control*.
2	11015	1	Soft local	1 = Control Access is passed from the switchgear control network to the local control station. M*Control* now responds to the hardwired inputs.
2	11016	1	Bus local	1 = Control Access is passed to any control station on the switchgear control network. Eg. M*View.*

(continued)

Table 6 Default Modbus Map Bit Status of M*Control*

Modbus Function Code	Modbus-Register	Device Number	Description	Remarks
2	11017	2	Stopped	1 = Motor Stopped or Tripped or Feeder open
2	11018	2	Runs	1 = Motor Runs or Feeder closed
2	11019	2	CW or K1	1 = Motor Runs Clockwise or K1 energised in Transparent mode
:	:	:	:	
2	11945	60	Stopped	1 = Motor Stopped or Tripped or Feeder open
2	11946	60	Runs	1 = Motor Runs or Feeder closed
2	11947	60	CW or K1	1 = Motor Runs Clockwise or K1 energised in Transparent mode
2	11948	60	CCW or K2	1 = Motor Runs Counter Clockwise or K2 energised in Transparent mode
2	11949	60	K3	1 = K3 energised in Transparent mode
2	11950	60	GP IP 1	1 = General Purpose 1 IP set
2	11951	60	GP IP 2	1 = General Purpose 2 IP set
2	11952	60	Ready to start	1 = M*Start* in correct location, & main switch on, & no trip, & no start inhibit.
2	11953	60	Alarm	1 = Any Alarm condition of protection or supervision functions.
2	11954	60	New Trip	1 = Any Trip condition of the protection or supervision functions
2	11955	60	Trip Ack	1 = Current Trip Acknowledged
2	11956	60	Failsafe	1 = Set when M*Start* runs, after loss off communication.
2	11957	60	Test	1 = M*Start* with main switch set to test position. (Motor cannot start)
2	11958	60	HW local	1 = Control Access is selected to hardwired I/O from Local / Remote input on M*Control*.
2	11959	60	Soft local	1 = Control Access is passed from the switchgear control network to the local control station. M*Control* now responds to the hardwired inputs.
2	11960	60	Bus local	1 = Control Access is passed to any control station on the switchgear control network. Eg. M*View.*

Table 7 Default Modbus Map Bit Status of M*Connect for Breakers*

Modbus Function Code	Modbus-Register	Device Number	Description	Remarks
2	11001	1	Opened	1 = Breaker open
2	11002	1	Closed	1 = Breaker closed
2	11003	1	Tripped	1 = Breaker tripped
2	11004	1	Undefined	1 = Breaker undefined
2	11005	1	Discharged	1 = Breaker discharged
2	11006	1	GPI 1	1 = General Purpose Input 1 set
2	11007	1	GPI 2	1 = General Purpose Input 2 set
2	11008	1		
2	11009	1	Alarm	1 = Any Alarm condition of protection or supervision functions.
2	11010	1	New Trip	1 = Any Trip condition of the protection or supervision functions
2	11011	1		
2	11012	1		
2	11013	1	Test	1 = Breaker is in test mode
2	11014	1	HW local	1 = Breaker is in local mode
2	11015	1		
2	11016	1	Bus local	1 = Breaker is in remote mode, Control Access is passed to any control station on the switchgear control network. Eg. M*View.*
2	11017	2	Opened	
2	11018	2	Closed	
…	…	…	…	

Monitoring with Function Code 03 and 04

Monitoring of the measured (analogue) values from the individual M*Control* is detailed in the following table.

Table 8 Default Modbus Map measured values of M*Control*

Modbus Function Code	Modbus-Register	Device Number	Modbus Register Name	Format	Remarks
3	40001	1	Phase current L1 % or Current %	Unsigned Int, 2Byte	% age L1 Current % age Current (MFeed-DC)
3	40002	1	Thermal image	Unsigned Int, 2 Byte, Scaled value, multiplied by 10	Used thermal capacity (only available if TOL protection function is used)
3	40003	1	Time to trip	Unsigned Int, 2Byte	Time before M*Control* will trip the motor (only available if TOL protection function is used)
3	40004	1	Time to reset	Unsigned Int, 2Byte	Time required before reset allowed (only available if TOL protection function is used)
3	40005	2	Phase current L1 %	Unsigned Int, 2Byte	% age L1 Current
3	40006	2	Thermal image	Unsigned Int, 2Byte	Used thermal capacity
3	40007	2	Time to trip	Unsigned Int, 2Byte	Time before M*Control* will trip the motor
3	40008	2	Time to reset	Unsigned Int, 2Byte	Time required before reset allowed
:	:	:	:	:	:
3	40237	60	Phase current L1 %	Unsigned Int, 2Byte	% age L1 Current
3	40238	60	Thermal image	Unsigned Int, 2Byte	Used thermal

					capacity
3	40239	60	Time to trip	Unsigned Int, 2Byte	Time before M*Control* will trip the motor
3	40240	60	Time to reset	Unsigned Int, 2Byte	Time required before reset allowed

Monitoring of the measured (analogue) values from the individual *MConnect* is detailed in the following table.

Table 9 Default Modbus Map measured values of M*Connect* with Circuit Breaker

Modbus Function Code	Modbus-Register	Device Number	Modbus Register Name	Format	Remarks
3	40001 + 40002	1	Phase current L1	Unsigned Long, 4 Bytes	L1 Current
3	40005 + 40006	2	Phase current L1	Unsigned Long, 4 Bytes	L1 Current
:	:	:	:	:	:
3	40237 + 40238	60	Phase current L1	Unsigned Long, 4 Bytes	L1 Current

Extended Status description for MControl

In addition to the above within the Default Modbus Map, the following 'Extended Status' is also supported in 4 bytes of data.

Table 10 Default Modbus Map Extended Status of M*Control and MConnect*

Modbus Function Code	Modbus-Register	Device Number	Modbus Register Name	Format
3	41001	1	Extended status	2Byte
3	41002	1	Extended status	2Byte
3	41003	2	Extended status	2Byte
3	41004	2	Extended status	2Byte
3	41005	3	Extended status	2Byte
3	4100	3	Extended status	2Byte
:	:	:	:	:
3	41117	59	Extended status	2 Byte
3	411118	59	Extended status	2 Byte
3	41119	60	Extended status	2 Byte
3	41120	60	Extended status	2 Byte

The content of the Extended Status 'Byte 1' is starter type dependant, and is described in following tables for each starter type.

Table 11 Extended Status Byte 1 for NR DOL, NR DOL RCU

BYTE 1	NR DOL, NR DOL RCU		Remark
Bit 0	1	Stopped	1 = Motor Stopped or Tripped
Bit 1	1	Runs	1 = Motor Runs
Bit 2			
Bit 3			
Bit 4			
Bit 5			
Bit 6			
Bit 7	1	Ready	1 = M*Start* in correct location & main switch on & no trip & no start inhibit

Table 12 Extended Status Byte 1 for REV DOL, REV DOL RCU

BYTE 1	REV DOL, REV DOL RCU		Remark
Bit 0	1	Stopped	1 = Motor Stopped or Tripped
Bit 1	1	Runs	1 = Motor Runs
Bit 2	1	Runs CW	1 = Motor Runs, Clockwise
Bit 3	1	Runs CCW	1 = Motor Runs, Counter Clockwise
Bit 4			
Bit 5			
Bit 6			
Bit 7	1	Ready	1 = M*Start* in correct location & main switch on & no trip & no start inhibit

Table 13 Extended Status Byte 1 for NR STAR/DELTA

BYTE 1	NR STAR/DELTA		Remark
Bit 0	1	Stopped	1 = Motor Stopped or Tripped
Bit 1	1	Runs	1 = Motor Runs
Bit 2			
Bit 3			
Bit 4			
Bit 5			
Bit 6	1	Runs Star	1 = Motor Runs; Star
Bit 7	1	Ready	1 = M*Start* in correct location & main switch on & no trip & no start inhibit

