Motor control and protection unit
M10x user guide

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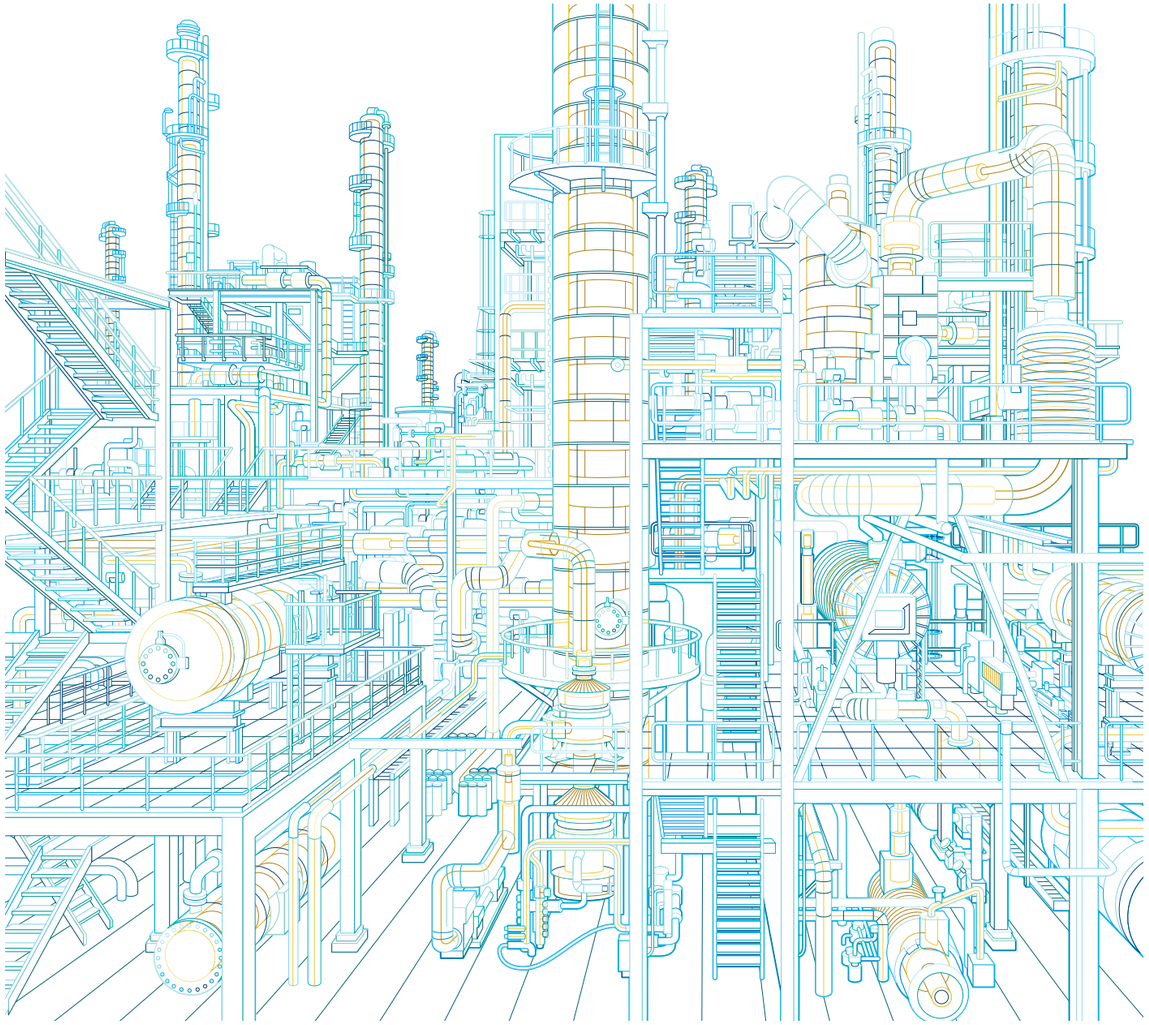

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General

Target group

The manual is primarily intended for those requiring information on the applications of M10x for the purpose of understanding, engineering, wiring and operating the product.

The objective of this manual is to provide the technical functions description of M10x.This manual should be studied carefully before installing, parameterizing or operating the motor control unit. It is assumed that the user has a basic knowledge of physical and electrical fundamentals, electrical wiring practices and electrical components.

This document should be used along with M10x Parameter Description, which provides detailed information about parameters and their applications.

Use of warning, caution, information and tip icon

This publication includes Warning, Caution, and Information icons where appropriate to point out safety related or other important information. It also includes Tip icons to point out useful hints to the reader. The corresponding symbols should be interpreted as follows:

	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 hazard that could result on 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 terms, acronyms, abbreviations and definitions used in the document:

Abbreviation	Term	Description
	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.
DCS	Distributed control system	High level distributed control system
	Local hardwiring	A control access term describing that the M10x accepts its commands from the hardwired inputs, when the local control authority is enabled.
PCS	Process control system	High level process control system
	MODBUS	Fieldbus communication protocol
	MODBUS RTU	Fieldbus communication protocol
	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).
PTC	Positive temperature coefficient	PTC thermistors are semiconductor elements with a very high positive temperature coefficient.
RCU	Remote control unit	Local control unit with pushbutton and indicator to operate a device (eg, motor) from field level.
	Remote fieldbus	A control access term describing that the M10x accepts its commands from the fieldbus inputs, when the remote control authority is enabled.
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.
STP	Shielded twisted pair	A type of cable commonly used for signal transmission.
TOL	Thermal overload protection	Protection against overheating caused by overload
	Trip	A consequence of an alarm activated or an external trip command from another device to stop the motor or trip the circuit breaker.
MCC	Motor control center	Common term for a switchgear used for motor control and protection.
SOE	Sequence of events	A record of events with time stamp.

Related documentation

1TNC 911105M0205 M10x Parameter Description
1TNC 911507M0207 M10x-P Profibus Protocol Implementation
1TNC 911505M0206 M10x-M MODBUS protocol Implementation
1TNC 911104M0205 MCUSetup User Guide

Related System Version

The content of this document is related to M10x products with the following hardware and firmware version release:

	HW	FW
M10x-M 24VDC	2.0	3.0
M10x-M 110VAC	1.0	3.0
M10x-M 240VAC	1.0	3.0
M10x-P 24VDC	3.2	5.0
M10x-P 110VAC	1.0	5.0
M10x-P 240VAC	5.2	5.0
MD21	1.0	1.0
MD31	1.0	1.0

Until further notice, this document is also applicable for future firmware versions other than those listed above.

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

Document revision history

Revision	Page(s)	Description of change	Date
D0201		Initial Edition	10/2003
D0202		Product revisions	10/2005
D0203		Revise COM terminals; Revise terminology of control authority. Revise earth fault setting.	10/2007
D0204		Template changed as per BU Guideline.	10/2010
D0205		Released for M10x products with new hardware, suitable for both M10x-M and M10x-P	01/2013
D0206		Feature "Ready to start" is added to DO	07/2013

New features available in enhanced products

In comparison with previous firmware and hardware revisions:

General features	
1	One single type of integrated CT ranging from 0.24~63A replaces all 6 types of CTs in previous products.
2	Products with options for 110VAC or 240VAC power supply and DI types are available in addition to 24VDC option.
3	Additional SOE function in M102 provides event recorder data up to 256 events with time stamp.
4	Products in the same categories are made with the same features and functionalities and are only different in power supply and communication interface from each type. For example, M101's range of products has identical functionalities regardless of different types of power supply and interfaces, such as M101-M 24VDC, M101-P 240VAC, etc.
Physical dimension	
1	Main unit dimension remains the same as previous revision. MDx panel is slightly larger in width and length (both 3mm extra) while cutout dimension remains the same.
Control features	
1	Contactor feeder & contactor feeder/RCU are added into starter types.
2	Two separate start types are available for two-speed starters. NR_2N is for two-speed motor with separate windings while NR_2N Dahlander is for Dahlander connection motor.
3	Control logic in NR_softstarter and REV_softstarter are modified slightly.
4	Control authority feature in M10x-M has been revised identical to M10x-P.
Digital inputs and outputs	
1	All DIs in M10x are configurable and also selectable with NO or NC.
2	E-stop, Limit 1, Limit 2, External trip input control definition has been revised.
3	More features are added to DOs.
Protection	
1	Long start protection is available to provide stall protection during motor startup.
2	Options are provided to enable or disable TOL protection during motor startup.
3	PTC short circuit protection and PTC open circuit protection are available.
Communication	
1	Additional communication speeds are available for MODBUS: 38400 bps and 57600 bps.
Measuring and monitoring	
1	Additional running data are monitored such as current phase unbalance, thermistor resistor, time to TOL trip, time to TOL reset, startup time, DI status.
2	Phase-to-phase instead of phase-to-neutral voltage is directly measured.
Maintenance	
1	More maintenance features are implemented, including providing number of trips, SOE with time stamp, etc.
Operator panel MDx	
1	MDx is provided as IP54.
2	Color and function of LEDs are selectable.
3	Messages on MD21 are selectable.
4	Two languages are supported, ie, English and Chinese.
5	Parameter setting via MD21 is available.
6	Parameter setting port on MDx is mini USB connector in lieu of USB connector.

Product overview

Introduction

M10x is an intelligent motor control and protection device based on current measurement or current measurement and voltage measurement. Installed in and supplied as part of ABB Low Voltage switchgear MNS®, it is part of a low voltage system family of products that provides customers with an ABB intelligent system solution.

M10x is a microprocessor-based product providing comprehensive but standard features in one device. Standard features simplify maintenance and plant expansion. Each motor starter is equipped with one standard M10x device. With dedicated parameters in each device, M10x provides specific control, monitoring and protection functions, tailored for various motor applications.

Coupled with the world's most common industrial fieldbus interfaces (PROFIBUS DP and MODBUS), M10x integrates smoothly and efficiently into industrial control and plant management systems. Every individual M10x device can be accessed and interrogated to determine both actual and operating parameters. Fast response time for alarm or trip status makes real time control of a complete process possible. Statistical recording of running hours and number of operations assists with predictive maintenance scheduling.

For AC motor and the operated installations this means:
- Reliable protection
- Maximum utilization
- Continuous supervision
- Flexibility

Structure

M10x has two parts:
- Main unit (with current converter unit)
- Operator panel MD21/MD31

Main unit

The main unit is constructed with two parts: the electronics of the motor control unit and the integrated CT. Main unit is a one type device with the integrated CT range starting from 0.24 to 63A. For motor ratings larger than 63A, interposing CTs can be selected.

Main unit is designed with a mounting rail fixed to the bottom of the device for easy vertical DIN rail mounting.

Screws and other mounting accessories also provide for vertical and horizontal screw mounting.

Operator panel MD21/MD31

The operator panel is the user interface mounted on the front door or drawer. With control buttons, LED, LCD module (MD21 only), MD21/MD31 provides functions for motor control, supervision and parameterizing. One operator panel is provided for each main unit upon request.

M10x material

The enclosure of the M10x is made of polycarbonate. Flammability rating of the material is UL 94 V-0 and material is halogen free.

Color of the enclosure is RAL 7012.

For a detailed description of MD21/MD31, refer to the chapter: Accessories.

Fig. 1. M10x and MD21

Mounting of M10x

Basic dimension of M10x
W x H x D=110mm x 140mm x 75mm

Typical installation of M10x
Vertical DIN rail or vertical screw mounting on horizontal plate

Basic dimension of MD21
W x H x D=91mm x 75mm x 24.3mm

Mounting dimension of MD21
W x H=84mm x 68mm

Basic dimension of MD31
W x H x D=88mm x 50mm x 24.3mm

Mounting dimension of MD31
W x H=84mm x 46mm

For installation details of M10x and MDx, see the related documentation installation manual.

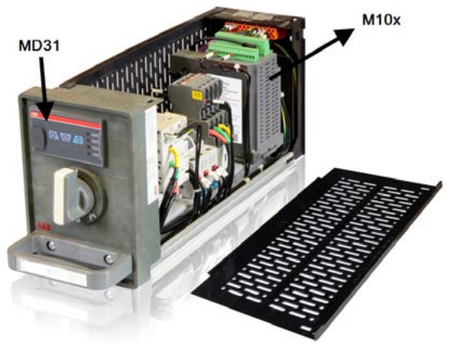


Fig. 2. M10x in 8E/4 module

Interfaces

Terminal blocks of M10x are located on the top of the main unit for easy access. There are 3 sets of I/O terminal blocks and 1 set of RJ11 connectors as shown.

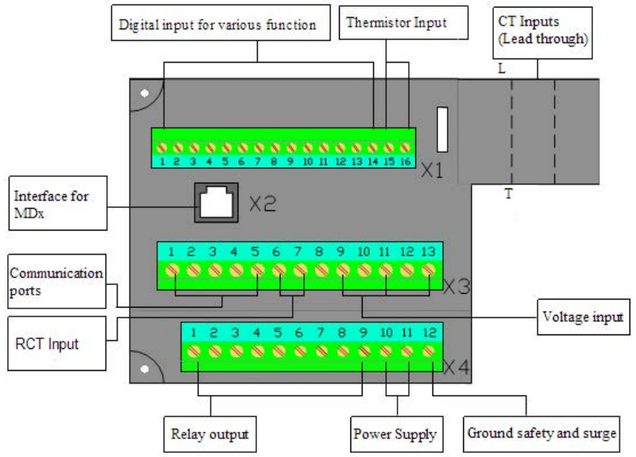
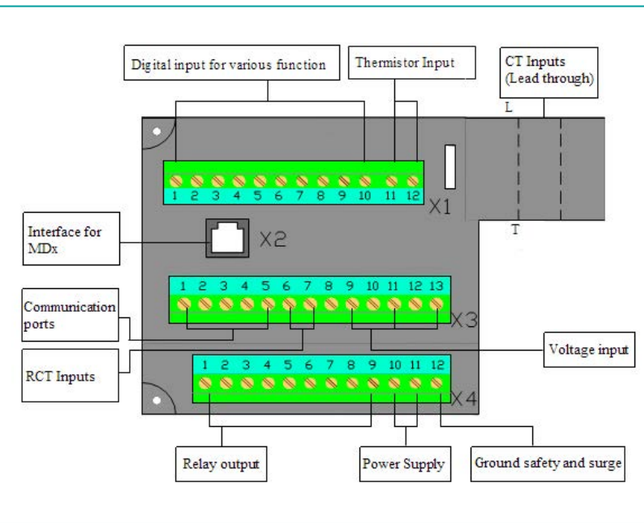


Fig. 3-1. Top view terminal layout (24VDC)



Picture 3-2. Top view terminals layout (110VAC or 240VAC)

Terminal designations

Terminal block		Terminal number	Designation... plug/contacts	Remarks
X1	24VDC type	X1:1...X1:14	Digital input	Cross section 1.5mm2
		X1:15...X1:16	PTC input	
	110/240VAC type	X1:1...X1:10	Digital input	Cross section 2.5mm2
		X1:11...X1:12	PTC input	
X2		X2:1...6	Interface for MDx	Cable with RJ11 connector provided
X3		X3:1...5	Fieldbus for external communication	Cross section 2.5mm2
		X3:6,7	RCT input	
		X3:8...13	Voltage input	
X4		X4:1...9	Relay output	Cross section 2.5mm2
		X4:10,11	Power supply	
		X4:12	Ground	
L1-T1;L2-T2;L3-T3		Lead-through	Current measurement	Φ10mm Window

Table 1. Device terminals

Power supply

Depending on the product type, three types of power supply are available, ie, 24VDC, 110VAC and 240VAC. Power supply of the device should be always derived from an uninterrupted and reliable supply source.

Terminal no.	Name	Description
X4:11	24VDC or L	24VDC +, 110VAC or 240VAC
X4:10	GND or N	0VDC or Neutral

Table 2. Power supply input terminals

Digital input

M10x 24VDC type has 13 DIs and M10x 110/240VAC type has 9 DIs. Digital inputs are cyclically read. Functions of all digital inputs are selectable, and can be assigned to a defined function.

M10x reads the status of input contacts by measuring the voltage drop on inputs:

Terminal no.	Name	Description
X1:1	DI0	Digital input 0
X1:2	DI1	Digital input 1
X1:3	DI2	Digital input 2
X1:4	DI3	Digital input 3
X1:5	DI4	Digital input 4
X1:6	DI5	Digital input 5
X1:7	DI6	Digital input 6
X1:8	DI7	Digital input 7
X1:9	DI8	Digital input 8
X1:10	DI9	Digital input 9
X1:11	DI10	Digital input 10
X1:12	DI11	Digital input 11
X1:13	DI12	Digital input 12
X1:14	DI_COM	Digital input common terminal

Table 3. Digital inputs with 24VDC supply

Terminal no.	Name	Description
X1:1	DI0	Digital input 0
X1:2	DI1	Digital input 1
X1:3	DI2	Digital input 2
X1:4	DI3	Digital input 3
X1:5	DI4	Digital input 4
X1:6	DI5	Digital input 5
X1:7	DI6	Digital input 6
X1:8	DI7	Digital input 7
X1:9	DI8	Digital input 8
X1:10	DI_COM	Digital input common terminal

Table 4. Digital inputs with 110/240VAC supply

i) For 24VDC, it is recommended to use separate supply source for power supply and digital inputs, especially in the case that DI signals are taken from the field which is located a long distance from MCCs.