Table 14 Extended Status Byte 1 for NR Softstarter

BYTE 1	NR DOL Softstarter		Remark
Bit 0	1	Stopped	1 = Motor Stopped or Tripped
Bit 1	1	Runs	1 = Motor Runs
Bit 2			
Bit 3			
Bit 4			

Bit 5	1	Softstop	1 = Motor Stopping, Softstop time active
Bit 6	1	Softstart	1 = Motor Starting, Softstart time active
Bit 7	1	Ready	1 = M*Start* in correct location & main switch on & no trip & no start inhibit

Table 15 Extended Status Byte 1 for Actuator

BYTE 1	Actuator		Remark
Bit 0	1	Stopped	1 = Motor Stopped or Tripped
Bit 1	1	Runs	1 = Motor Runs
Bit 2	1	(Runs) Close	1 = Close direction
Bit 3	1	(Runs) Open	1 = Open direction
Bit 4			
Bit 5	1	Close Position	1 = Close Position
Bit 6	1	Open Position	1 = Open Position
Bit 7	1	Ready	1 = M*Start* in correct location & main switch on & no trip & no start inhibit.

Table 16 Extended Status Byte 1 for CFeed, CFeed-RCU

BYTE 1	CFeed		Remark
Bit 0	1	Open	1 = Contactor open
Bit 1	1	Closed	1 = Contactor closed
Bit 2			
Bit 3			
Bit 4			
Bit 5			
Bit 6			
Bit 7	1	Ready	1 = C*Feed* in correct location & main switch on & no trip & no start inhibit

Table 17 Extended Status Byte 1 for MFeed / MFeed-DC

BYTE 1	MFeed		Remark
Bit 0	1	Open	1 = Isolator open
Bit 1	1	Closed	1 = Isolator closed
Bit 2			
Bit 3			
Bit 4			
Bit 5			
Bit 6			
Bit 7			

Table 18 Extended Status Byte 1 for MConnect with Breaker

BYTE 1	Actuator		Remark
Bit 0	1	CB Open	1 = Breaker opened
Bit 1	1	CB Closed	1 = Breaker Closed
Bit 2	1	CB Tr+ipped	1 = Breaker Tripped
Bit 3	1	Undefined	1 = Breaker undefined
Bit 4	1	Discharged	1 = Breaker discharged
Bit 5			
Bit 6			
Bit 7			

Events and Alarm Repository Log

The content of the Extended Status 'Byte 2' contains the Events and Alarm Repository Log (EARO). This is general information for each M*Control*.

Table 19 Extended Status Byte 2 EARO Log

BYTE 2	Events and Alarms		Remark
Bit 0	1	Any Alarm	Set when any Alarm is present
Bit 1	1	New Trip	Set when any New Trip is present
Bit 2	1	Trip Acknowledged	Set when last trip has been acknowledged
Bit 3	1	Reset Trip Remote	Set when reset is allowed from serial link
Bit 4	1	Failsafe	Set when Failsafe mode is active
Bit 5			Reserved
Bit 6			Reserved
Bit 7			Reserved

Table20 Extended Status Byte 2 for MConnect with Breaker

BYTE 2	Events and Alarms		Remark
Bit 0	1	Any Alarm	Set when any Alarm is present
Bit 1	1	New Trip	Set when any New Trip is present
Bit 2			Reserved
Bit 3	1		Reserved
Bit 4	1		Reserved
Bit 5			Reserved
Bit 6			Reserved
Bit 7			Reserved

M*Control* / M*Start* (C*Feed*) Status

The content of the Extended Status 'Byte 3' contains availability information for the power module

Table 21 Extended Status Byte 3 M*Control* / M*Start*

BYTE 3	Events and Alarms		Remark
Bit 0	1	Test Input	Isolator set to ‘Test’ position
Bit 1	1	Main Switch Input	Isolator set to ‘On’ position
Bit 2			Reserved
Bit 3			Reserved
Bit 4			Reserved
Bit 5	1	M*Control* Inhibited	TOL Inhibit / Start Inhibit protection active
Bit 6	1	TOL Inhibit	TOL Inhibit protection active
Bit 7	1	TOL Bypass	TOL Bypass Active.

Table 22 Extended Status Byte 3 M*Connect for Breakers*

BYTE 3	Events and Alarms		Remark
Bit 0	1	Test Input	Breaker set to ‘Test’ mode
Bit 1			Reserved
Bit 2			Reserved
Bit 3	1	Communication running	Modbus communication between MConnect and breaker is running
Bit 4	1	Isolated	Breaker is isolated
Bit 5			Reserved
Bit 6			Reserved
Bit 7			Reserved

Control Access Status

The content of the Extended Status 'Byte 4' is related to the Control Access function in MNS *i*S, for more information please refer to the Control Access section within this document.

Table 23 Extended Status Byte 4 CA Status

BYTE 4	CA Status		Remark
Bit 0	1	HW -Local	M*Control* accepts control commands from the hardwired inputs on M*Control*, when the respective Local control input is set to true.
Bit 1	1	SW-Local	M*Control* accepts control commands from the hardwired inputs. This control access authority must be given by a command from either the PCS or M*View*. Note: Does not require the hardwired local input to be set to true.
Bit 2	1	BUS-Local	M*Control* accepts control commands from a device on the switchgear control network, eg. M*View*.
Bit 3		2nd Fieldbus	M*Contro*l Fieldbus interface accepts control commands from the Profibus direct interface to M*Control*.
Bit 4			Reserved
Bit 5			Reserved
Bit 6			Reserved
Bit 7	1	Remote	M*Control* accepts control commands from DCS only

Table 24 Extended Status Byte 4 CA Status with MConnect for Breakers

BYTE 4	CA Status		Remark
Bit 0	1	HW -Local	Breaker could only controlled by its push buttons and wired inputs
Bit 1			Reserved
Bit 2	1	BUS-Local	Breaker accepts control commands from a device on the switchgear control network, eg. M*View*.
Bit 3			Reserved
Bit 4			Reserved
Bit 5			Reserved
Bit 6			Reserved
Bit 7	1	Remote	Breaker accepts control commands via MConnect from DCS only

Control Commands

Outputs to M*Control*

Control commands written to the M*Control* handled by the M*Link* is possible utilizing the following function codes and address ranges.

FC06, FC 16 40001 …. 49999 Word registers

The following default MODBUS registers must be used for writing control commands to the M*Control* via the M*Link*.

Table 25 Default Modbus Command Registers

Modbus Function Code	Modbus-Register	Device Number	Modbus Register Name	Description/Remarks
6/16	43001	1	Command	**Note:** content of the register indicates the command
6/16	43002	2	Command	
6/16	43003	3	Command	
6/16	:	:	:	
6/16	43060	60	Command	

Switching Commands

The following table details the commands that are required from the Master (DCS / PLC) to be sent to the M*Control* in order to control the motor or feeder module.

Table 26 Switching Commands sent from DCS to Motor Starter / Feeder

Operation Type	Drive Type	Description	Modbus Command	Remarks
Control Access	All	Remote control	0x2100	M*Control* is controlled via DCS.
	All	Soft-Local control	0x2102	DCS allows control via local inputs.
	All	Bus-Local control	0x2104	DCS allows control via local HMI.
Stop	All	Stop, Open	0x0201	Stops the M*Start, Opens contactor K1 for CFeed*
Start	NR DOL	Start	0x0202	Starts the M*Start*
Start CW	REV DOL	Start Clockwise	0x0202	Starts the M*Start* clockwise
Close	C*Feed*, C*Feed*-RCU	Close	0x0202	Closes contactor K1
Start CCW	REV DOL	Start Counter Clockwise	0x0203	Starts the M*Start* counterclockwise
Open	Actuator	Open	0x0202	Opens the actuator
Close	Actuator	Close	0x0203	Closes the actuator
Contactor Control	Transparent with Control	Close K1	0x0301	Close contactor K1
	Transparent	Open K1	0x0310	Open contactor K1
	Transparent	Close K2	0x0302	Close contactor K2
		Open K2	0x0320	Open contactor K2
		Close K3	0x0304	Close contactor K3
		Open K3	0x0340	Open contactor K3
Reset	All	Reset	0x1100	Reset of all trips
Reset	All	Customized Trip Reset	0x1500	Predefined customizable trip reset command
Failsafe Reset	All	Resets Failsafe Status	0x0200	Resets failsafe without sending a switching command.

The following table details the commands that are required from the Master (DCS / PLC) to be sent to the M*Connect* in order to control the breaker.

Table 27 Switching Commands sent from DCS to MConnect with Breaker

Operation Type	Drive Type	Description	Modbus Command	Remarks
Control Access	All	Remote control	0x2100	Breaker is controlled via DCS.
	All	Bus-Local control	0x2104	DCS allows control via local HMI.
CB Close	Breaker	Close	0x6900	Closes breaker
CB Open	Breaker	Open	0x6800	*Opens breaker*
CB Reset	Breaker	Reset of Circuit Breaker	0x6A00	Resets circuit breaker status. Without this command is it not possible to re-close CB.
Trip Reset	Breaker	Trip Reset	0x6100	Resets trip information stored in Programmable Release
Wink Toggle	Breaker	Wink Toggle Command	0x6B00	Starts or stops blinking of breakers LCD display
Nop	Breaker	Nop Command	0x6000	No operation command

General Purpose Outputs Commands

It is possible with the M*Control* to utilize General Purpose Outputs for various function in connection with logic blocks and or control functions. The General Purpose Outputs are configured with M*Navigate* with respect to individual M*Controls*. Please refer to the M*Navigate* Help file for more information.

Two types of output registers are supported;

Persistent	The status of these registers are maintained during the Re-Boot of the M*Control*.
Non – Persistent	The status of these registers are not maintained the Re-Boot of the M*Control*.

For setting of digital signals there a 8 persistent and 8 non persistent registers per MControl. For analogue there is 1 persistent and 1 non persistant.

Table 28 **Setting and Resetting of Persistent General Purpose Outputs**

Operation Type	Drive Type	Description	Modbus Command	Remarks
Set	All	Set GPO1	0x0601	Sets GP01 to ‘ON’
		Set GPO2	0x0602	Sets GP02 to ‘ON’
		Set GPO 3	0x0604	Sets GP03 to ‘ON’
		Set GPO 4	0x0608	Sets GP04 to ‘ON’
		Set GPO 5	0x0610	Sets GP05 to ‘ON’
		Set GPO 6	0x0620	Sets GP06 to ‘ON’
		Set GPO 7	0x0640	Sets GP07 to ‘ON’
		Set GPO 8	0x0680	Sets GP08 to ‘ON’
Reset		Reset GPO 1	0x1601	Resets GP01 to ‘OFF’
		Reset GPO 2	0x1602	Resets GP02 to ‘OFF’
		Reset GPO 3	0x1604	Resets GP03 to ‘OFF’
		Reset GPO 4	0x1608	Resets GP04 to ‘OFF’
		Reset GPO 5	0x1610	Resets GP05 to ‘OFF’
		Reset GPO 6	0x1620	Resets GP06 to ‘OFF’
		Reset GPO 7	0x1640	Resets GP07 to ‘OFF’
		Reset GPO 8	0x1780	Resets GP08 to ‘OFF’

Table 29 **Setting and Resetting of Non Persistent General Purpose Outputs**

Operation Type	Drive Type	Description	Modbus Command	Remarks
Set	All	Set GO 1	0x0701	Sets G01 to 'ON'
		Set GO 2	0x0702	Sets G02 to 'ON'
		Set GO 3	0x0704	Sets G03 to 'ON'
		Set GO 4	0x0708	Sets G04 to 'ON'
		Set GO 5	0x0710	Sets G05 to 'ON'
		Set GO 6	0x0720	Sets G06 to 'ON'
		Set GO 7	0x0740	Sets G07 to 'ON'
		Set GO 8	0x0780	Sets G08 to 'ON'
Reset		Reset GO 1	0x1701	Resets G01 to 'OFF'
		Reset GO 2	0x1702	Resets G02 to 'OFF'
		Reset GO 3	0x1704	Resets G03 to 'OFF'
		Reset GO 4	0x1708	Resets G04 to 'OFF'
		Reset GO 5	0x1710	Resets G05 to 'OFF'
		Reset GO 6	0x1720	Resets G06 to 'OFF'
		Reset GO 7	0x1740	Resets G07 to 'OFF'
		Reset GO 8	0x1780	Resets G08 to 'OFF'

Commands in following table are available only in user mapping as bit commands:

Table 30 **Setting and Resetting of Non Persistent and Persitent General Purpose Outputs by bit commands**

Operation Type	Drive Type	Description	Modbus bit Command	Remarks
Set or Reset	All	GO 1	1 or 0	Sets G01 to 'ON' or 'OFF'
		GO 2	1 or 0	Sets G01 to 'ON' or 'OFF'
		GO 3	1 or 0	Sets G01 to 'ON' or 'OFF'
		GO 4	1 or 0	Sets G01 to 'ON' or 'OFF'
		GO 5	1 or 0	Sets G01 to 'ON' or 'OFF'
		GO 6	1 or 0	Sets G01 to 'ON' or 'OFF'
		GO 7	1 or 0	Sets G01 to 'ON' or 'OFF'
		GO 8	1 or 0	Sets G01 to 'ON' or 'OFF'

Set or Reset		GPO 1	1 or 0	Sets GP01 to ‘ON’ or ‘OFF’
		GPO 2	1 or 0	Sets GP01 to ‘ON’ or ‘OFF’
		GPO 3	1 or 0	Sets GP01 to ‘ON’ or ‘OFF’
		GPO 4	1 or 0	Sets GP01 to ‘ON’ or ‘OFF’
		GPO 5	1 or 0	Sets GP01 to ‘ON’ or ‘OFF’
		GPO 6	1 or 0	Sets GP01 to ‘ON’ or ‘OFF’
		GPO 7	1 or 0	Sets GP01 to ‘ON’ or ‘OFF’
		GPO 8	1 or 0	Sets GP01 to ‘ON’ or ‘OFF’

Table 31 **Setting Analog General Purpose Outputs**

Operation Type	Drive Type	Description	Modbus Command	Remarks
Set	All	Set APO 1	0x8nnn	Sets APO1 to Value ‘nnn’
Analog Output		Persistent		‘nnn’ is a hex value. Decimal range of value is 0 to 1023 means 0.0..102.3%. (See following examples)
Set	All	Set AO 1	0x9nnn	Sets AO1 to Value ‘nnn’
Analog		Non Persistent		

Example for Setting Analog Output HEX values required

0x9000 Sets AO1 to value 0 (minimum)

0x9001 Sets AO1 to value 1 (0.1%)

0x9064 Sets AO1 to value 100 (10%)

0x90FA Sets AO1 to value 250 (25%)

0x9100 Sets AO1 to value 256

0x91F4 Sets AO1 to value 500 (50%)

0x93E8 Sets AO1 to value 1000 (100%)

0x93FF Sets AO1 to value 1023 (maximum)

For more details on setting of scaling factors of the AI / AO applications please refer to the M*Navigate* help file, (M*Start* Function, Measurement scaling section).

Refer to M*Navigate* help file of M*Control* I/O for persistent and non-persistent output signals.