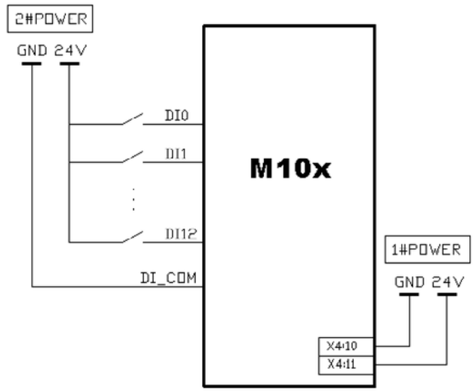


Fig. 4. Illustration of DIs wiring to M10x

PTC input (M102 only)

PTC function is only available in M102 series of products. Type A temperature sensor with a characteristic curve according to IEC 60947-8 to follow the temperature of motor winding is used in the device. PTC connector is located on the top of M102 unit, terminal X1.

i) M101 series of products do NOT have PTC function built in.

ii) It is recommended to short terminal X1:15 and X1:16 together to avoid potential external disturbance when this function is not activated.

iii) STP cable is recommended for PTC circuit connections.

Terminal no.	Name	Description
X1:15	PTCA	PTC measurement input A
X1:16	PTCB	PTC measurement input B

Table 5-1. PTC input terminals (24VDC type)

Terminal no.	Name	Description
X1:11	PTCA	PTC measurement input A
X1:12	PTCB	PTC measurement input B

Table 5-2. PTC input terminals (110/240VAC type)

Fieldbus interface

Selected by different product types, M10x can be used directly on MODBUS RTU or PROFIBUS DP networks. Both types of product are based on physical RS485 layer. Dual RS485 interfaces are provided in MODBUS type of device to support full redundancy network design.

Terminal no.	Name	Description
X3:1	2B	Serial RS485 B
X3:2	2A	Serial RS485 A
X3:3	SHIELD	485 shield
X3:4	1B	Serial RS485 B
X3:5	1A	Serial RS485 A

Table 6. MODBUS dual RS485 interfaces

Terminal no.	Name	Description
X3:1	5V	Power supply 5V+ for bus terminator
X3:2	B	RS485 B
X3:3	A	RS485 A
X3:4	GND	Power supply GND for bus terminator
X3:5	SHIELD	Shield

Table 7. PROFIBUS RS485 interface

Residual current transformer

M10x supports earth fault protection through external residual current transformer (RCT).

Terminal no.	Name	Description
X3:6	Ioa	Residual current transformer input A
X3:7	Iob	Residual current transformer input B

Table 8. Residual current transformer terminals

i) Different sizes or types of RCT are available. Refer to M10x ordering guide for details.

ii) It is recommended to short terminals X3:6 and X3:7 to avoid potential external disturbance when RCT is not in use.

iii) It is recommended to use STP cable for RCT circuit connections.

Voltage measurement (M102 only)

Voltage measurement and protections are available in M102 range of products.

Voltage unit is available in M102 only.

Terminal no.	Name	Description
X3:9	V_{L3}	Phase L3 voltage input
X3:11	V_{L2}	Phase L2 voltage input
X3:13	V_{L1}	Phase L1 voltage input

Table 9. Voltage input terminals

i) When single phase system is selected, voltage measurement is based on phase L1 - phase L3. Connect L to V_{L1}(X3:13) and neutral to V_{L3}(X3:9).

Current measurement terminal

M10x continuously measures three motor phase currents. The phase current data will be used by the protection functions and is reported to the fieldbus. Phase currents are reported as a value relative to the motor nominal current In.

Current wires are fed through current sensors from either side of the terminal.

Direction can be either L->T or T->L considering that all currents must have the same direction.

Motor nominal currents above 63A are not measured directly, but instead intermediate current transformer's secondary side is connected through M10x current measurement terminal.

i) When single phase system is selected, current measurement is based on phase L1.
ii) The measurement range of internal CT is from 0.08A to 63A.

Contactor control output

M10x supports various motor starter types. The control of the contactor by M10x is via internal output relays (CCA, CCB, CCC relays) by the microprocessor.

Internal relays CCA and CCB are hardwire-interlocked to prevent both contactors being closed at the same time.

1) M101 is equipped with CCA and CCB output relays only.
2) For external connecting contactors, spark suppression is necessary for all types of contactors except the AF types to maintain reasonable service life of relays.

Terminal no.	Name	Description	M101	M102
X4:6	CCLI	Contactor control voltage input	✓	✓
X4:7	CCA	Contactor control A	✓	✓
X4:8	CCB	Contactor control B	✓	✓
X4:9	CCC	Contactor control C		✓

Table 10. Contactor control terminals

Digital output

M10x is also equipped with two sets of auxiliary programmable digital output relays which function according to project specific settings.

Terminal no.	Name	Description	M101	M102
X4:1	GR1_A	Contactor control voltage input	✓	✓
X4:2	GR1_B			
X4:3	GR1_C			
X4:4	GR2_A	Programmable relay output 2 (NO)		✓
X4:5	GR2_B			

Table 11. Digital output terminals

The output status of programmable relays may change in response to different assigned functions.

1) M101 is equipped with only one set of output relay (GR1).

2) For external connecting contactors, spark suppression is necessary for all types of contactors except the AF types to maintain reasonable service life of relays.

Interface for MD21/MD31

M10x is connected with operator panel MD21/MD31 using RJ11 interface.

Ground terminal

Terminal no.	Name	Description
X4:12	GROUND	Ground safety and surge

Table 12. Ground terminal

This is an additional ground terminal provided for dissipating transient signals and surges. It must be connected by a thick wire or braid to the system ground for reliable operation.

Typical diagram

Typical wiring diagrams of different types of M10x are shown in this section.

M101 24VDC

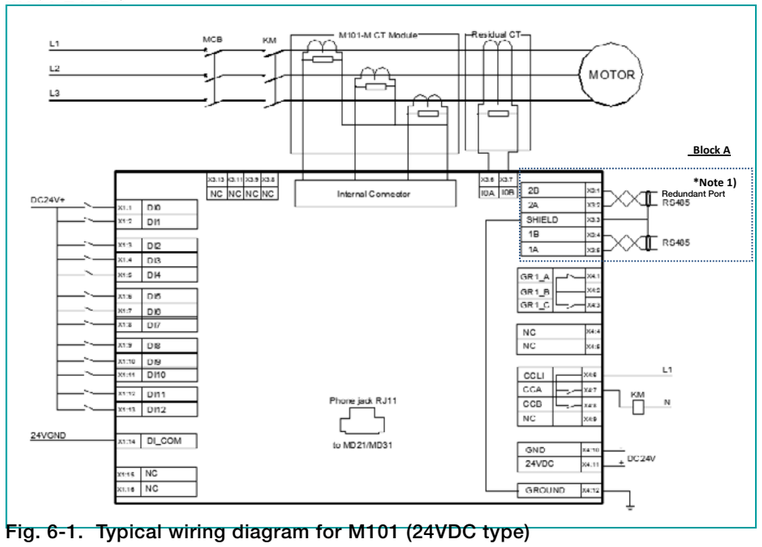
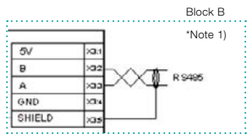


Fig. 6-1. Typical wiring diagram for M101 (24VDC type)

Note 1) Block A shows MODBUS dual RS485 interface. For PROFIBUS interface, Block B below should replace Block A.



Shield and Ground (X4:12) are connected internal of M10x.

Digital output contacts (GR1_A, GR1_B &GR1_C) as shown are floating NC and NO contacts from the same relay and respond to parameter settings.

Eg. when 'Trip' is set to digital output, NO contact will close under healthy conditions. In the case of power loss, contact status will restore as shown.

M101 110VAC or 240VAC

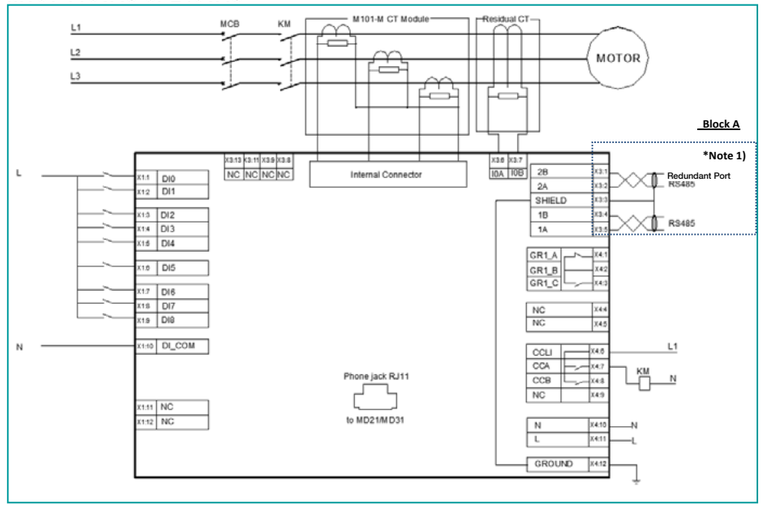
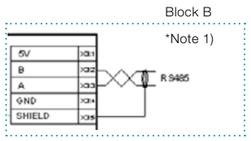


Fig. 6-2. Typical wiring diagram for M101 (110/240VAC type)

Note 1) Block A shows MODBUS dual RS485 interface. For PROFIBUS interface, Block B below should replace Block A.



Shield and Ground (X4:12) are connected inside M10x.

Digital output contacts (GR1_A, GR1_B &GR1_C) as shown are floating NC and NO contacts from the same relay and respond to parameter settings, eg, when Trip is set to digital output, NO contact will close under healthy conditions.In the case of power loss, contact status will restore as shown.

M102 24VDC

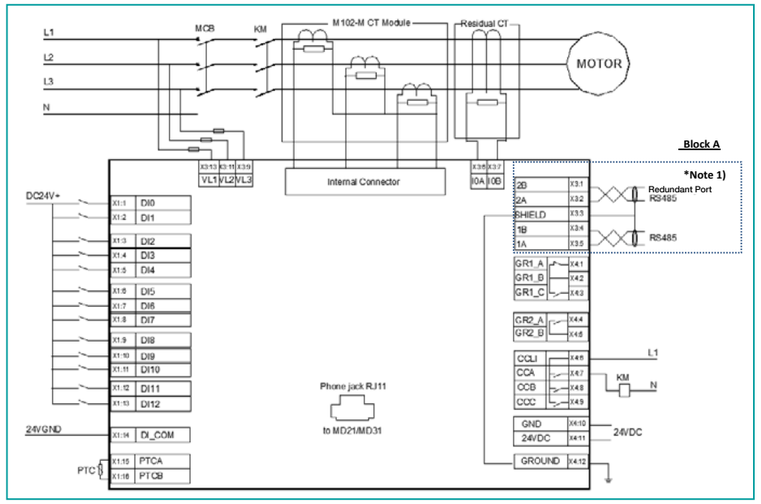
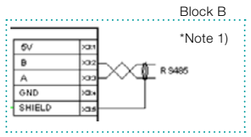


Fig. 7-1. Typical wiring diagram for M102 (24VDC type)

Note 1) Block A shows MODBUS dual RS485 interface. For PROFIBUS interface, Block B below should replace Block A.



Shield and Ground (X4:12) are connected internal of M10x.

Digital output contacts (GR1_A, GR1_B &GR1_C) as shown are floating NC and NO contacts from the same relay and respond to parameter settings, eg, when Trip is set to digital output, NO contact will close under healthy conditions. In the case of power loss, contact status will restore as shown.

M102 110VAC or 240VAC

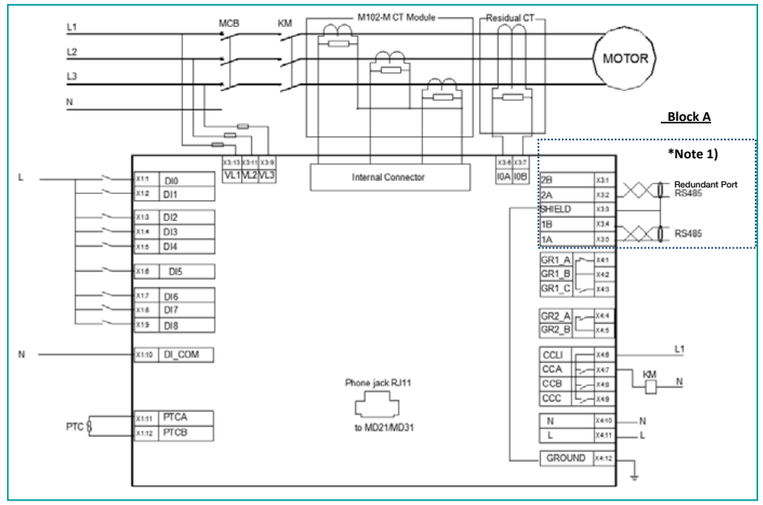
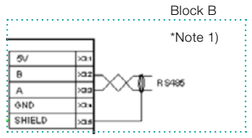


Fig. 7-2. Typical wiring diagram for M102 (110/240VAC type)

Note 1) Block A shows MODBUS dual RS485 interface. For PROFIBUS interface, Block B below should replace Block A.



Shield and Ground (X4:12) are connected inside M10x.

Digital output contacts (GR1_A, GR1_B &GR1_C) as shown are floating NC and NO contacts from the same relay and respond to parameter settings, eg, when Trip is set to digital output, N/O contact will close under healthy conditions. In the case of power loss, contact status will restore as shown.

Starter types

M10x offers various kinds of motor starting control modes via the control of relay output. It supervises the operating state of the contactor according to the feedback of auxiliary contact, predefined feedback timeout and current.

The following starting control modes are offered:

Starter type	M101	M102
NR-DOL	✓	✓
REV-DOL	✓	✓
NR-DOL/RCU	✓	✓
REV-DOL/RCU	✓	✓
Actuator		✓
NR-S/D		✓
NR-2N		✓
NR-2N Dahlander		✓
Autotransformer		✓
NR_softstarter		✓
REV_softstarter		✓
Contactor feeder	✓	✓
Contactor feeder/RCU	✓	✓
Feeder	✓	✓

Table 13. Starter types supported by M10x

- NR_DOL: non reversing direct online
- REV_DOL: reversing direct online
- NR_DOL/RCU: non reversing direct online with RCU
- REV_DOL/RCU: reversing direct online with RCU
- Actuator: actuator with limit switch input
- NR_S/D: non reversing star-delta
- NR_2N: two-speed driver for non reversing starter with separate winding
- NR_2N Dahlander: two-speed driver for Dahlander connection
- Autotransformer: autotransformer starter
- NR_softstarter: non reversing softstarter control
- REV_softstarter: reversing softstarter control
- Contactor feeder: contactor controlled feeder
- Contactor feeder/RCU: contactor controlled feeder with RCU
- Feeder: feeder is regarded as a specific starter mode in M10x

Starter type is selected with a dedicated parameter to match the wiring for contactor and motor control circuits.

i) PIN numbers assigned for DIs in below starters are shown as per default settings and and are subject to change to meet engineering requirements.

ii) Spark suppression is necessary for all types of connecting contactors except AF types through M10x output relays to maintain reasonable service life of the output relays. Interface relays should also be considered in engineering to increase reasonable service life. Interface relay is recommended to be used for contactor type A75 and above.

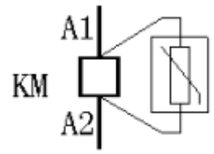


Fig. 8. Surge suppressors on contactor coils

Precautions must be taken in system designs to avoid potential high electromagnetic disturbance which may result in unstable network and malfunction of M10x relays. For example, in applications that variable speed drives are used in a large scale, harmonic filter devices are required in system design to reduce impact to the network.

NR-DOL STARTER

NR_DOL starter is a basic starter type for driving motor in one direction. When start command has been received from field or local I/O, the contactor control output will be energized and remains in this in condition until stop command has been received or any protection function is activated.

Name	Pin	Description
CCLI	X4:6	Contactor control voltage input
CCA	X4:7	Contactor control A
DI6(F_Ca)	X1:7	Contactor control A feedback
DI5(Loc/R)	X1:6	Local/remote control switch input

Table 14. NR-DOL starter contactor control interface (for M10x)

The definition of the terminal X1 in the above list is only an example.