Switching Commands– Bit Control

The bit control command gives the possibility to control a starter by setting of a single bit. (In addition to control a starter by command codes as described in previous chapter.)

16 single command bits are located in one Modbus word register. More than one bit can set at simultaneously. For example it is possible to set a MControl to remote and to start it with one Modbus register write command.

Function Codes

Depending from Modbus function code the commands are handled as described below.

Function 06: Commands (bit =1) are always sent to MControl, regardless of any change to the command bit value.

Function 16: Commands to 0) Are sent only when the command bit is toggled, (either 0 to 1 or 1

The following tables detail the registers, bit functionalities and show examples of utilizing Modbus bit commands.

To ensure optimal performance, an MControl (via the MLink) can accept a maximum of 6 bit commands per second.

Table 32 Default Modbus Bit Command Registers

Modbus Function Code	Modbus-Register	Device Number	Modbus Register Name	Description/Remarks
6/16	45001	1	Bit Commands	**Note:** content of the register indicates up to 16 commands
6/16	45002	2	Bit Commands	
6/16	45003	3	Bit Commands	
6/16	:	:	:	
6/16	:	:	:	
6/16	45060	60	Bit Commands	

Table 33 Default Bit Map Control commands for M*Control*

Execution order is from highest (bit 15) to lowest bit (bit 0).																
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 09	Bit 08	Bit 07	Bit 06	Bit 05	Bit 04	Bit 03	Bit 02	Bit 01	Bit 00	Register 45001
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Device Number
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 09	Bit 08	Bit 07	Bit 06	Bit 05	Bit 04	Bit 03	Bit 02	Bit 01	Bit 00	Register 45002
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	Device Number
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 09	Bit 08	Bit 07	Bit 06	Bit 05	Bit 04	Bit 03	Bit 02	Bit 01	Bit 00	Register 45060
60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	Device Number
Remote	Bus Local	Soft Local	Reset	Stop	Start (CW)	Start CCW	Close K1	Open K1	Not used	Reset GPO3	Set GPO3	Reset GPO2	Set GPO2	Reset GPO1	Set GPO1	Bit Function
	The content of the register indicates the command															

Please Note:

Actuator drive type control and MConnect is not supported with ‘Bit Control’.

Following table shows how to control a starter by control command bits

Execution order is from highest (bit 15) to lowest bit (bit 0).

Table 34 **Possible Control Command bit combinations**

Execution order is from highest (bit 15) to lowest bit (bit 0).																
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 09	Bit 08	Bit 07	Bit 06	Bit 05	Bit 04	Bit 03	Bit 02	Bit 01	Bit 00	Control command
Remote	Bus Local	Soft Local	Reset	Stop	Start (CW)	Start CCW	Close K1	Open K1	Not used	Reset GPO3	Set GPO3	Reset GPO2	Set GPO2	Reset GPO1	Set GPO1	
1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	Remote + Stop
1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	Remote + CW
1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	Remote + CCW
1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	Remote + K1 close
1	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1	Remote + trip reset + Start + Set GPO2 + Set GPO1
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	Go to Soft local
1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	Set GPO's 1,2,3

Redundant MLink MODBUS data

The following additional data mapping is provided for a redundant data interface to determine the status of M*Link* (Primary/Backup, Redundancy Error). It is also possible to send commands to force a change-over.

Please refer to the Redundancy Manual for further details.

Table 35 Redundant data for monitoring by the Modbus master

Modbus Function Code	Modbus-Register	Device Number	Modbus Register Name	Format	Description/Remarks
2	12001		Primary M*Link*	Bit	Set to 1 indicates M*Link* is Primary
2	12002	-	Redundancy Error	Bit	Set to 1 indicates Redundancy error.

Table 36 Redundant Command possible from the Modbus master

Modbus Function Code	Modbus-Register	Device Number	Modbus Register Name	Format	Description/Remarks
6/16	44001	-	Force to changeover to Backup M*Link*	Unsigned Integer 2Byte	Master must send 0x0001 to force to changeover
	This command may be sent to either the Primary or Backup M*Link* to initiate a changeover.				

Control Access

Control Access (CA) is a mechanism within MNS *i*S to define and determine which user interface has control rights to operate the M*Start* or M*Feed* modules. These interfaces are defined below in command handling. Control Access rights can be given, for example, by a specific command sent to switch operation rights from push-button (hardwired to M*Control*) to any other interface connected via the M*Link* (e.g. M*View* or DCS).

Command Handling

The control access command defines the control rights of defined interfaces for an M*Control*.

Remote - M*Control* switches to Remote operation mode and can be operated via Fieldbus from process control system (DCS / PLC)

Bus-Local - M*Control* switches to the Bus-Local mode and operation is possible:

- via M*View* (local operation panel in switchboard) or
- via web interface (similar to M*View*).

Soft-Local - M*Control* switches to local mode, and operation is possible via the digital inputs on the M*Control.* Soft Local does not require a hardware input to be set. Soft-Local may only be activated by a command sent from the DCS or M*View*. It may also be configured directly in the M*Control* parameters.

Hardware-Local - M*Control* switches to the Hardware-Local mode and operation is possible only through digital inputs on M*Control* Hardware. Hardware-Local must be activated by the setting the input on the M*Contro*l

Table 37 **Commands and status for Control Access (default map)**

	Command	Command	Command	Status Bit
CA Interface	**Auto Mode (CA Remote)**	**Soft Local (CA SoftLocal)**	**Bus Local (CA BusLocal)**	**Auto Mode (Bus Control)**
DCS only	1	0	0	1
M*View* (Web interface)	0	0	1	1
Hardware Inputs (Hardware Local or Soft Local)	0	1	0	0
Hardware Local (Hardware Inputs)	X	X	X	0
	The Remote signal may be monitored / mapped by selecting the ‘CA Remote’ Input Signal in the parameterization options in M*Navigate*, it can then be utilized in conjunction with the ‘General Purpose Inputs’ of the M*Control*, see Table 6. This is also possible by monitoring the Extended Status, see Table 18.			

Notes:

At any time any control station can obtain the control access by sending a control access command to M*Control*. On M*View* (or web interface) the user must have the appropriate user right to do so.

Hardware-Local must be activated by the setting the input on the M*Contro*l.

CA Remote is set if the command ‘Remote Control’ command is sent to the M*Control* from the DCS. Only then it is possible to send switching commands from the DCS.

CA SoftLocal (or CA BusLocal) will be active if Auto Mode is not set and the Soft Local (or Bus Local) command bit goes from 0 to 1.

Hardware-Local overrides all other CA Levels. It is not possible for the DCS or MView to take control when the MControl is set to HW-Local.

The current active control station (Control Access Owner) can be identified by reading data through DP-V1 functionality, see Table 25.

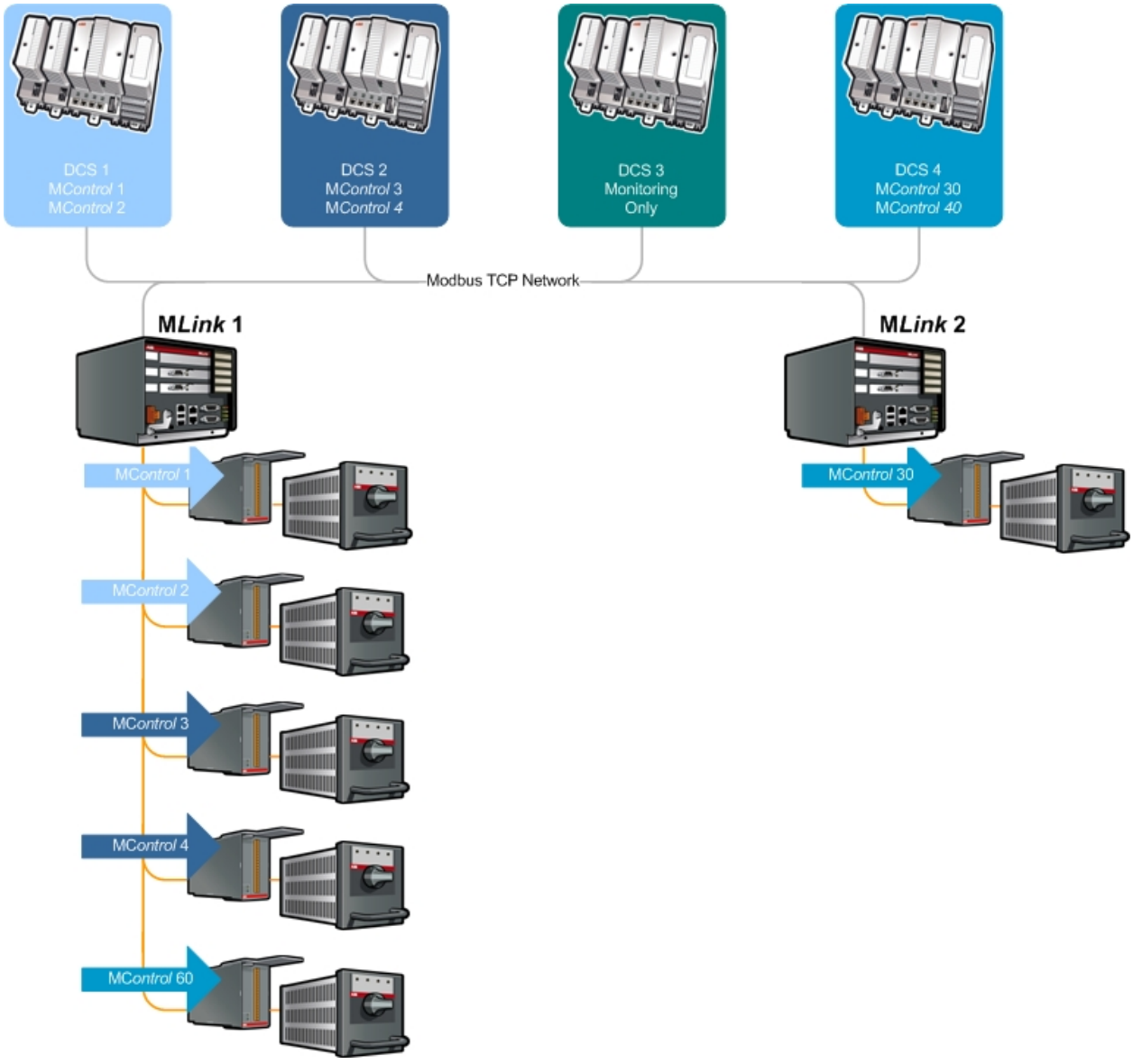
Recommended procedure for sending control commands for a motor starter

1. Set the M*Control* to "Remote" with the command “0x2100”
2. Set the desired state, "Run Reverse", "Off", "Run Forward" or "Trip Reset"
3. Wait until desired state is shown in motor state (received from Slave).
4. Reset previous command "Run Reverse", "Off", "Run Forward" or "Trip Reset"

Extended Failsafe for Modbus TCP

This function allows supervision of the communication path between the DCS and each M*Control*. If the DCS or DCS communication fails only the related (configured) M*Controls* activate failsafe mode. The M*Control* executes the parameterized action (e.g. Stop the motor, Start the motor, etc. *-> for details ref. to Failsafe description of each motor starter type in the MNavigate Help File*).

Following examples explains the general functionality:



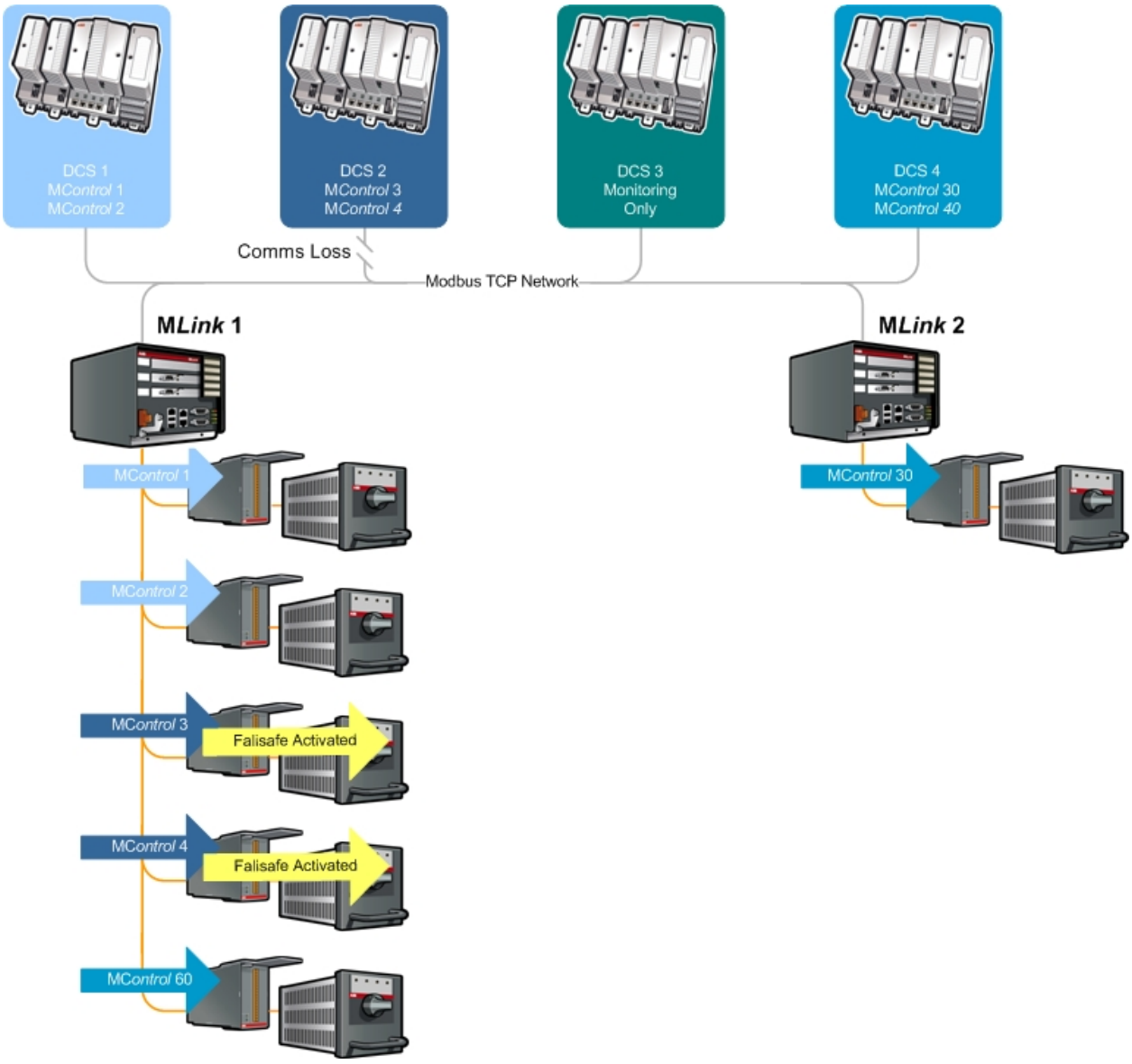
- DCS 1 controls M*Control* 1 and 2 connected to M*Link* 1
- DCS 2 controls M*Control* 3 and 4 connected to M*Link* 1
- DCS 3 monitors only several M*Controls* connected to M*Link* 1 or 2
- DCS 4 controls M*Control* 60 and M*Control* 30 of a second M*Link* 2

Failure examples

The following scenarios shows failure handling in a non redundant system and redundant systems.