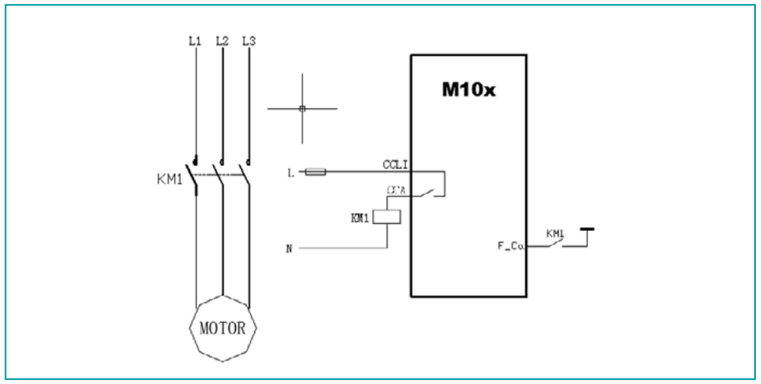


Fig. 9. Control circuit for NR-DOL starter (for M10x)

NR-DOL/RCU STARTER

Remote control unit (RCU) is a starter type where contactors are directly controlled by a special RCU switch located near the motor. This allows control of the motor even without the M10x.

Name	Pin	Description	Remarks
CCLI	X4:6	Contactor control voltage input	
CCA	X4:7	Contactor control A	
GR1_C	X4:3	Programmable relay output	Only for M101
CCC	X4:9	Contactor control C	Only for M102
DI6(F_Ca)	X1:7	Contactor control A feedback	
DI5(Loc/R)	X1:6	Local/remote control switch input	

Table 15. NR-DOL/RCU starter contactor control interface (for M10x)

The definition of the terminal X1 in the above list is only an example.

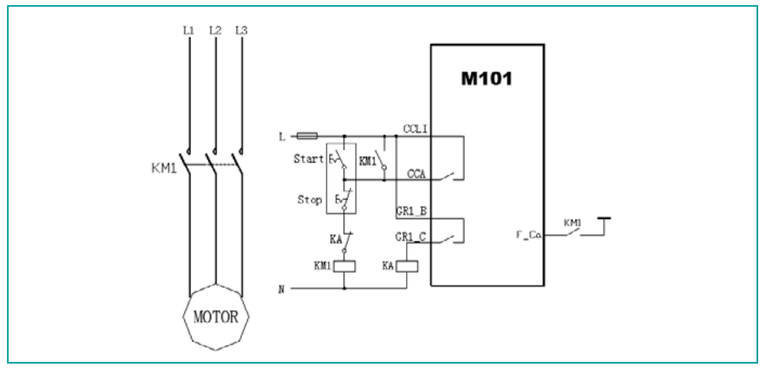


Fig. 10-1. Control circuit for NR-DOL/RCU starter (for M101)

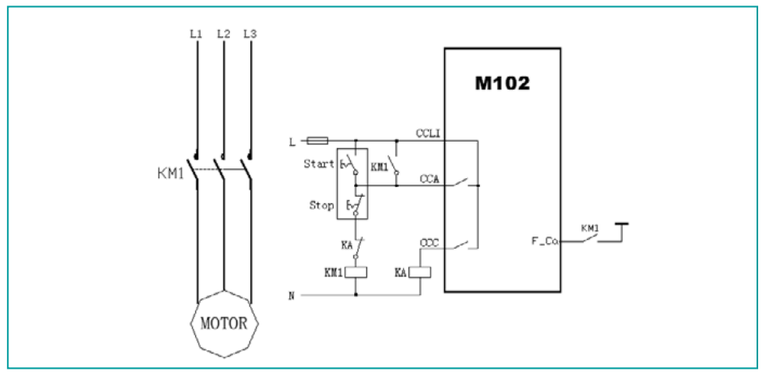


Fig. 10-2 Control circuit for NR-DOL/RCU starter (for M102)

REV-DOL STARTER

REV-DOL uses contactor control output A to control the contactor that drives the motor in direction CW. Correspondingly, contactor control output B is used for direction CCW. When the starting motor to either direction contactor will be energized and is stopped (not energized) by command from fieldbus or local I/O, or active protection function.

Name	Pin	Description
CCLI	X4:6	Contactor control voltage input
CCA	X4:7	Contactor control A
CCB	X4:8	Contactor control B
DI6(F_Ca)	X1:7	Contactor control A feedback
DI7(F_Cb)	X1:8	Contactor control B feedback
DI5(Loc/R)	X1:6	Local/remote control switch input

Table 16. REV-DOL starter contactor control interface (for M10x)

The definition of the terminal X1 in the above list is only an example.

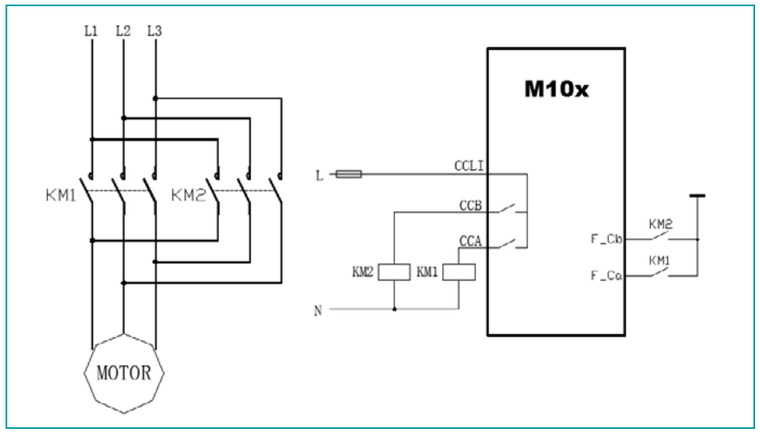


Fig. 11. Control circuit for REV-DOL starter (for M10x)

REV-DOL/RCU starter

The functionality of this starter type is the same as the to NR-DOL/RCU starter with support for reversing use of motor.

Name	Pin	Description	Remarks
CCLI	X4:6	Contactor control voltage input	
CCA	X4:7	Contactor control A	
CCB	X4:8	Contactor control B	
GR1_C	X4:3	Programmable relay output1	Only for M101
CCC	X4:9	Contactor control C	Only for M102
DI6(F_Ca)	X1:7	Contactor control A feedback	
DI7(F_Cb)	X1:8	Contactor control B feedback	
DI5(Loc/R)	X1:6	Local/remote control switch input	

Table 17. REV-DOL starter contactor control interface (for M10x)

The definition of the terminal X1 in the above list is only an example.

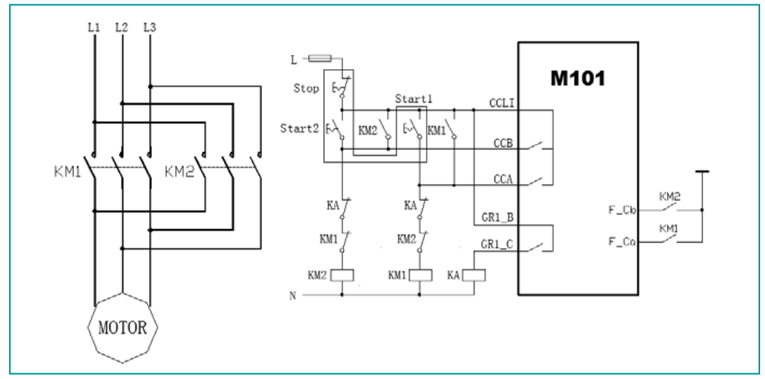


Fig. 12. Control circuit for REV-DOL/RCU starter (for M101)

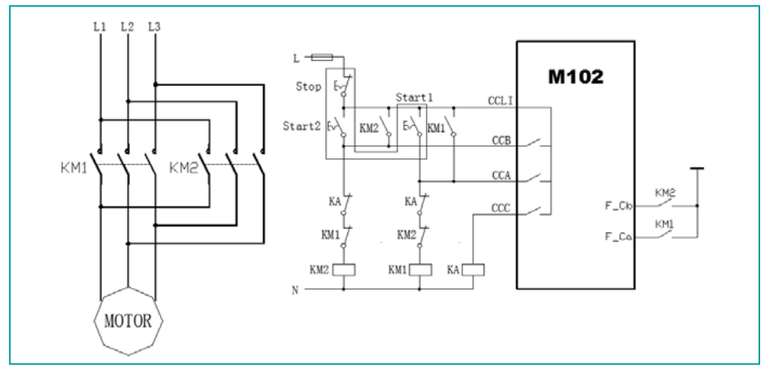


Fig. 13. Control circuit for REV-DOL/RCU starter (for M102)

Actuator starter (M102 only)

This starter type is for controlling valves and actuators by using limit switches

Name	Pin	Description
CCLI	X4:6	Contactor control voltage input
CCA	X4:7	Contactor control A
CCB	X4:8	Contactor control B
CCC	X4:9	Contactor control C
DI0 (Limit1)	X1:1	Limit position switch 1 input
DI1 (Limit2)	X1:2	Limit position switch 2 input
DI9 (Torque)	X1:10	Torque switch input
DI6 (F_Ca)	X1:7	Contactor control A feedback
DI7 (F_Cb)	X1:8	Contactor control B feedback
DI5 (Loc/R)	X1:6	Local/remote control switch input

Table 18. Actuator starter contactor control interface

The definition of the terminal X1 in the above list is only an example.

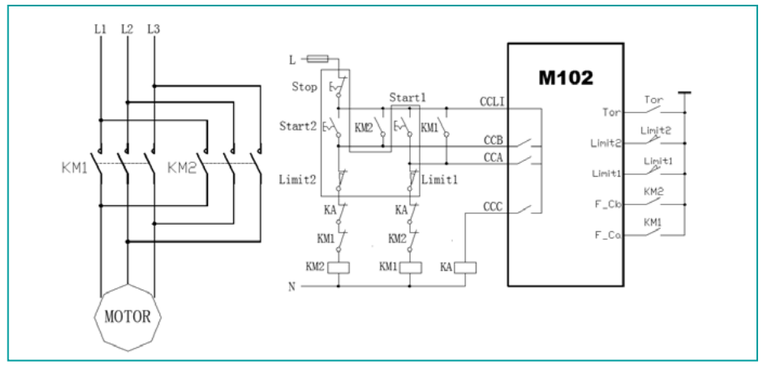


Fig. 14. Control circuit for actuator starter

Limit switch stops the motor when activated. Additionally, the start command is only allowed to reverse direction. Torque switch is selectable by parameterization.

NR-S/D starter (M102 only)

Motor start current is reduced in star connection to 1/3 of the current in delta connection, with lower torque during the same time.

Start-to-delta starting sequence is based on the presented control logic (Figure 15). The changeover condition is time.

The following guideline is applied for selecting parameter values:

Changeover time < Motor startup time

Name	Pin	Description
CCLI	X4:6	Contactor control voltage input
CCA	X4:7	Contactor control A
CCB	X4:8	Contactor control B
CCC	X4:9	Contactor control C
DI5 (Loc/R)	X1:6	Local/remote control switch input
DI6 (F_Ca)	X1:7	Contactor control A feedback
DI7 (F_Cb)	X1:8	Contactor control B feedback
DI8 (F_Cc)	X1:9	Contactor control C feedback

Table 19. NR_S/D starter contactor control interface

The definition of the terminal X1 in the above list is only an example.

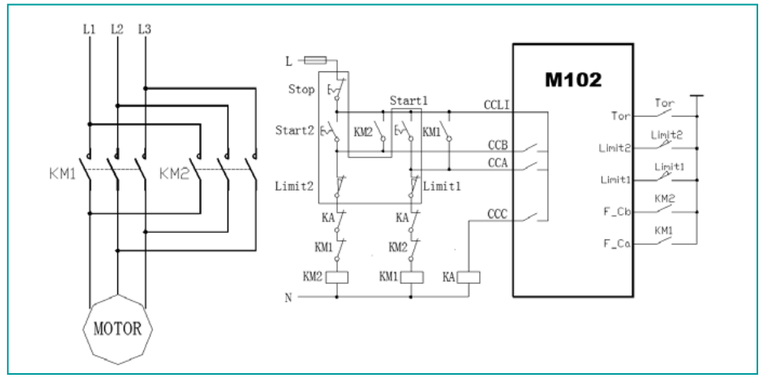


Fig. 15. Control circuit for NR-S/D starter

NR-2N starter (M102 Only)

NR-2N uses two contactors to control motor rotation speed; the motor contains separate windings. Rotation speed can be changed “on the fly” without stop command in between. Low speed (start 1) can be changed to high speed (start 2) immediately, and high speed can be changed to low speed after a changeover time.

Current measurement for NR-2N uses two external current transformers measuring current from motor main supply. External current transformers can be selected separately for both speeds.

The following guideline is applied for selecting parameter values:

Changeover time < Motor startup time

Name	Pin	Description
CCLI	X4:6	Contactor control voltage input
CCA	X4:7	Contactor control A
CCB	X4:8	Contactor control B
DI6 (F_Ca)	X1:7	Contactor control A feedback
DI7 (F_Cb)	X1:8	Contactor control B feedback
DI5 (Loc/R)	X1:6	Local/remote control switch input

Table 20. NR-2N starter contactor control interface

The definition of the terminal X1 in the above list is only an example.

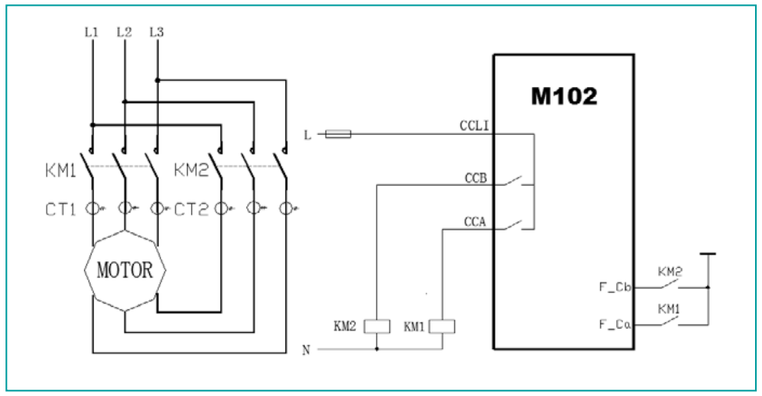


Fig. 16 Control circuit for NR_2N starter, separate windings

Operating sequence in NR-2N

- Sending command Start1 (low speed N1) to close contactor CCA
- Sending command Start2 (high speed N2) to close contactor CCB
- Contactors are latched
- Stop command opens CCA or CCB

Motor can be controlled with sequences:

- Stop -> Start1 -> Stop
- Stop -> Start2 -> Stop
- Stop -> Start1 -> Start2 ->Stop
- Stop -> Start2 -> Changeover delay-> Start1 -> Stop

NR-2N Dahlander STARTER (M102 Only)

NR-2N Dahlander uses three contactors to control motor rotation speed where motor is equipped with a three-phase winding. Rotation speed can be changed “on the fly” without stop command in between. Low speed (start 1) can be changed to high speed (start 2) immediately, and high speed can be changed to low speed after a changeover time.

Current measurement for NR-2N Dahlander uses two external current transformers measuring current from motor main supply. External current transformers can be selected separately for both speeds.

The following guideline is applied for selecting parameter values:
Changeover time < Motor startup time

Name	Pin	Description
CCLI	X4:6	Contactor control voltage input
CCA	X4:7	Contactor control A
CCB	X4:8	Contactor control B
CCC	X4:9	Contactor control C
DI5 (Loc/R)	X1:6	Local/remote control switch input
DI6 (F_Ca)	X1:7	Contactor control A feedback
DI7 (F_Cb)	X1:8	Contactor control B feedback
DI8 (F_Cc)	X1:9	Contactor control C feedback

Table 21. NR-2N Dahlander starter contactor control interface

The definition of the terminal X1 in the above list is only an example.