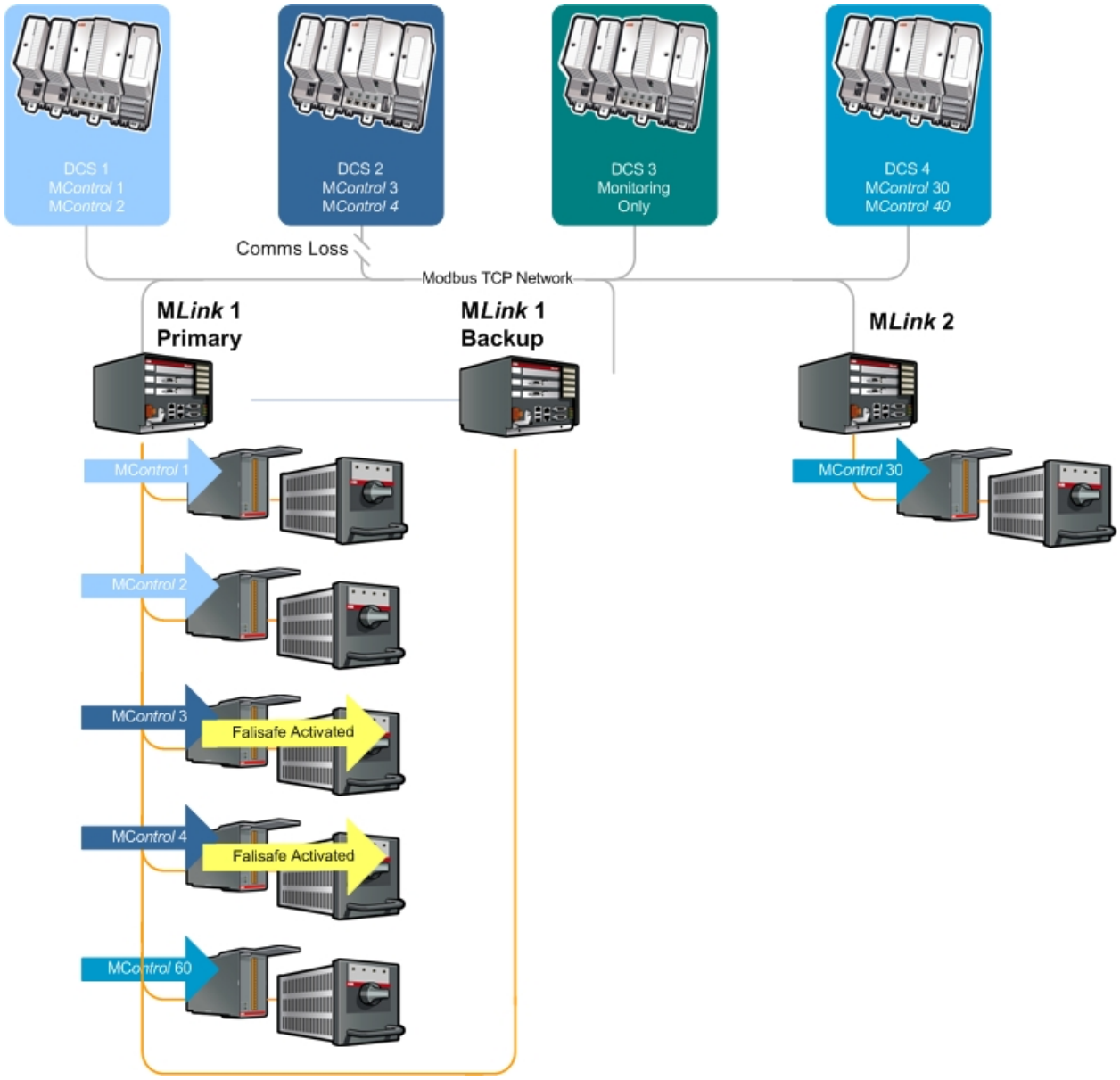
Non-Redundant system - One DCS controller fails

DCS 2 is unavailable (e.g. Ethernet cable broken or power loss); only M*Control* 3 and 4 go to Failsafe mode :



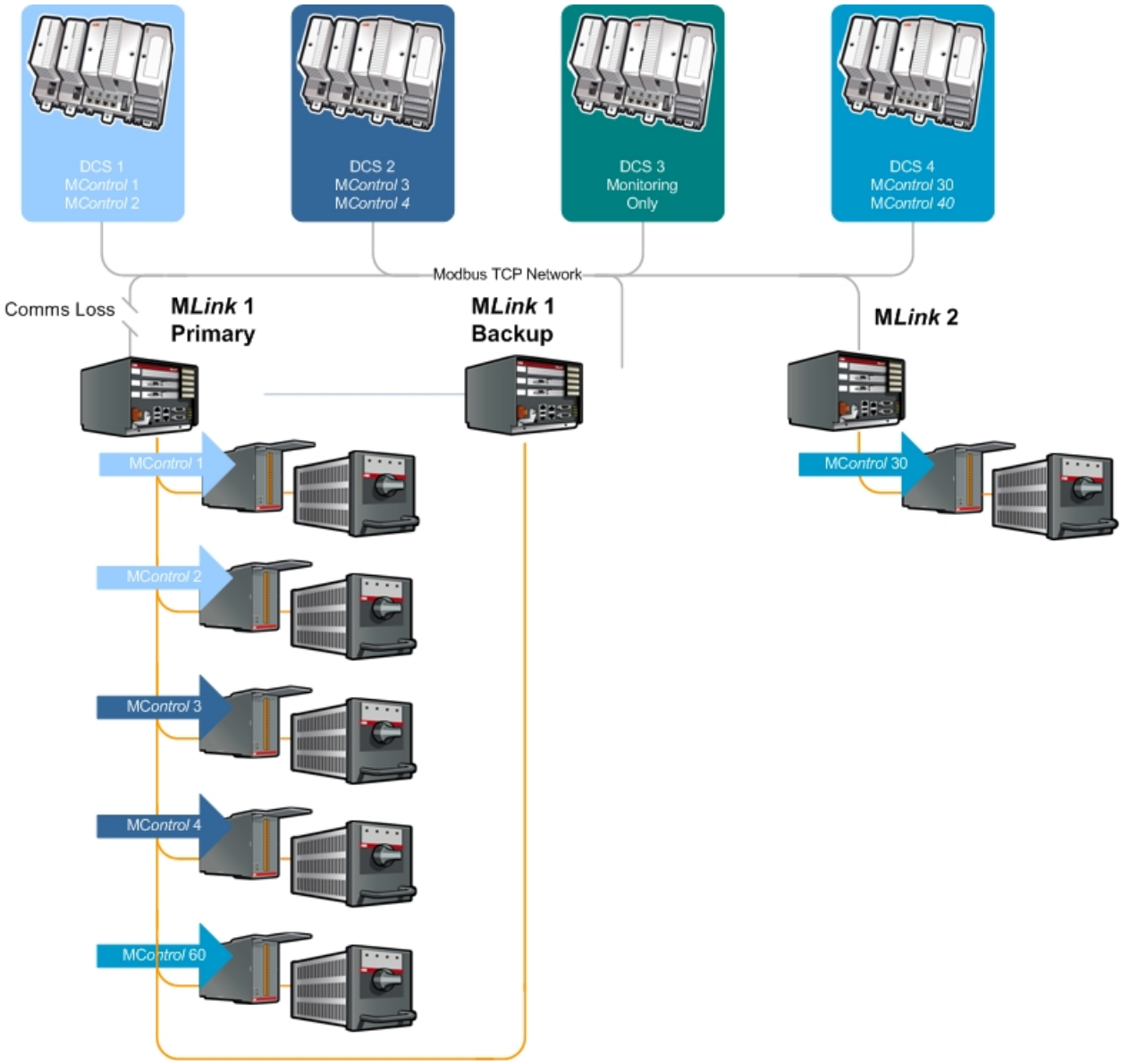
Redundant system loss of controller.