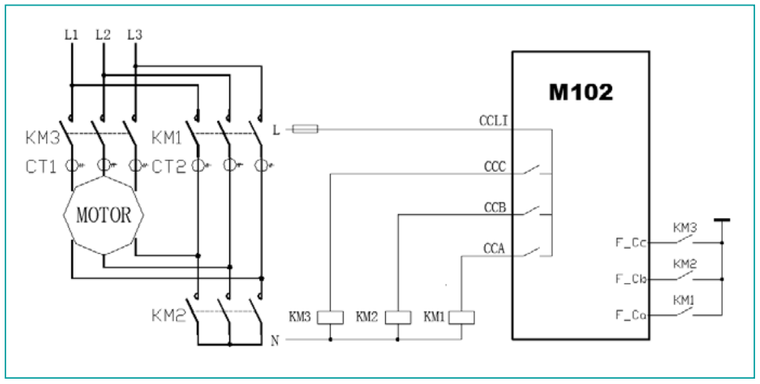


Fig. 17. Control circuit for NR_2N Dahlander starter

Operating sequence in NR-2N Dahlander

- Sending command Speed1 to close contactor CCA
- Sending command Speed2 to close contactor CCB and CCC
- Contactors are latched
- Sending stop command to open CCA or CCB + CCC

Motor can be controlled with sequences:

- Stop -> Start1 -> Stop
- Stop -> Start2 -> Stop
- Stop -> Start1 -> Start2 ->Stop
- Stop -> Start2 -> Chang over delay-> Start1 -> Stop

Autotransformer starter (M102 only)

This starter type is used to control the autotransformer unit in order to minimize voltage drop during motor startup. Autotransformer starter with three contactors supports motor starting with reduced voltage, thus providing reduced motor startup current. The starting torque will be reduced accordingly,

The following guideline applies for selecting parameter values:
Changeover time < Motor startup time

Name	Pin	Description
CCLI	X4:6	Contactor control voltage input
CCA	X4:7	Contactor control A
CCB	X4:8	Contactor control B
CCC	X4:9	Contactor control C
DI5 (Loc/R)	X1:6	Local/remote control switch input
DI6 (F_Ca)	X1:7	Contactor control A feedback
DI7 (F_Cb)	X1:8	Contactor control B feedback
DI8 (F_Cc)	X1:9	Contactor control C feedback

Table 22. Autotransformer starter contactor control interface

The definition of the terminal X1 in the above list is only an example.

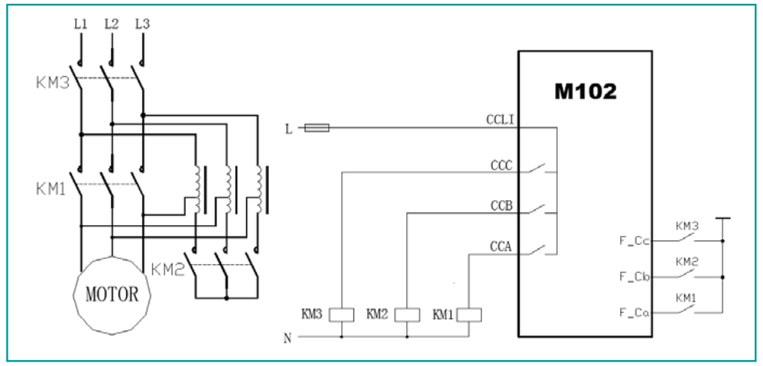


Fig. 18. Control circuit for autotransformer starter

NR-softstarter (M102 only)

Softstarter applications are for controlling the motor accessory softstarter device. M102 gives start and stop commands to the softstarter unit. The softstarter is set for adjusting motor voltage with its own parameters. More information about softstarter can be found in the softstarter manual.

This starter type supports all protection functions during normal running situations. For motor start and stop period, some of the protection functions are disabled by these parameters.

Name	Pin	Description
CCLI	X4:6	Contactor control voltage input
CCA	X4:7	Contactor control A
CCC	X4:9	Contactor control C
DI6 (F_Ca)	X1:7	Contactor control A feedback
DI5 (Loc/R)	X1:6	Local/remote control switch input

Table 23. NR_softstarter starter contactor control interface

The definition of the terminal X1 in the above list is only an example.

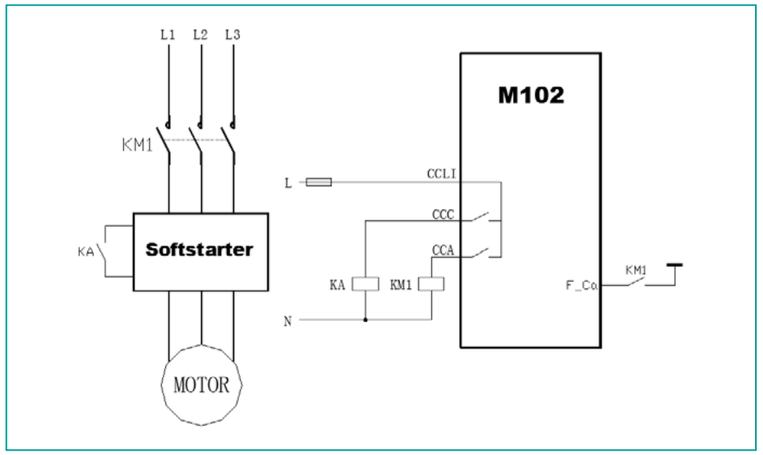


Fig. 19. Control circuit for NR-softstarter

Operating sequence for NR-softstarter

- Start1 to close CCA followed by CCC
- Stop to open CCC followed by CCA after ramp down time delay.

REV-softstarter (M102 Only)

This starter is of similar functionality as the NR-softstarter starter, with additional function to support reversing the motor.

Name	Pin	Description
CCLI	X4:6	Contactor control voltage input
CCA	X4:7	Contactor control A
CCB	X4:8	Contactor control B
CCC	X4:9	Contactor control C
DI5 (Loc/R)	X1:6	Local/Remote control switch input
DI6 (F_Ca)	X1:7	Contactor control A feedback
DI7 (F_Cb)	X1:8	Contactor control B feedback

Table 24. REV-softstarter starter contactor control interface

The definition of the terminal X1 in the above list is only an example.

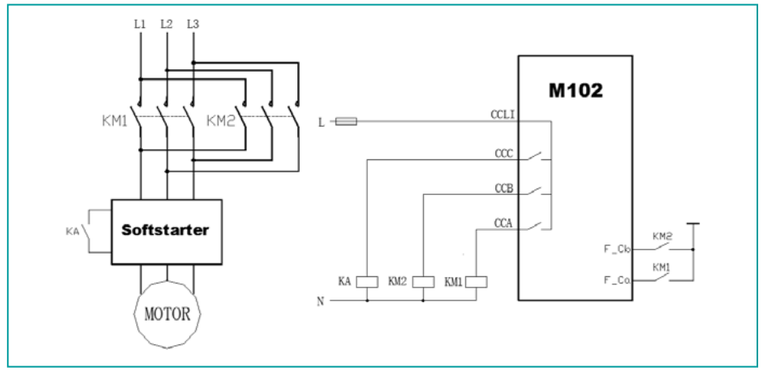


Fig. 20. Control circuit for REV-softstarter

Operating sequence for REV-softstarter

- Start1 to close CCA followed by CCC
- Start2 to close CCB followed by CCC
- Stop to open CCC followed by CCA or CCB after ramp down time delay.

Contactor feeder

Contactor feeder is regarded in M10x as a specific starter type to provide measurement, control and protection functionality to a contactor feeder circuit. When start command has been received from field or local I/O, the contactor control output will be energized and remains in this condition until stop command has been received or any protection function is activated.

Name	Pin	Description
CCLI	X4:6	Contactor control voltage input
CCA	X4:7	Contactor control A
DI6(F_Ca)	X1:5	Contactor control A feedback
DI5(Loc/R)	X1:6	Local/remote control switch input

Table 25. Contactor feeder contactor control interface

(i) The definition of the terminal X1 in the above list is only an example.

(ii) Power, energy and other parameters related to Power factor are NOT correct and should not be referred to.

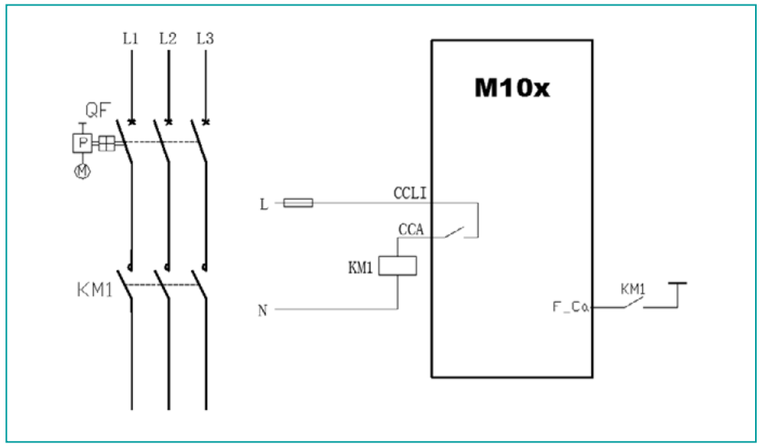


Fig. 22. Control circuit for contactor feeder

Contactor feeder/RCU

Remote control unit (RCU) is a starter type where contacters are directly controlled by a special RCU switch located near the motor. This allows control of the motor even without the M10x.

Name	Pin	Description	Remark
CCLI	X4:6	Contactor control voltage input	
CCA	X4:7	Contactor control A	
GR1_C	X4:3	Programmable relay output	Only for M101
CCC	X4:9	Contactor control C	Only for M102
DI6(F_Ca)	X1:7	Contactor control A feedback	
DI5(Loc/R)	X1:6	Local/remote control switch input	

Table 26. Contactor feeder/RCU contactor control interface (for M10x)

i) The definition of the terminal X1 in the above list is only an example.
ii) Power, energy and other parameters related to power factor are NOT correct and should not be referred to.

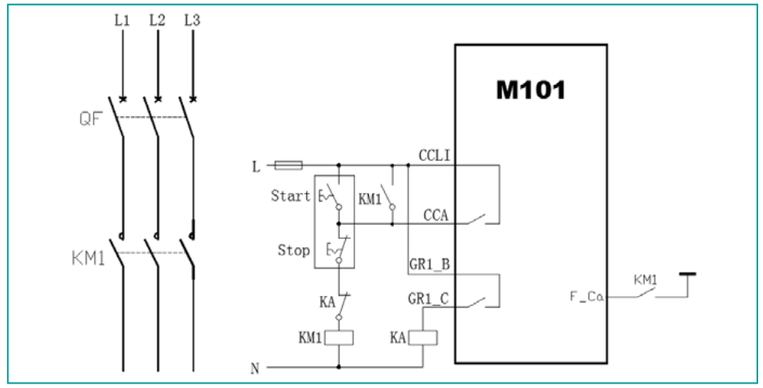


Fig. 23-1. Control circuit for contactor feeder/RCU (for M101)

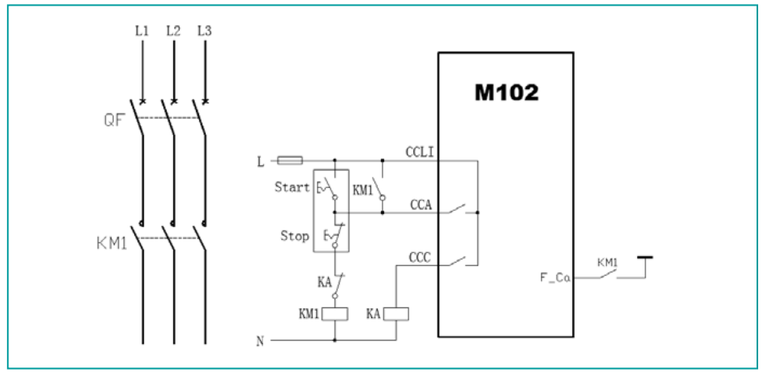


Fig. 23-2. Control circuit for contactor feeder/RCU (for M102)

Feeder

Feeder mode is regarded in M10x as a specific starter type to provide measurement and control functionality. The protection of feeder is not covered in M10x and is normally done by main circuit breaker. The feeder mode in M10x is designed to provide a complete intelligent solution in MCC plants where the feeder circuits are usually small, but important parts from the MCC plant management point of view.

Name	Pin	Description
CCLI	X4:6	Contactor control voltage input
CCA	X4:7	Control YC /motor drive in MCCB (2 seconds holding)
CCB	X4:8	Control YO/motor drive in MCCB (2 seconds holding)
DI6 (F_Ca)	X1:7	Circuit breaker position aux. feedback
DI9 (External trip input)	X1:10	Circuit breaker trip aux. feedback
DI5 (Loc/R)	X1:6	Local/remote control switch input*

Table 27. Feeder control interface

i) The definition of the terminal X1 in the above list is only an example.
ii) Power, energy and other parameters related to power factor are NOT correct and should not be referred to.

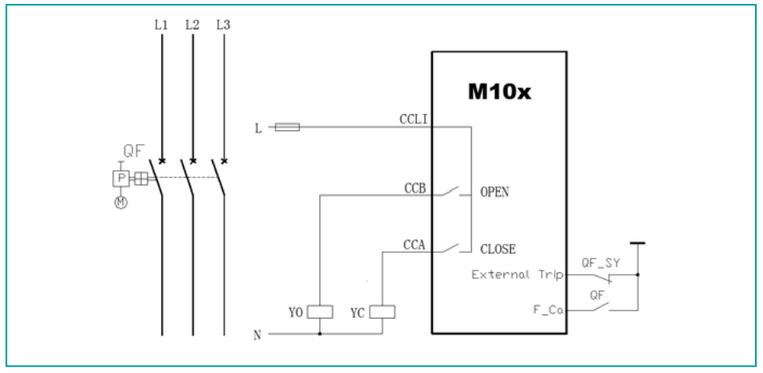


Fig. 21. Control circuit for feeder

Feeder application in M10x is confined to certain features. End users need to be informed on these confines when feeder application is required through M10x.

- **Operating:**

  Start1 command activates contactor output relay CCA for 2 seconds.

  Stop command activates contactor output relay CCB for 2 seconds and clear fault annunciation after fault is cleared.

  External trip occurs a trip message and will be reset when the signal is inactive.

- **Monitoring:**

  Circuit breaker close/open status

  Circuit breaker trip

- **Protection:**

  Motor protection functions are not suitable for feeder application. All protections except earth fault protection in M10x are automatically disabled during parameter setting when feeder type is selected.

- **Measuring:**

  Current, voltage are measured by M10x. Power, energy and other parameters related to power factor are NOT correct and should not be referred to.

Protection functions

The module provides full protection for motors by supervising three voltage phases, three current phases, earth fault current, PTC sensor, startup time, the state of contactors and the state of the main switch.

Response of protection functions is based on the parameters given by the user. The operation of separate functions is independent, thus protection functions can be active at the same time but the one which indicates the situation first will give a trip for the motor.

According to the application, all kinds of protection can be enabled, disabled by the upper level system or MCU setup tool, and the protection characteristics can be adjusted. Protection module offers the following protection and supervisory functions:

Protection type	M101	M102
Overload protection	✓	✓
Stall protection	✓	✓
Long start protection	✓	✓
Phase failure protection	✓	✓
Unbalance protection	✓	✓
Underload protection	✓	✓
Noload protection	✓	✓
Earth fault protection	✓	✓
PTC protection		✓
Undervoltage protection		✓
Start limitation protection	✓	✓

Table 28. Protection functions in M10x

Overload protection

Thermal overload protection (TOL) protects the motor against overheating.The motor thermal condition is simulated by a calculation. The result of the calculation is stored in a thermal register and can be reported via operator panel or fieldbus interface.

Calculation is accomplished in a different motor operation conditions, principly presented below. Thermal increase and decrease are simulated by TOL protection function for running and stopped motor.

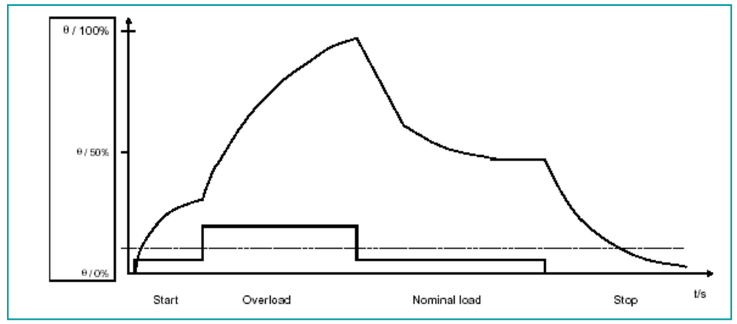


Fig. 24. Principle picture of motor thermal simulation

M10x simulates thermal conditions in the motor for all operating modes (running or stopped). This permits maximum utilization of an installation and assures safe protection of the motor. Thermal overload protection simulation accounts for the temperature rise of both the stator winding and the iron mass of the motor. It gives thorough consideration of the effect of motor overheating due to three-phase unbalance during the simulation calculation of motor thermal overload.

There are two thermal models supported by M10x: standard or EEx e. The standard model makes use of parameters trip class, t6 in thermal overload calculation. The protection of explosion proof three-phase motors with type of protection 'increased safety' EEx e is done with two special parameters, the Ia/In ratio (stall/nominal current ratio) and Te time.

The following diagram offers the characteristic curve of overload protection, in which the characteristics are adjusted by changing t6 (trip time for current $I_{L\,max}$=6xIn from the cold state).

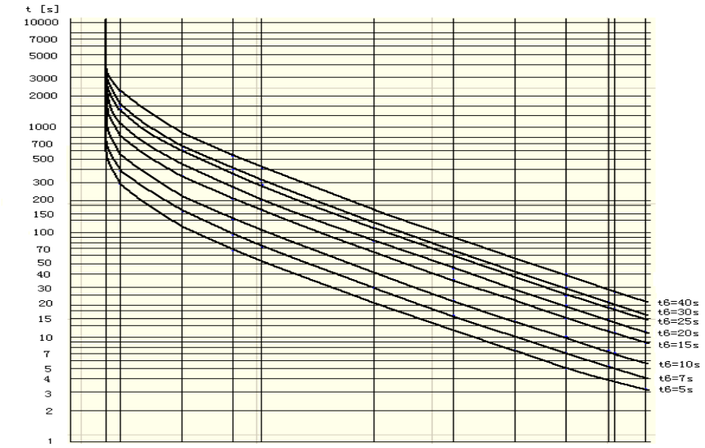


Fig. 25. Trip curve from cold condition

The maximum thermal capacity level is 100%. Maximum level is reached when the motor has been running with a current 6xIn at the time t6 starting from the cold state in ambient temperature 40°C.

Trip class	T6
10A	3-7
10	7-12
20	10-25
30	15-38

Table 29. IEC 60947-4-1 trip class when ambient temperature 40°C, balanced motor current

In some applications, it is beneficial to be able to bypass the TOL protection momentarily because of the process reasons. The lifetime of the motor will be shortened, but it might the more costly to stop the process. TOL bypass is a special command given through the fieldbus.

There is a dedicated parameter to enable the execution of this command. TOL bypass function is available only for TOL standard model, thus it cannot be enabled if TOL EEx e model is in use.

When thermal level is above parameterized alarm level, it is possible to to send a bypass command to M10x via fieldbus. When bypass function is activated, the thermal image is allowed to rise to 200% level before a trip will occur. If the thermal level decreases below alarm level before a trip occurs, bypass function will be automatically clear. New command has to be sent to reactivate it after alarm level is crossed.

If motor is in overload condition, i.e. I_{Lmax} > 1.14 x TFLC (thermal full load current multiplier reduced by motor ambient temperature), the overload alarm is activated to indicate overload. If motor is stopped before trip and the thermal capacity decreases below TOL alarm level, the bypass functionality is disabled. Bypass command is ignored when running under alarm level.

Function	
Setting range	0=Disabled 1=Enabled 2=Disabled during motor startup
Default value	Enabled
Step value	1
Disabled during motor startup	
Setting range	0=Enabled during motor startup 1=Disabled during motor startup
Default value	0
Step value	1
Trip reset mode	
Setting range	1=Auto 2=Local 3=Remote 4=Remote and local
Default value	4
Step value	1
Thermal model	
Setting range	0=Standard model 1=EEX e
Default value	0
Step value	1

TOL bypass	
Setting range	0=Disabled 1=Enabled
Default value	Disabled
T6❷	
Setting range	3-40sec
Default value	6sec
Step value	1
Cool coefficient	
Setting range	1-10
Default value	4
Step value	1
Ia/In❸	
Setting range	1.2-8.0
Default value	5.0
Step value	0.1
Te❸	
Setting range	5-40sec
Default value	5sec
Step value	1sec
TOL alarm level	
Setting range	60-100%
Default value	90%
Step value	1%
TOL trip level	
Setting range	60-100%
Default value	100%
Step value	1%
TOL reset level	
Setting range	10-60%
Default value	50%
Step value	1%
Ambient temperature	
Setting range	0-80°C
Default value	40°C
Step value	5°C

Table 30. TOL protection parameters

❷When Standard thermal model is selected
❸When EEX e thermal model is selected

Stall protection

Stall protection is used to protect the driven mechanical system from jams and excessive overload. Stall protection function uses Imax as the criterion. There are other parameters to be determined as follow:

Function	
Setting range	0=Disable 1=Enable
Default value	1
Step value	1
Trip reset mode	
Setting range	2=Local 3=Remote 4=Remote and local
Default value	4
Step value	1
Trip level	
Setting range	120-800%
Default value	400%
Step value	10%
Trip delay	
Setting range	0.0-25.0sec
Default value	0.5sec
Step value	0.1sec

Table 3. Stall protection parameters

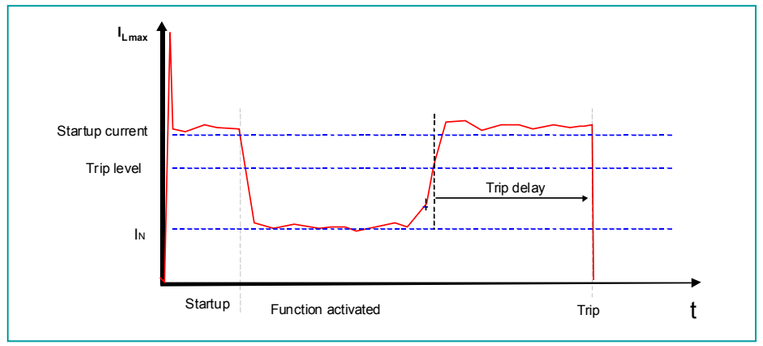


Fig. 24. Stall protection

Stall function activates after motor nominal startup time has elapsed.

The highest measured phase current (I_{Lmax}) is compared against the trip level. When I_{Lmax} remains over the trip level at a time longer than trip delay, a stall alarm is issued and the contactor tripped.

Long start protection

The long start protection protects motor against locked or stalled rotor in starting state. M10x detects the current after a start command, and signals a fault when current continuously exceeds a separately set threshold of the period of start time.

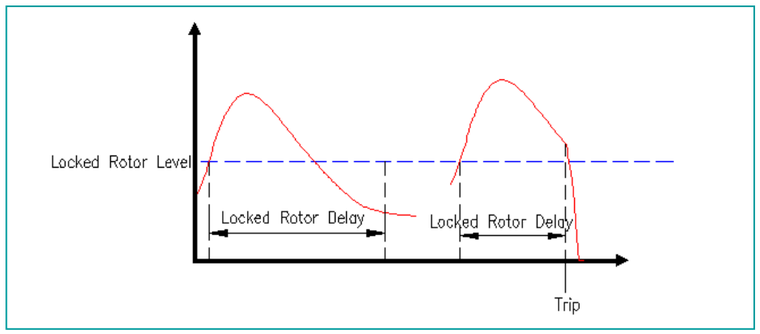


Fig. 25 Long start protection

Function	
Setting range	0=Disabled 1=Enabled
Default value	Disabled
Step value	1
Locked rotor level	
Setting range	120-800%
Default value	120%
Step value	10%
Locked Rotor Delay	
Setting range	0-250sec
Default value	10sec
Step value	1sec
Trip reset mode	
Setting range	2=Local 3=Remote 4=Remote and Local
Default value	4
Step value	1

Table 32. Long start protection parameters

Phase failure protection

M10x protects the motor against phase current loss condition. Phase failure protection function uses I_{Lmin}/I_{Lmax} (the ratio of lowest I_{Lmin} and highest measured phase value I_{Lmax}) as the criterion. Function is suppressed by parameters Motor startup time, number of phases and Softstart ramp time.

Function	
Setting range	0=Disabled 1=Enabled 3=Alarm only
Default value	Disabled
Step value	1
Trip delay	
Setting range	0-60sec
Default value	10sec
Step value	1s
Alarm level	
Setting range	10-90%
Default value	80%
Step value	1%
Trip level	
Setting range	5-90%
Default value	70%
Step value	1%
Trip reset mode	
Setting range	2=Local 3=Remote 4=Remote and local
Default value	4
Step value	1

Table 33. Phase failure parameters

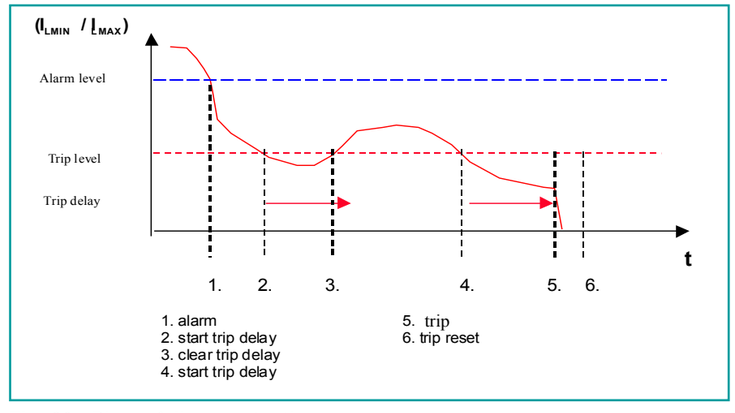


Fig. 26 Phase failure protection

ILmin/ILmax is compared against the phase failure alarm level. When ILmin/ILmax decreases below the Alarm level, a “Phase failure alarm” alarm is issued.

ILmin/ILmax is compared against the phase failure trip level. When ILmin/ILmax remains below the trip level at a time longer the trip delay, a “Phase failure trip” alarm is issued and the contactor tripped.

Unbalance protection

M10x protects the motor against unbalance conditions. Unbalance protection function also uses I_{Lmin}/I_{Lmax} as the criterion. Function is suppressed by parameters Motor startup time, Number of phases and Softstart ramp time.

Function	
Setting range	0=Disabled 1=Enabled 3=Alarm only
Default value	Disabled
Step value	1
Trip delay	
Setting range	0-60sec
Default value	10sec
Step value	1s
Alarm level	
Setting range	50-90%
Default value	90%
Step value	1%
Trip level	
Setting range	5090%
Default value	85%
Step value	1%
Trip reset mode	
Setting range	2=Local 3=Remote 4=Remote and local
Default value	4
Step value	1

Table 34. Unbalance protection parameters

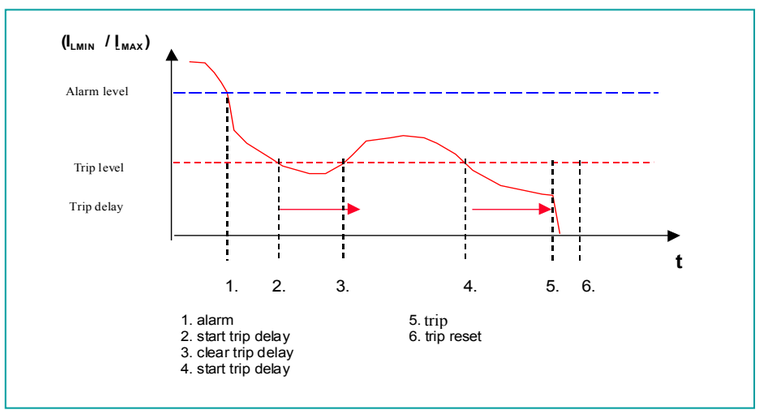


Fig. 27. Unbalance protection

I_{Lmin}/I_{Lmax} is compared against the unbalance alarm level. When I_{Lmin}/I_{Lmax} decreases below the alarm level, a unbalance alarm is issued.

I_{Lmin}/I_{Lmax} is compared against the unbalance trip level. When I_{Lmin}/I_{Lmax} remain below the trip level at a time longer the trip delay, a unbalanced trip alarm is issued and the contactor tripped.

Underload protection

M10x protects the motor against underload conditions. Underload protection function uses I_{Lmax}/In (the ratio of highest measured phase value I_{Lmax} and the rated current of the motor In) as the criterion. There are other parameters to be determined, such as alarm level, trip level and trip delay. The protection characteristic are as follows:

Function	
Setting range	0=Disabled 1=Enabled 3=Alarm only
Default value	Disabled
Step value	1
Alarm level	
Setting range	20-90%
Default value	30%
Step value	1%
Trip level	
Setting range	5-90%
Default value	20%
Step value	1%
Trip delay	
Setting range	0-1800sec
Default value	10sec
Step value	1sec
Trip reset mode	
Setting range	2=Local 3=Remote 4=Remote and local
Default value	4
Step value	1

Table 35. Underload protection parameters

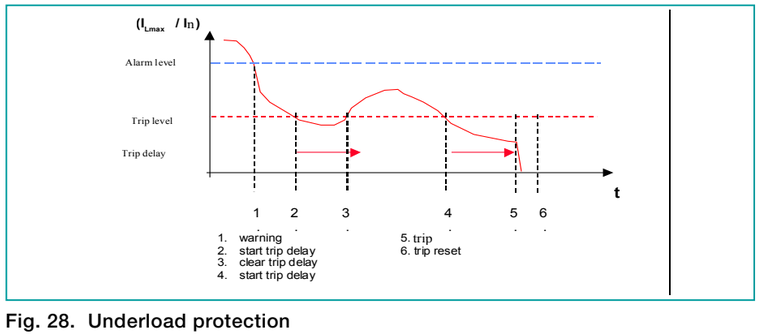


Fig. 28. Underload protection

The I_{Lmax}/In is compared against the underload alarm level. When I_{Lmax}/In decreases below the alarm level an underload alarm is issued.

The I_{Lmax}/In is compared against the underload trip level. When ILmax/In remains below the trip level at a time longer than underload trip delay, an underload trip alarm is issued and the contactor tripped.

Noload protection

M10x protects the motor against no load conditions. Practically, noload protection is the same function as underload protection. The function also uses I_{LMAX}/In as the criterion.

Function	
Setting range	0=Disabled 1=Enabled 3=Alarm only
Default value	Disabled
Step value	1
Alarm level	
Setting range	5-50%
Default value	20%
Step value	1%
Trip level	
Setting range	5-50%
Default value	15%
Step value	1%
Trip delay	
Setting range	0-1800sec
Default value	5sec
Step value	1sec
Trip reset mode	
Setting range	2=Local 3=Remote 4=Remote and local
Default value	4
Step value	1

Table 36. Noload protection parameters

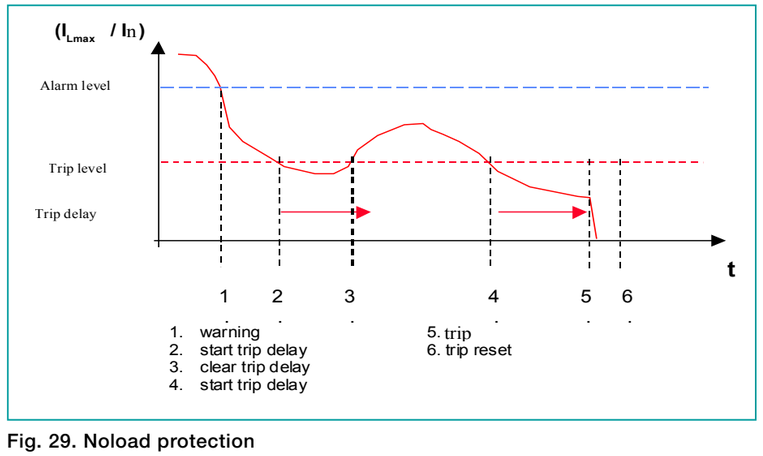


Fig. 29. Noload protection

The I_{Lmax}/In is compared against the no load alarm level. When I_{LMAX}/In decreases below the alarm level a noload alarm is issued.

The I_{LMAX}/In is compared against the noload trip level. When I_{LMAX}/In remains below the trip level at a time longer than noload trip delay, a noload trip alarm is issued and the contactor tripped.

Earth fault protection

M10x protects the motor against the earth fault condition with an additional residual current transformer.

The function is by default suppressed by parameters motor startup time and softstarter ramp up time to avoid nuisance tripping due to harmonics caused by saturation of the current transformers. In some cases, it may need to be switched on during startup in order to meet specific project requirements.

M10x relay is NOT a residual current protection device. This protection is neither intended to be used for pre-emptive isolation supervision nor for personnel protection against electrical shock. For these applications ABB recommends the usage of external protection devices (PRCDs/RCDs).

Earth fault protection uses the following parameters:

Function	
Setting range	0=Disabled 1=Enabled 3=Alarm only
Default value	Disabled
Step value	1

Earth fault protection is activated during motor startup time	
Setting range	0=Disabled 1=Enabled
Default value	0
Step value	1
Alarm level	
Setting range	100-3000mA (Earth fault primary = 1A) 500-15000mA (Earth fault primary = 5A)
Default value	500mA
Step value	100mA
Trip level	
Setting range	100-3000mA (Earth fault primary = 1A) 500-15000mA (Earth fault primary = 5A)
Default value	800mA
Step value	100mA
Trip delay	
Setting range	0.2-60.0sec
Default value	10.0sec
Step value	0.1sec
Trip reset mode	
Setting range	2=Local 3=Remote 4=Remote and local
Default value	4
Step value	1

Table 37. Earth fault protection parameters

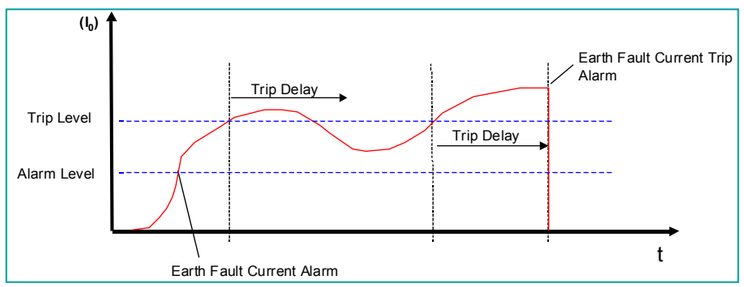


Fig. 30. Earth fault protection (I_0 = measured earth fault current)

I_0 is compared against the earth fault current fault alarm level. When I_0 exceeds above the alarm level, an earth fault alarm is issued.