In this example DCS 2 is Off line / unavailable, - again M*Control* 3 and 4 go to Failsafe mode.



Redundant system loss of communication to M*Link*.

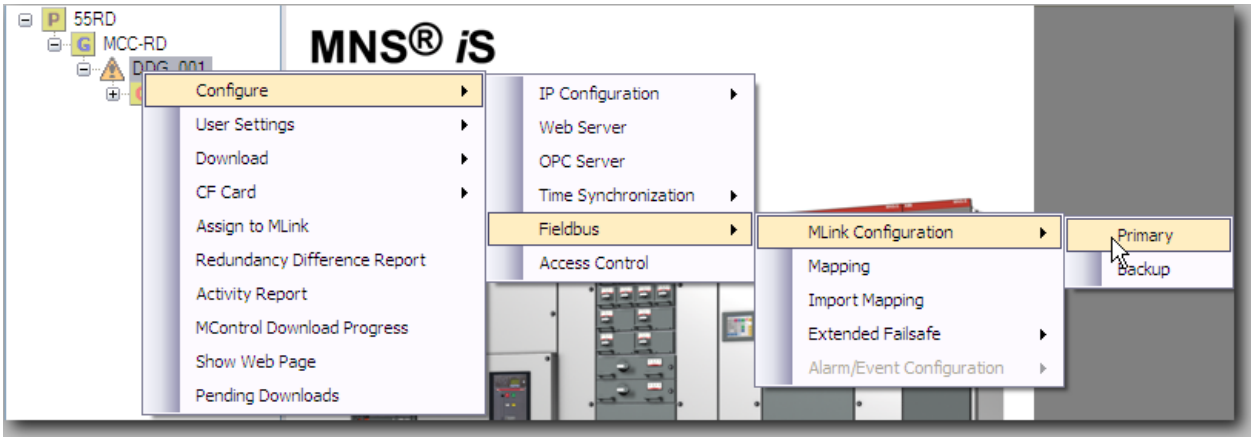
In this example DCS 2 is available, however communication has been lost to the Primary M*Link.* As the redundancy handling is executed between Primary and Backup M*Links*, no Failsafe is activated. For more information please refer to the Redundancy Interface Manual..

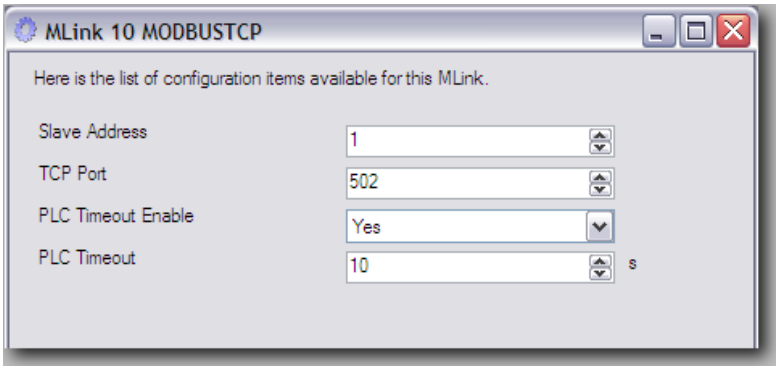


Parametrization of Extended Failsafe in MNavigate

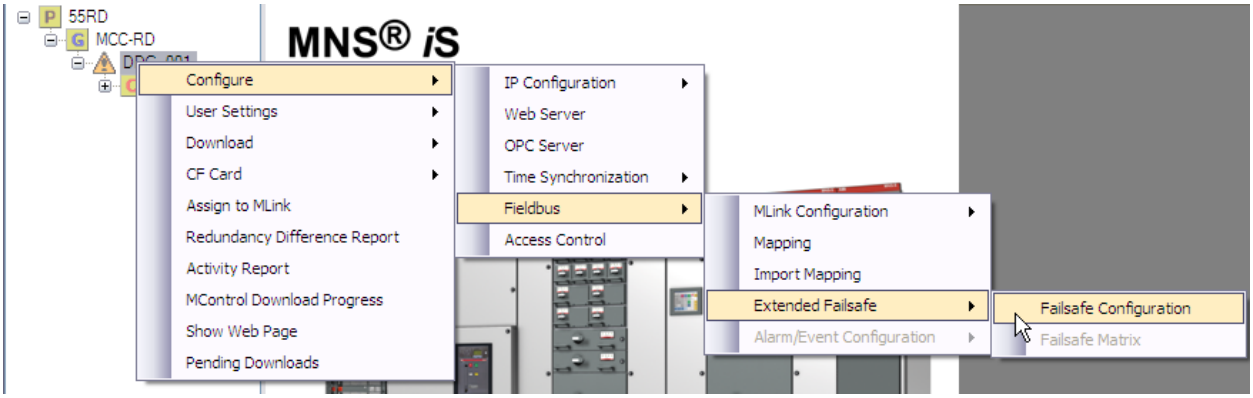
For more information please refer to the M*Navigate* Help File

Extended Failsafe Configuration menu is enabled with the following steps.

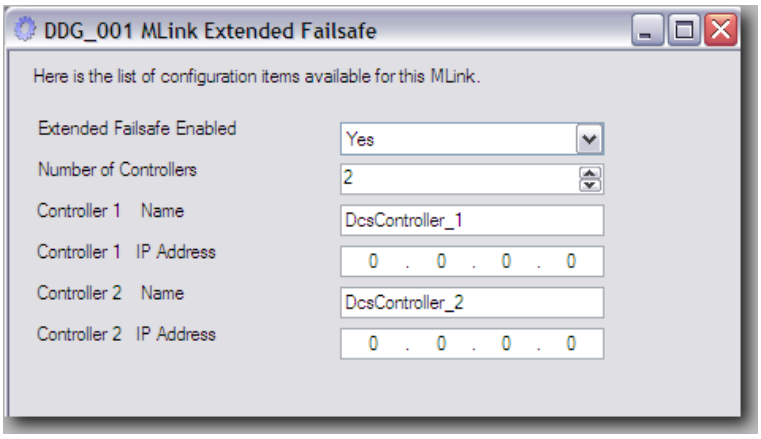




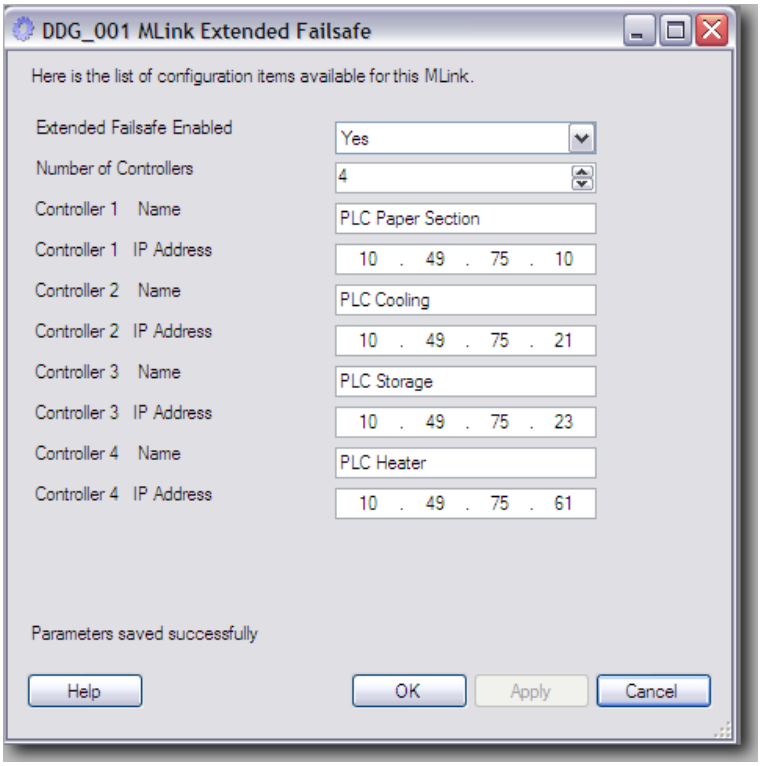
Once the 'PLC Timeout Enable' has been set to 'Yes' it is then possible to enter the 'PLC Timeout' time in seconds. Following this the 'Exte



The 'Extended Failsafe' function must then be activated.