I_0 is compared against the earth fault current trip level. When I_0 remains above the earth fault current Trip level at a time longer than trip delay, an earth fault trip alarm is issued and the contactor tripped.

PTC protection (M102 only)

PTC protection protects the motor against too-high temperature by using PTC-sensor embedded in the stator winding or the bearings. For M102, use a type A temperature sensor with a characteristic curve according to IEC 60947-8.

Function	
Setting range	0=Disabled 1=Enabled 3=Alarm only
Default value	Disabled
Step value	1
PTC Alarm level	
Setting range	1000-10000Ω
Default value	1600Ω
Step value	1Ω
PTC trip level	
Setting range	1000-10000Ω
Default value	3600Ω
Step value	1Ω
PTC trip delay	
Setting range	1-1800sec
Default value	1sec
Step value	1sec
PTC reset level	
Setting range	100-10000Ω
Default value	1600Ω
Step value	1Ω
PTC trip reset mode	
Setting range	1=Auto 2=Local 3=Remote 4=Remote and local
Default value	4
Step value	1
PTC short circuit alarm level	
Setting range	0-250Ω
Default value	10 Ω
Step value	1 Ω

Table 38. PTC protection parameters

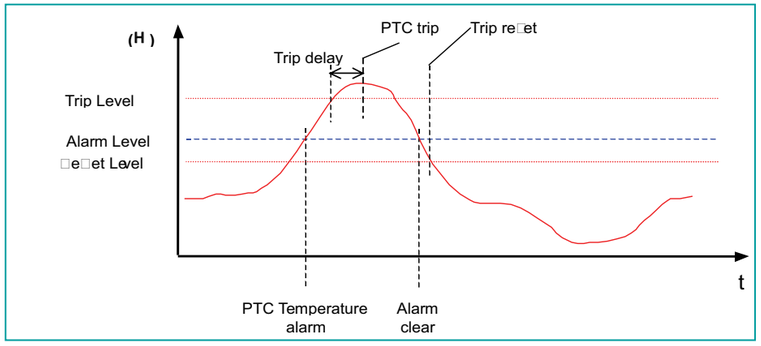


Fig. 31. PTC protection

The resistance of PTC input is compared against the alarm level. When resistance of PTC input exceeds above the alarm level, a PTC alarm message is issued.

The resistance of the PTC input is compared against the trip level. When resistance of PTC input is above the trip level PTC trip alarm is issued and the contactor tripped.

After PTC trip is executed, the resistance of PTC input is compared against the PTC reset level. When resistance of PTC input decreases below the reset level, the PTC protection function executes the function set by PTC reset mode.

M10x provides short circuit and open circuit detection for the temperature sensing element. Short circuit alarm level is settable, and open circuit alarm level is fixed. When the resistance of PTC input falls below short circuit alarm level, a PTC short circuit alarm message is issued.

When the resistance of PTC input exceeds 12kΩ, a PTC open circuit alarm message is issued.

Short circuit and open circuit detection threshold have no fault time delay. The short circuit and open circuit protection is enabled when PTC protection is enabled, and cannot be disabled.

If the measured resistance is over 20kΩ, thermistor resistor will display, 20kΩ.

The distance between PTC sensors and M10x PTC measuring inputs cannot exceed the following to be able to maintain reasonable reading:

Cross section	Length
2.5mm2	2x250m
1.5mm2	2x150m
0.5mm2	2x50m

Undervoltage protection (M102 Only)

M102 protects the motor against undervoltage conditions such as voltage dip. The undervoltage protection function uses U_{Lmin} as the criterion. There are other parameters to be determined, such as alarm level, trip level and trip delay, and reset voltage level. The protection characteristic is as follows:

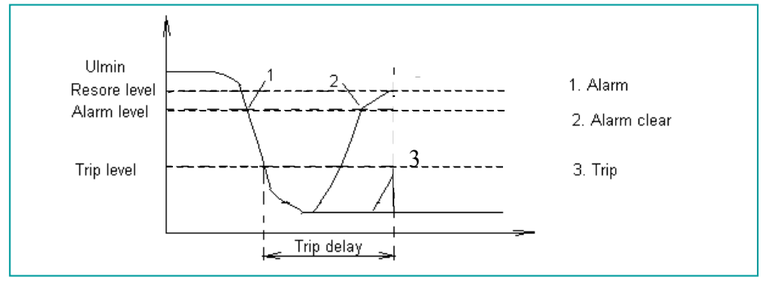


Fig. 32. Undervoltage protection

The lowest measured main line voltage (U_{lmin}) is compared against the undervoltage alarm level. When U_{lmin} decreases below the undervoltage alarm level, an undervoltage alarm is issued.

The lowest measured main line voltage (U_{lmin}) is compared against the undervoltage trip level and voltage restore level. When U_{lmin} recovers above undervoltage restore level before trip delay expires and motor continues running. If U_{lmin} remains below the restore level at a time longer than trip delay, undervoltage trip is issued and contactor will be opened.

When autorestart function is active, undervoltage trip delay will be same as maximum power down time automatically.

Function	
Setting range	0=Disabled 1=Enabled 3=Alarm only
Default value	Disabled
Step value	1
Alarm level	
Setting range	50-100%
Default value	80%
Step value	1%
Trip level	
Setting range	30-100%
Default value	65%
Step value	1%
Trip delay	
Setting range	0.2-5.0sec
Default value	1.0sec
Step value	0.1sec
Reset level	
Setting range	50-100%
Default value	90%
Step value	1%
Trip reset mode	
Setting range	1=Auto 2=Local 3=Remote 4=Remote and local
Default value	4
Step value	1

Table 39. Undervoltage protection parameters

Start limitation

Start limitation helps to protect the motor and also the process against excess number of starts in a given interval. When the number of starts is reached and the motor is switched off, a new start is prevented. The time interval, starts from the first start. After the elapse of the time interval, the counter is reset to the preset value. The permissible motor starts per hour can be obtained from the manufacturer's motor and apparatus data sheet. However, the minimum waiting time between two starts must be observed.

The parameterization of the protection function can be the number of starts per time interval or the time between two consecutive starts. In the first case, the user must wait after the trip for the reset to take place before making a start.

Independent of this function, the motor is protected by TOL function and a start is possible only if the thermal capacity is below the startup inhibit level. If motor data specifies the number of starts during a certain time span, this function can be used to supervise the number of starts. In some other cases, the process may require a motor start number, which the protection can provide.

Functionality is presented in the following example. The next Figure 33 illustrates the start limitation protection with 3 starts allowed.

1) **Normal situation**, after stop command motor can be started normally, start 2. Every start activates an internal timer for the time defined by time interval parameter. The number of active timers are reviewed after every stop command and compared to value of number of starts parameter. Stop command can be implemented during active or elapsed timer.

2) **Two timers are still active**, thus stop command generates alarm message start limitation alarm and one more start, Start 3 is allowed.

3) **The 3rd start has been executed**. A contactor trip and trip message start limitation trip alarm will follow when motor is stopped while there are two active timers, starting from Start 1.

4) **Trip can be automatically reset** when the first timer from Start 1 is finished. Motor start is possible when all pending trips are reset. Supervision continues with a new timer from Start 4.

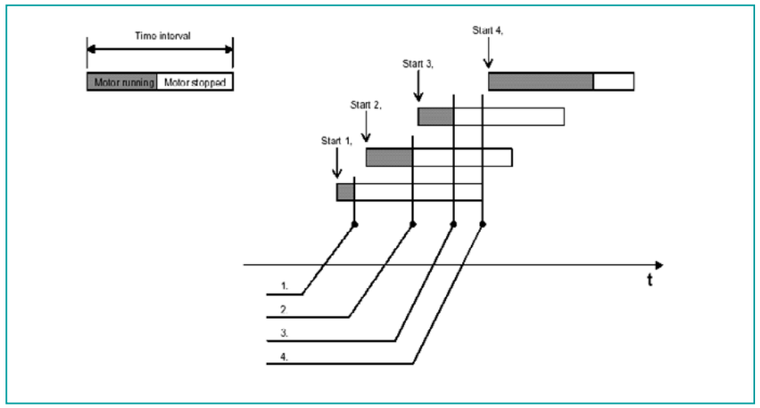


Fig. 33. Start limitation protection

Function	
Setting range	0=Disable 1=Enable
Default value	Disabled
Step value	1
Time interval	
Setting range	1-600min
Default value	1min
Step value	1
Number of starts	
Setting range	2-100
Default value	2
Step value	1

Table 40. Start limitation parameters

Autorestart function (M102 Only)

The line voltage (U_{L1L3}) is supervised continuously. It is possible to automatically restart the motor after momentary power loss. Two alternative models of auto restart function are provided in M102: standard and enhanced.

M101 does not have the autorestart function.

Function	
Setting range	0=Disabled 1=Enabled
Default value	Disabled
Step value	1
Function mode	
Setting range	0=standard 1=enhanced
Default value	0
Step value	1
Maximum autoreclose time	
Setting range	0-5000msec
Default value	200msec
Step value	100msec
Maximum powerdown time	
Setting range	0-1200sec
Default value	5sec
Step value	0.1sec
Staggered start delay	
Setting range	0-1200sec
Default value	5sec
Step value	0.1sec

Table 41. Auto restart function parameters

Autorestart function (standard)

In standard mode, the reaction of the auto restart function depends on the length of the voltage dip. The following cases show the different reactions of M102 in different voltage dip situations

Case 1: Voltage dip< autoreclose time.

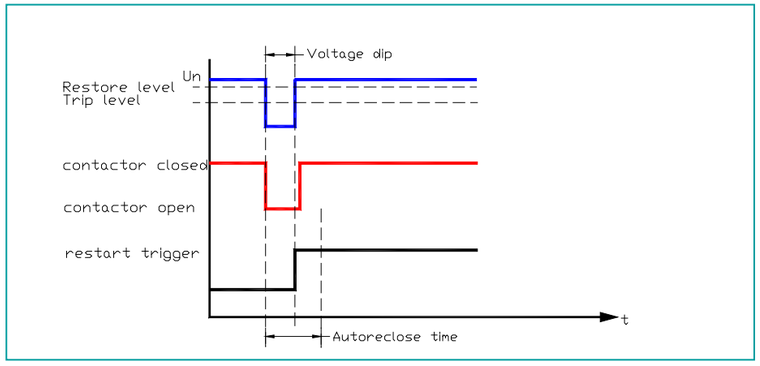


Fig. 34. Autorestart (Voltage dip< autoreclose time)

Case 2: Autoreclose time<voltage dip< Maximum powerdown time.

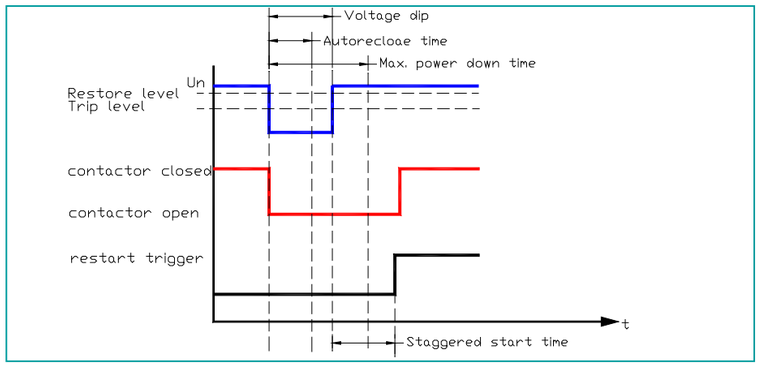


Fig. 35. Autorestart (autoreclose time<voltage dip< Maximum powerdown time)

If power is restored after autoreclose time but before maximum powerdown time, motor will be restarted after the staggered start delay time.

Case 3: Voltage dip> Maximum powerdown time.

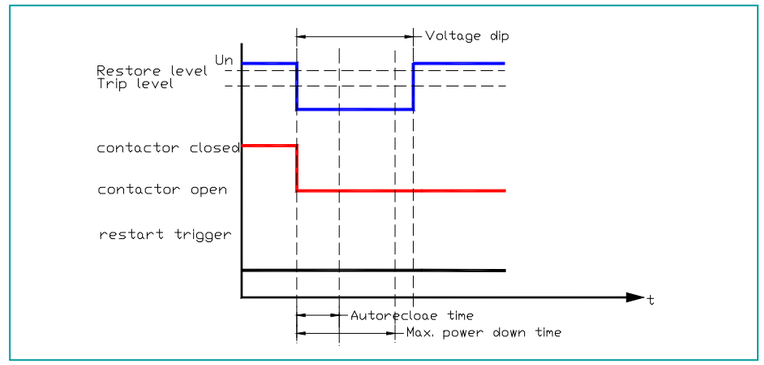


Fig. 36. Restart (Voltage dip> Maximum powerdown time)

If supply voltage remains below restore level long enough and exceeds maximum powerdown time, no automatic restart will be initiated.

Autorestart function (enhanced)

If the voltage dip is more serious, the enhanced autorestart function can be applied.

In the enhanced mode, the reaction of the autorestart function not only depends on the length of the voltage dip, but also the number of voltage dips within a short period of time.

The following cases show the different reactions of M102 in different voltage dip situations:

Case 1:
Voltage dip< autoreclose time
Identical to Case1 of standard mode

Case 2:
autoreclose time<voltage dip< Maximum powerdown time
Identical to Case2 of standard mode

Case 3:
Voltage dip> Maximum powerdown time
Identical to Case3 of standard mode

Case 4:
2xdip<200ms within 1sec

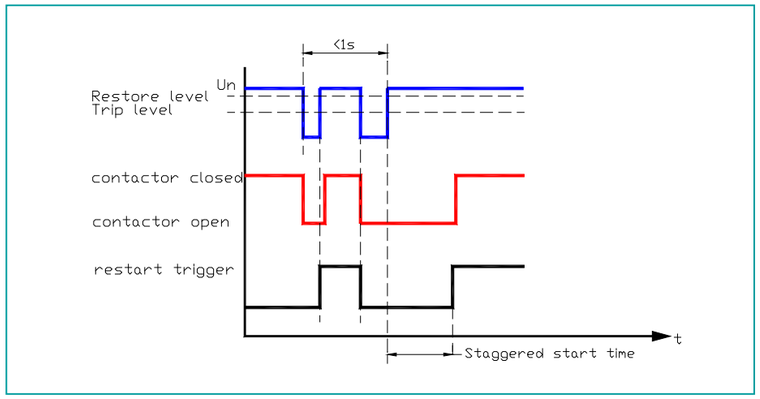


Fig. 37. Restart (2xdip<200ms within 1sec)

If the interval between two voltage dips (length less than 200ms) is less than 1 sec, automatic delay restart is triggered after second voltage restore.

Number of starts

M10x counts number of starts. For each operation cycle, M10x updates the number of operating cycles in a memory map. When start number alarm level is exceeded, M10x issues an alarm.

Motor running time

M10x counts motor's running hours. When operating running hours limit will be crossed M10x issues a “running time” alarm.

Failsafe functionality

M10x failsafe function supervises the network interface and connection to the remote devices controlling the motor/starter equipmen. Remote devices have to refresh certain M10x network input variables to indicate that the control is operating normally and the network interface is in good condition.

If a loss of communications for 5-25sec is detected, the failsafe activates with the parameterized function as follows:

- No operation
- Start motor direction 1
- Start motor direction 2
- Stop motor

Additionally, control access to motor will be switched to/remain in local control (hardwire control) and MD control while ignoring previous control access settings. When the communication is restored, the control access will recover to the original setting.

M10x control authority

Control authority

M10x control authority is the term describing the privileges allowing motor control operation through M10x. It is also a setting parameter in M10x to define which control access group has privileges to operate the motor via M10x.

Control access

There are three control access groups defined in M10x:

- Local hardwiring: M10x accepts its commands from the hardwired inputs
- Remote fieldbus: M10x accepts its commands from a PLC or higher control system via fieldbus, ie, MODBUS or PROFIBUS.
- MDx control: M10x accepts its commands from operator panel MDx located on the front panel of each starter unit on switchgear.

Assign control authority

There are several means in M10x to assign control authority and decide which control access group has control privileges.

- Parameter setting:
  Select the access group from parameter setting window (Fig. 36a). This is the most direct option where control access is defined by parameterization software.

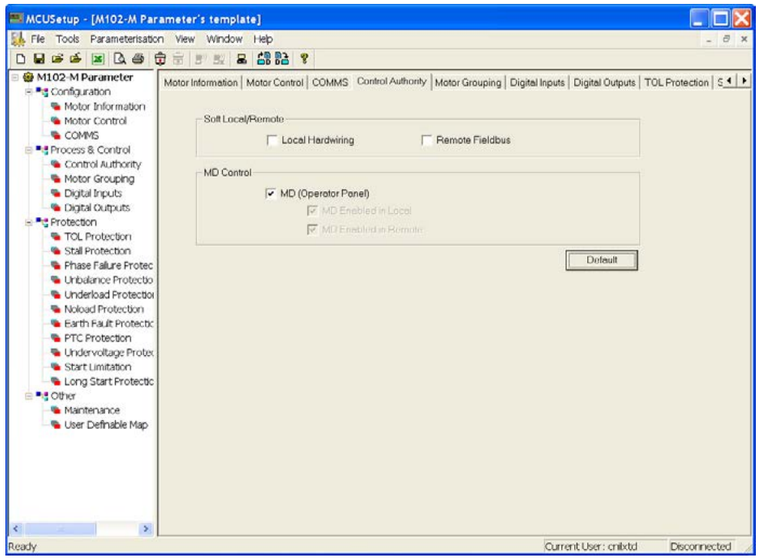


Fig. 36-1. Parameter setting of local/remote of control authority

Multi-control access group is supported!

1) For M10x-P, only when Profibus option is not selected and no DI is assigned Loc/R, Soft Local/Remote could be selected.

2) If Soft Local/Remote is selected, Profibus option is not available.

- Local/remote selector switch

M10x supports hardwired local remote selector switch function which allows selecting control access groups via hardwired inputs. To enable this function, one of the digital inputs has to be defined as ‘Loc/R’ in M10x (Fig. 36b).

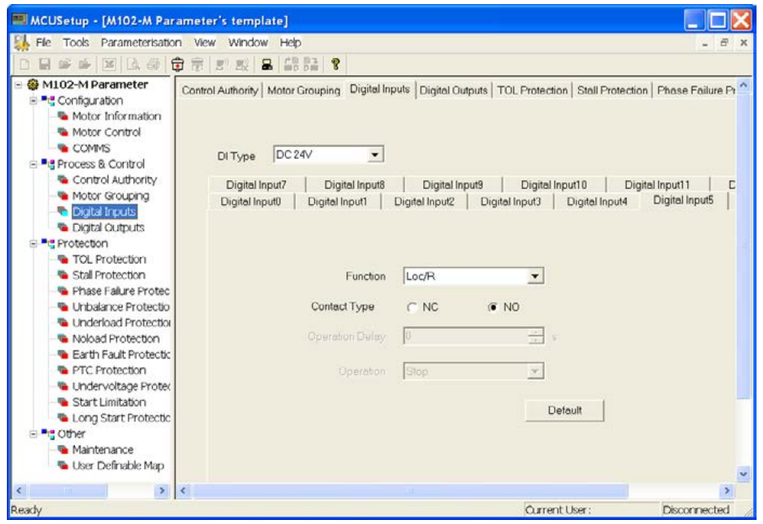


Fig. 36-2. Assign local/remote function to digital input

Local/remote selector switch will then define if control access goes to local (local hardwired) or remote (remote fieldbus). This function does not include the selection of operator panel MDx control which is independent of either Local or Remote and has to be further defined in this case.

Loc/R selector switch input	Control authority			
	Local hardwiring	Remote fieldbus	MDx enabled in local	MDx enabled in remote
False (open input)	Disabled	Enabled	Disabled	Enabled
True (close input)	Enabled	Disabled	Enabled	Disabled

Fig. 36-3. Local/Remote selector switch

When “Loc/R” is enabled in one of the digital inputs, only “MD control” is available.

Profibus option(M10x-P only):

M10x supports superior control system to select control access groups via fieldbus command. To enable this function, Profibus Auto Mode Active has to be selected (Fig36d).

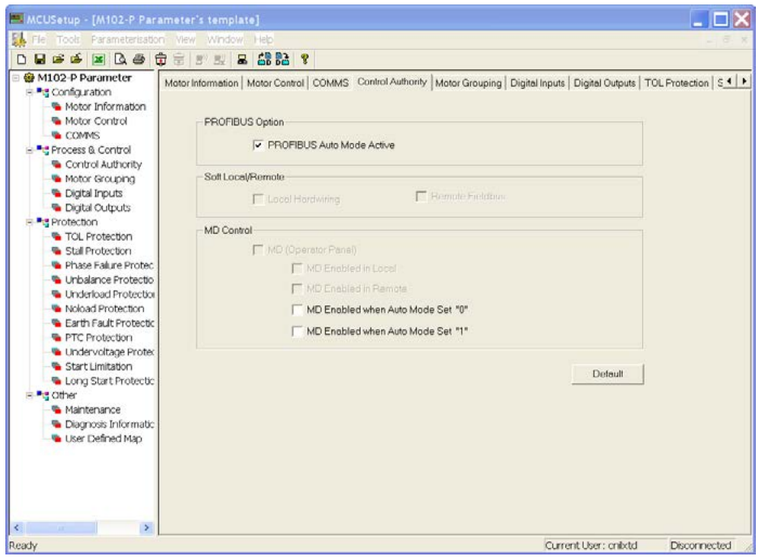


Fig. 36-4. Enable PROFIBUS option

1) Only when soft local/remote is not selected and no DI is assigned Loc/R, Profibus option can be selected.
2) If Profibus option is selected, control mode is not available.

- Parameter Setting

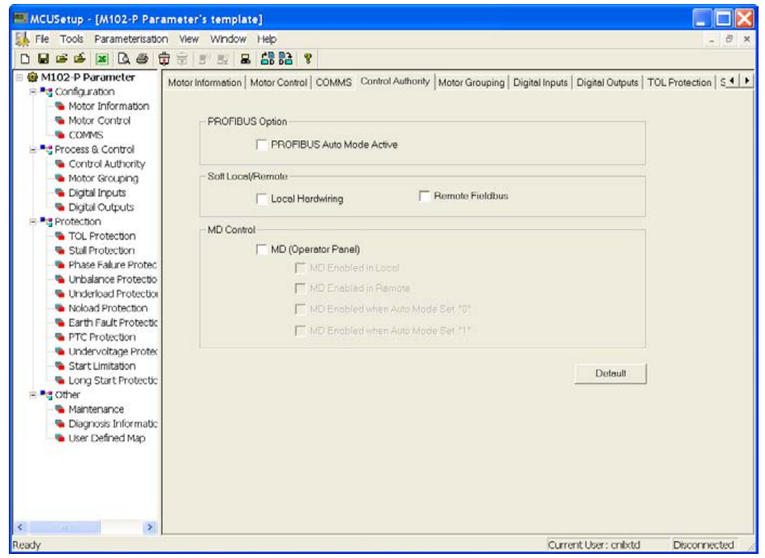


Fig. 36-5. MD Control

Select the access group from parameter setting window (Fig 36e). This is the most direct option where control access is defined by parameterization software. Meanwhile, option of MD control is defined in this case by Loc/R Selector Switch Input and Profibus Option.

Loc/R Selector Switch Input	MD Control			
	MD enabled in local	MD enabled in remote	MD enabled when Auto mode set “0“	MD enabled when Auto mode set “1“
Loc/R selector Switch input	Available	Available	Not available	Not available
Profibus option enabled	Not available	Not available	Available	Available

- Hardwired input

Use external selector switch to select MD control. As in the local/remote selector switch function, one of the digital inputs must be defined as MD control to enable the function.

When “Loc/R” is enabled in one of the digital inputs, control access group options under the control authority tab are limited to MD only, just as when MDx control is enabled, the MD control access option under the control authority tab is grayed out.

In other words, hardwired selection has privileges over parameter setting selection in terms of assigning control authority.

Digital inputs

There are 13 separate 24VDC programmable digital inputs (DIs) or 9 separate 110VAC or 230VAC DIs in M10x. These digital inputs can be assigned one of the functions listed below.

- **NOP**

  No special operation for the NOP function, only for checking digital input status. This input can be used for status transfer for digital input, and works in level check mode.

- **Start1**

  To use start1 function, local control authority must be enabled. The start1 input is used to start motor via hardwire. Motor can be running CW/N1 via start1. This input works in edge triggering mode.

- **Start2**

  To use start2 function, local control authority must be enabled. The start2 input is used to start motor via hardwire. Motor can be running CCW/N2 via start2. This input works in edge triggering mode.

- **Stop**

  To use stop function, local control authority must be enabled.

  The stop input is used to stop motor via hardwire. This input works in edge triggering mode.

- **Limit1**

  The limit1 input is limit position switch1 input to stop the motor from running CW, used only for actuator. This input works in level check mode.

- **Limit2**

  The limit2 input is limit position switch2 input to stop the motor from running CCW, used only for actuator. This input works in level check mode.

- **Process interlock1**

  The process interlock1 function is used to provide time dependent trip/alarm/stop features based on a switch input. This function is used together with OPERATION DELAY and OPERATION parameters.

The OPERATION DELAY parameter sets the amount of time that the process interlock1 switch can remain inactive on the occurrence of a motor start. If the switch remains inactive for longer than this time, a trip/stop will occur. If there is valid active process interlock1 input detected in the defined operation delay, motor will keep running. After the operation delay time, the inactive status of process interlock1 input will not affect the running of motor. If the OPERATION DELAY parameter is set to 0, the process interlock1 switch must be active while motor is started, which means motor start will not be allowed if the input is inactive.

The OPERATION parameter determines whether process interlock1 feature is a trip (reset required in order to restart the motor), a stop (no reset required) or an alarm.

This input works in level check mode.

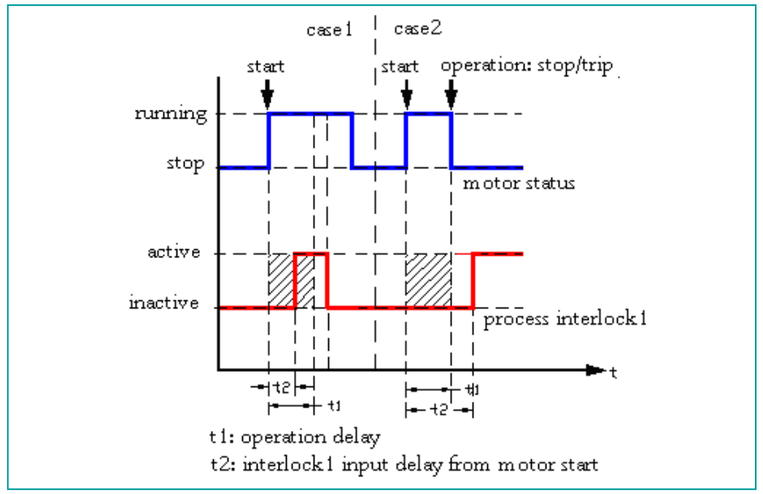


Figure 38. Process interlock1

Case 1: When t1>t2, motor can run normally.

Case 2: When t1<t2, a trip or stop will be performed according to the predefined operation.

If the signal is detected active, the trip will be reset automatically.

▪ Process interlock2

Process interlock2 function is used to provide time dependent trip/alarm/stop features based on a switch input. This function is used together with OPERATION DELAY and OPERATION parameters.

The OPERATION DELAY parameter sets the amount of time that the process interlock2 switch can be remain active when motor is in running. If the switch remains active for longer than this time, a trip/stop will occur. If the OPERATION DELAY parameter is set to 0, than the process interlock2 switch must be inactive while motor is started, which means motor start will not be allowed if the input is active.

The OPERATION parameter determines whether process interlock feature is a trip (reset required in order to restart the motor), a stop (no reset required) or an alarm.

This input works in level check mode.

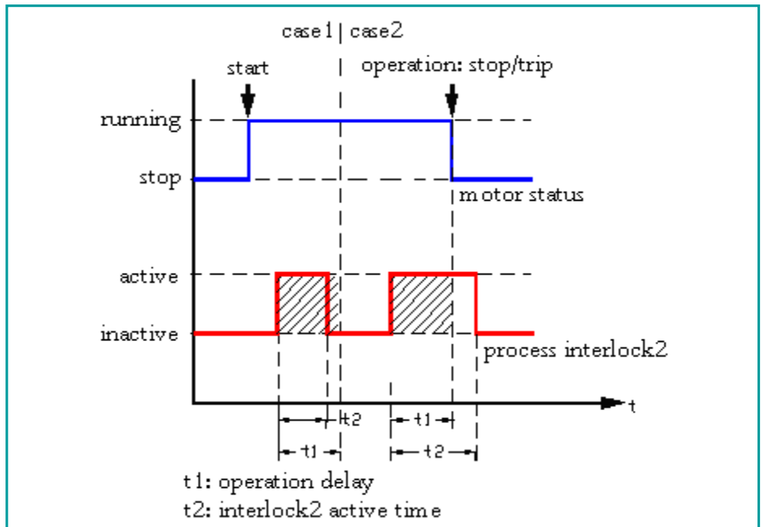


Figure 39. Process interlock2

Case 1: when t1>t2, motor can run normally.

Case 2: when t1<t2, a trip or stop will be performed according to the predefined operation.

If the signal is detected active, the trip will be reset automatically.

▪ Test switch

This input is used to indicate whether the main switch is in the test position. While the main switch is in test position, M10x monitors the I/O status and voltages/currents. Contactor operations by M10x are allowed but all protection functions based on the current and voltage measurement are disabled and the test of control circuit is allowed.

If the current is detected nonzero, all protection functions defined enabled in parameter setting will be enabled automatically. This protects the motor in case the test switch input is not working. This input works in level check mode.

Test switch input funtion works together with main switch supervision function. If test switch is assigned to the DI, main switch status has to be wired into another DI to activate the fuction.

▪ Emergency stop

This input is used for the emergency stop device. When the input is active, the motor will be stopped/tripped and cannot be restarted until the input is inactive. This function is used together with OPERATION parameters.

OPERATION: This parameter determines whether the emergency stop feature is a trip (reset required in order to restart the motor) or a stop (no reset required).

This input works in a separate level check mode from the stop function.

1) Emergency stop function is not used for functional safety.
2) If the signal is detected inactive, the trip will be reset automatically.

▪ PLC control 1 & PLC control 2

'PLC control 1' & 'PLC control 2' determine jogging control through the digital input. When DI detects an active signal, the motor will run continuously on one direction or at one speed until the inactive signal in detected to stop the motor.

'PLC control 1' is designed for forward control (CW) or first speed control in two speed starters.

'PLC control 2' is designed for reverse control (CCW) or second speed control in two speed starters.

To enabled PLC control function (jogging control), local control access has to be enabled.

▪ Trip reset

The input is used to reset a trip.
This input works in edge triggering mode.

▪ Torque switch

This input is used to check the status of torque switch used for actuator starter. When the input is different from normal state, M10x will release all contactor control relays to stop the motor. This input works in level check mode.

▪ F_CA

The F_CA input is the feedback detection signal of contactor control relay CCA. This input works in level check mode.

▪ F_CB

The F_CB input is the feedback detection signal of contactor control relay CCB. This input works in level check mode.

▪ F_CC

The F_CC input is the feedback detection signal of contactor control relay CCC. This input works in level check mode.

▪ Loc/R

The Loc/R input is local/remote control switch input.

For M10x, if the Loc/R input is active, the control authority will be local hardwiring. If the Loc/R input is inactive, the control authority will be remote fieldbus.

This input works in level check mode.

▪ Main switch status

Once the DI is defines as ‘main switch status’, the main switch monitoring and protection function is switched on. This input works in level check mode. Main switch function is normally working with module test position monitoring function (if “test switch” is defined.)

When main switch is changed between “ON’, ‘OFF’ “Test” position, the following events are generated:

1) If the main switch is switched from “ON” to “OFF” or “TEST” to “OFF” while motor is running (with detected motor running current or contactor closed), M10x sends out the ‘trip’ command to control contactor and ‘main switch off’ message is generated.

2) If the main switch is switched from “ON” to “OFF” or “TEST” to “OFF” while motor is stopped (with detected zero current or contactor open), no alarm or trip indication is generated.

▪ External trip

This input is used for external trip signal to trip the motor. When the input is active, the motor will be tripped and cannot be restarted until the input is inactive.

1) In feeder mode, ‘External trip’ function only occurs a message and details refer to ‘Feeder’ chapter on page 38.
2) If the signal is detected inactive, the trip will be reset automatically.

This input works in level check mode.

▪ MD control

MD control is used to decide whether the control command from MD is active or not. When one of the digital inputs is assigned as MD control, the control authority of MD will not be changed via parameterization but depend on the input status of the DI. If the input status is active, motor can be controlled via MD and vice versa.

This input works in level check mode.