This then enables the number of 'Controllers' (DCS / PLC) to be set, names for each controller can be given an the IP Address for each must be entered.



Examples of setting shown.

Notes: The Extended Failsafe settings must be configured individually for each M*Link* in the project !

The maximum number of configurable controllers is 12.

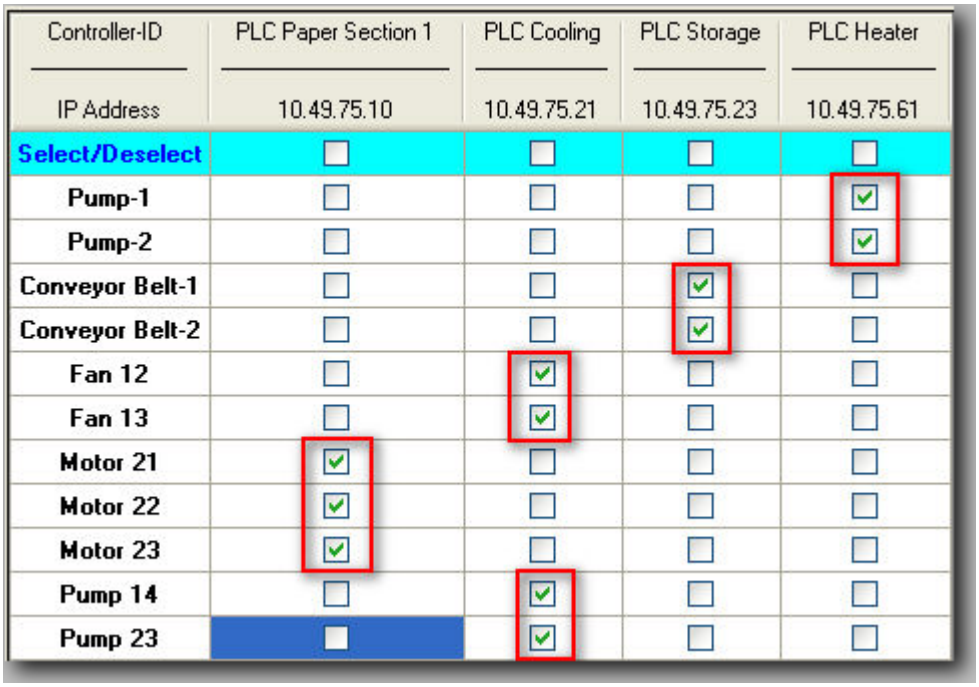
Note: If number of controller is increased then each new controller has the default address 0.0.0.0 and a default controller name to indicate that the settings must be parameterised!

Whenever a controller is added or deleted this procedure and the following Failsafe Matrix must be updated.

Failsafe Matrix

After the Extended Failsafe Configuration is finished user can start to specify the relation between DCS Controller and the M*Control* (e.g. motor) in the Failsafe Matrix.

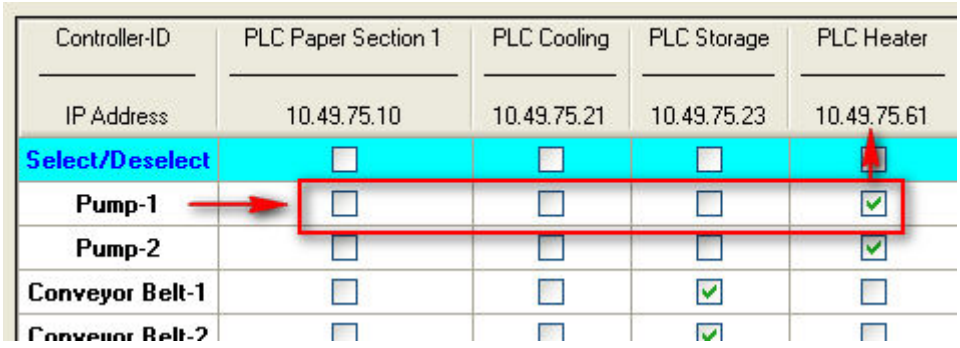
To specify a connection simply the check the respective box.



The first column shows all configured devices connected to the selected M*Link*.

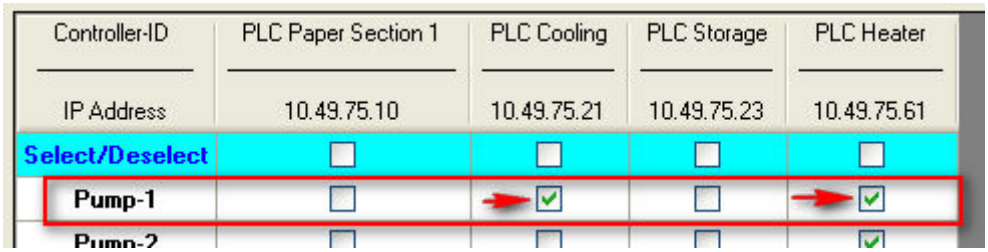
The following columns show the given DCS Controller names and the related specified IP address (as configured in the Extended Failsafe Configuration window)

In following example Failsafe mode is initiated for "Pump-1" if communication between M*Link* and DCS Controller 10.49.75.61 fails, irrespective of communication status of the other configured DCS Controllers:



It is possible to assign a M*Control* to multiple controllers (multiple master). Where this is the case Failsafe mode is only executed when communication from the M*Link* is lost to all selected controllers, as below.

Controllers with IP 10.49.75.21 and 10.49.75.61 must both loose communication to the M*Link* and, only then the motor "Pump 1" will activate Failsafe mode.



For the example above, communication must be lost to both ‘PLC Cooling’ and ‘PLC Heater’ for ‘Pump 1’ to activate the failsafe command.

Downloading Extended Failsafe configuration to M*Link*

Following the finalisation of the Failsafe matrix these settings now require to be downloaded to the respective M*Link*.

Troubleshooting

LED - Status Information

For further details on LED indication please refer to the M*Link* Interface Manuals, reference hereunder.

Hardware ID numbers	1TGE1020x9Rxxxx	1TGE120021R0010
MLink Types		
Hardware available for MNS iS Versions	up to V6.0	from V6.1 onwards
MNS iS Interface Manual **MLink**	1TGC 91012x M020x	1TGC 91021x M020x

Comms check

If it is not possible to achieve communications between the Modbus master and the M*Link*, in the first instance please check the following:

For Modbus RTU Cable connection and Termination are all in line with the requirements detailed in the Serial Link connections section.

Slave address parameters for RTU should in line with the ranges defined in Table 1

Slave address parameters for Modbus TCP should in line with the ranges defined in Table 2. In addition please also check the following:

IP Address settings required	
IP Address LAN1 10 . 49 . 46 . 101 Subnet Mask LAN1 255 . 255 . 255 . 128 Broadcast Address LAN1 10 . 49 . 46 . 127 Default Gateway LAN1 10 . 49 . 46 . 1	For further clarifications with respect to Modbus TCP network setting, please contact the responsible network administrator for the project. Note: The Broadcast address is calculated by MNavigate from a combination of the IP Address and the Subnet mask.

Contact us

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