Trigger mode	Contactor type	Function	Description
Edge triggering	NO, NC	Start1	If the input status is different than the setting, the function will be active.
		Start2	
		Stop	
		Trip reset	
		PLC control1	
		PLC control2	
Level triggering	NO, NC	Process interlock1	If the input status is the same as the setting, the function will be active.
		Emergency stop	If the input status is different than the setting, the function will be active.
		Torque switch	
		Process interlock2	
		MD control	
		Test switch	
		NOP	Only detects the input status.

Table 42. Operation character of digital inputs

Followed functions only can be assigned once at a parameterization:
Limit1,Limit2, PLC control1, PLC control2, F_CA, F_CB, F_CC, Loc/R, Main switch status, MD control.

Digital outputs

The M101 range of products is equipped with one set of programmable digital outputs while the M102 range of products comes with two sets. These outputs can be assigned any of the following functions:

- **Energize on motor start delay :**
  Provides a delayed energization of relay when motor is started.

- **De-energize on motor stop delay:**
  Provides a delayed de-energization of relay when motor is stopped.

- **Fieldbus control:**
  The relay can be energized or de-energized via the serial port.

- **DI9 status(only for 24VDC DIs):**
  The relay will be energized while the DI9 switch is closed.

- **DI10 status(only for 24VDC DIs):**
  The relay will be energized while the DI10 switch is closed.

- **DI11 status(only for 24VDC DIs):**
  The relay will be energized while the DI11 switch is closed.

- **DI0 status(only for 110VAC or 240VAC DIs):**
  The relay will be energized while the DI0 switch is closed.

- **DI1 status(only for 110VAC or 240VAC DIs):**
  The relay will be energized while the DI1 switch is closed.

- **DI2 status(only for 110VAC or 240VAC DIs):**
  The relay will be energized while the DI2 switch is closed.

- **Trips:**
  When a trip occurs, the relay can be set to energized or de-energized via parameterization.

- **Earth fault trip:**
  When earth fault trip occurs, the relay can be set to energized or de-energized after a preset trip delay via parameterization.

- **TOL:**
  When overload trip occurs, the relay can be set to energized or de-energized via parameterization.

- **Watchdog output:**
  M10x has an internal hardware watchdog supervising the behavior of the microprocessor software. Digital output can be used as signaling output relay for indicating the status of the unit's internal watchdog. When overload trip occurs, the relay can be set to energized or de-energized via parameterization.

- **Communication failure:**
  When a failure occurs, the relay can be set to energized or de-energized via parameterization.

- **Contactor welded:**
  When contactor welded occurs, the relay can be set to energized or de-energized via parameterization.

- **RCU mode (M101 only):**
  This definition is assigned to the programmable output when NR DOL/RCU, REV DOL/RCU or contactor feeder/RCU is selected as the motor start mode. The relay output serves the same function of de-energizing the contactor coil as CCC output in M102.

- **Local_remote output:**
  The relay is energized when the control authority is remote only. The relay will be de-energized when the control authority is local.

- **Ready to start:**
  The relay will energized when the module is ready for start.

Maintenance function
M10x provides maintenance for the motor by supervising running hours and start numbers.

Functionality of maintenance functions is based on the parameters given by user. Functions operate independently so that maintenance functions can be active and alarms can be given at the same time.

Number of starts
M10x counts number of starts. For each operation cycle, M10x updates the number of operating cycles in a memory map. When the start number alarm level is exceeded, M10x issues an alarm.

Motor running time
M10x counts motors running hours. When the running hours limit is crossed, M10x issues a “running time” alarm.

M10x also provides other maintenance information on the motor to expedite user reporting.

Number of trips
M10x counts number of trips and updates them in a memory map.

SOE
M102 provides event recorder data for up to 256 events with time stamp.

Metering and monitoring
M10x provides an extensive range of motor operation supervisory functions. Supervisory data are transmitted via the fieldbus to the upper level system for centralized management and are optionally directly displayed on the operator panel MD21 if installed on the front of the motor starter module.

Metering and monitoring	M101	M102
Power information		
Current L1,L2,L3 (A)	✓	✓
Current L1,L2,L3 (%)[1]	✓	✓
Current unbalance (%)[2]	✓	✓
Thermal capacity (%)	✓	✓
Power factor	-	✓
Line voltages (V)	-	✓
Frequency (Hz)	-	✓
Earth fault current (A)	✓	✓
Active power (kW)	-	✓
Apparent power (kVA)	-	✓
Energy (kWh)	-	✓
Thermistor resistor (ohm)	-	✓
Time to TOL trip	✓	✓
Time to TOL reset	✓	✓
Actual startup time	✓	✓
Motor status		
Motor status	✓	✓
DI status	✓	✓
Diagnosis		
Alarm/trip for each function	✓	✓
Maintenance		
Motor running hours	✓	✓
Motor stop time	✓	✓
Number of starts	✓	✓
Number of trips	✓	✓
SOE		✓

Table 43. Monitoring and metering by M10x

1) Current% measured current compares with nominal current.
   For example, Current% of L1 = I_{L1} / In*100%

2) Current unbalance measured the maximum difference between current and average current with average current. The formula is :
   $I_{ave}=(I_{L1}+I_{L2}+I_{L3})/3$
   Current Unbalance = $\max(I_{L1}- I_{ave} , I_{L2}- I_{ave} , I_{L3}- I_{ave})/ I_{ave}$ *100%

Communication interface

Overview

M10x supports two types of communication protocol: MODBUS RTU and PROFIBUS DP.

MODBUS RTU

The physical fieldbus interface in M10x-M is RS485. There are two identical RS485 interfaces for redundant design. All functions are supported via RS485, eg, parameterization, control, supervisions, etc.

The M10x-M implements a subset of the Modicon MODBUS RTU serial communication standard. MODBUS is a single master/multiple slave type of protocol suitable for a multi-drop configuration as provided by RS485 hardware. The M10x-M is always a MODBUS slave, and cannot be programmed as a master. Commonly, computers or PLCs serve as masters.

Both monitoring and control are possible using read and write register commands. Other commands are supported to provide additional functions.

RS485 interface cable

All devices are connected in bus structure. In one segment, up to 32 modules can be connected. At the beginning and the end of one segment, the cable is terminated with a resistor. The maximum length depends on cable type and baud rate.

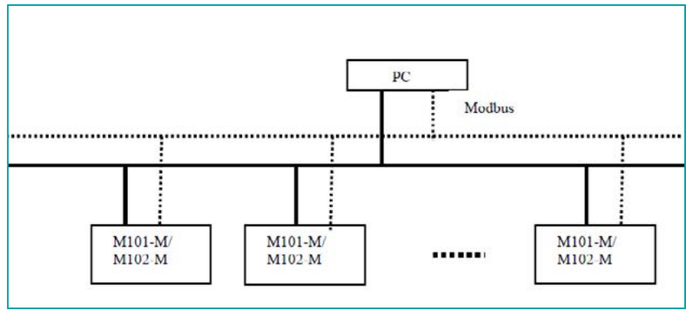


Fig. 40. Network connection of M10x-M

Function description

The following functions are supported by the M10x-M:

- FUNCTION CODE 02 - Read settings and actual values
- FUNCTION CODE 03 - Read settings and actual values
- FUNCTION CODE 04 - Read settings and actual values
- FUNCTION CODE 05 - Execute operation
- FUNCTION CODE 06 - Store single setting
- FUNCTION CODE 08 – Loop back test
- FUNCTION CODE 10 - Store multiple settings

For more details on the M10x MODBUS, refer to M10x-M MODBUS Protocol Implementation.

PROFIBUS DP

The M10x implements a subset of the PROFIBUS DPV1 serial communication standard. PROFIBUS is a multiple master/multiple slave type of protocol suitable for a multi-drop configuration as provided by RS485 hardware. M10x always acts as PROFIBUS-DP slave in the network. Usually, computers or PLCs act as masters in the network.

The physical interface used from the M10x is RS485. All functions are supported via RS485 interfaces, eg, parameterization, control, supervisions, etc.

Both bus network and tree network are supported by M10x PROFIBUS installation. Two network types are illustrated below:

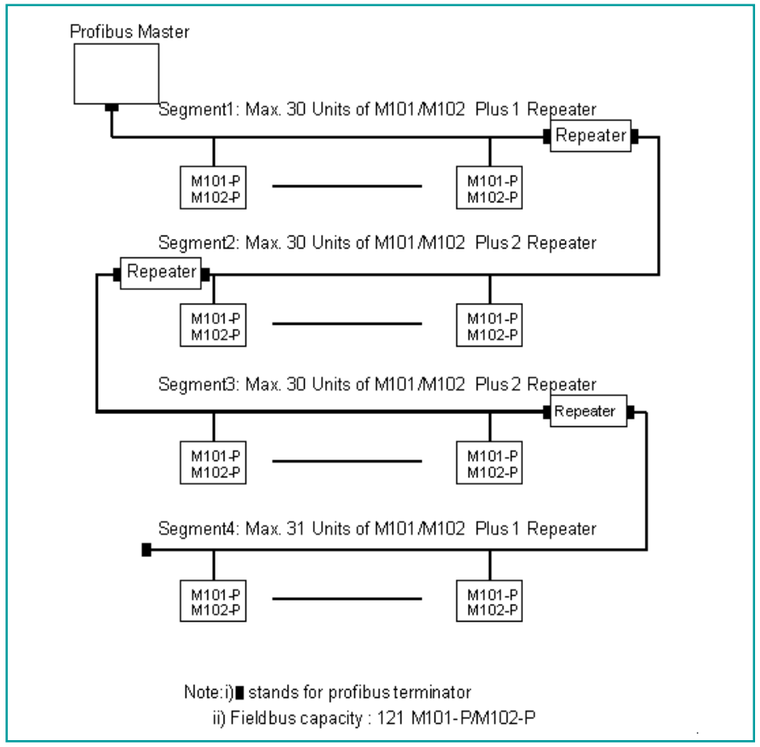


Fig. 41-1. Bus (line) network

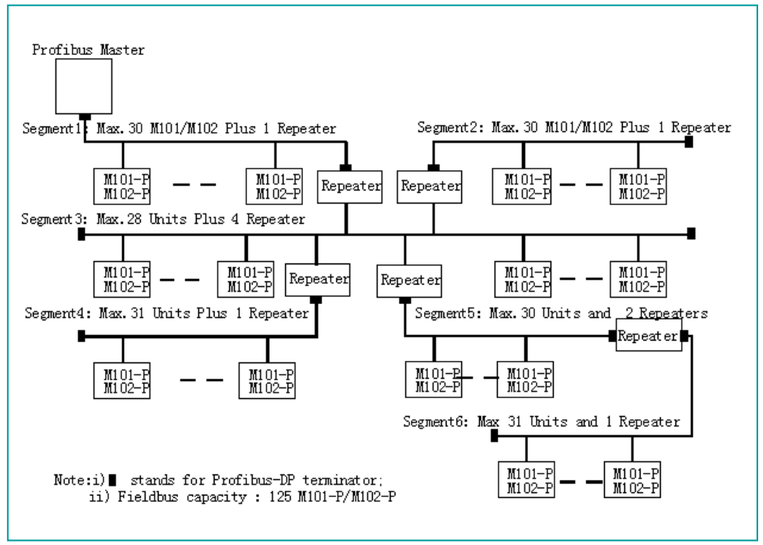


Fig. 41-2. Tree network

PROFIBUS interface wiring

All devices are connected in bus structure or tree structure. Up to 32 nodes can be connected in one segment. The cable is terminated with a resistor at both ends of each segment. The maximum length of the cable depends on cable type and baud rate.

For more detailed information, please consult with PROFIBUS organization or the manufacturer.

PROFIBUS DP description

PROFIBUS-DP is a distributed I/O system that enables the master to use a large number of peripheral modules and field devices. The data transfer is mainly cyclic: the master reads the input information from the slaves and sends the output information back to the slaves. PROFIBUS-DPV1 is an extension of the DP protocol. Additionally, it allows the acyclic exchange of data between master station and slave station.

The services of the PROFIBUS data link layer (Layer 2) are used by PROFIBUS-DP through service access Points (SAPs). Precisely defined functions are assigned to individual SAPs. For further information on SAPs, refer to the PROFIBUS master manual.

The following SAPs are supported by the M10x:
- SAP47 – acyclic read/write of MSAC_C2, abort
- SAP48 – acyclic read/write of MSAC_C2, abort
- SAP49 – initiate req of MSAC_C2
- SAP51 – acyclical read/write of MSAC_C1
- SAP56 – read input
- SAP57 – read output
- SAP58 – global control command
- SAP59 – read configuration data
- SAP60 – read diagnosis data
- SAP61 – initial parameters
- SAP62 – check the configuration data

For more information on PROFIBUS implementation in M10x, please refer to M10x-P PROFIBUS protocol implementation.

Parameterization

Overview
M10x relays can be configured with MD21 or MD31 operator panel keypad, via MCUSetup software, and through fieldbus if the communication network is available.

Parameterization via MD21
Most parameters can be set or changed through the MD21 operator panel keypad. For details of the parameters menu structure, please refer to the chapter: MD21/ MD31 Operator Panel.

Parameterization via MCUSetup software
Users can complete parameter settings by connecting a computer with installed MCUSetup software to MD21 or MD31 with a mini USB-pin physical interface.

Parameterization via fieldbus
M10x parameters are listed in the memory map. The user can parameterize M10x-M by MODBUS RTU protocol and M10x-P by DPV1 protocol. For detailed information, refer to the M10x-M MODBUS Protocol Implementation and M10x-P PROFIBUS Protocol Implementation.

M10x parameters
M10x Parameters are listed together with explanations, possible ranges and default values in a separate document: M10x Parameter Description.

Accessories

MD21/MD31 operator panel

Overview

M10x devices provide operator panels as optional accessories for local operation and setting parameters for individual motor starters. There are two types of operator panels available: MD21 and MD31. MD21 is equipped with control buttons, LED indicators and LCD display. MD31 is more compact in size with control buttons and LED indicators only. Both operator panel types are equipped with communication port (mini USB connector) in the front for remote parameterizing via engineering station.

The operator panel is connected to the main M10x device via RJ11 interface (RS485 port), located on the back of the panel.

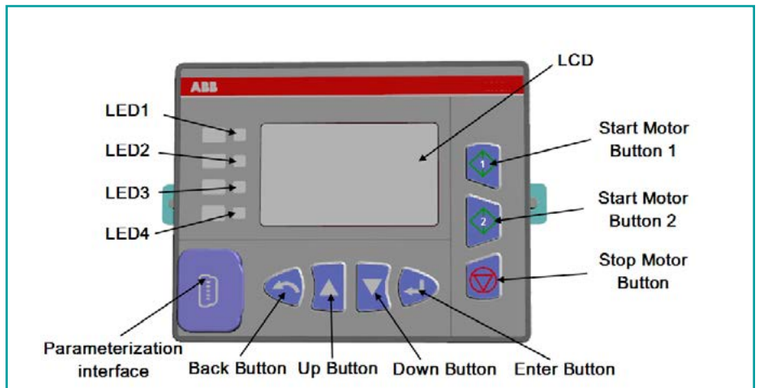


Fig. 42. MD21 operator panel

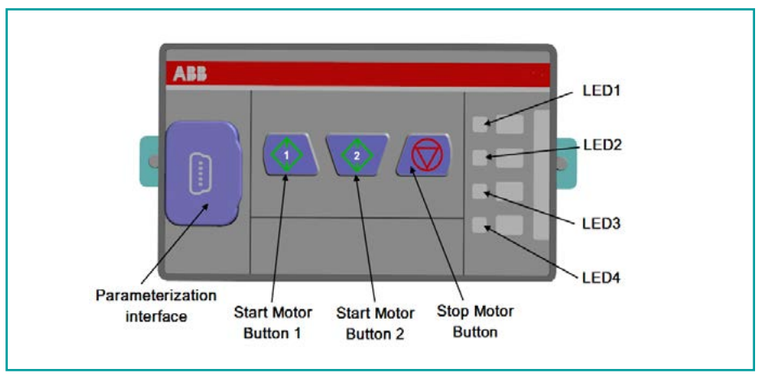


Fig. 43. MD31 operator panel

LED indicators

Four sets of LEDs are available on the front of the MDx panel. LED1 is a single green color, while the other three are dual colors. All four sets are configurable with the functions listed below:

LEDs	Configurable color	Configurable functions
LED1		Ready(default), Running, Stop, Fault, Ready to Start, Start1, Start2, DI0, DI1, DI2, DI3, DI4, DI5, DI6, DI7, DI8, DI9[iii], DI10[iii], DI11[iii], DI12[iii]
LED2	(default)	Ready, Running, Stop, Fault, Ready to Start, Start1(default), Start2, DI0, DI1, DI2, DI3, DI4, DI5, DI6, DI7, DI8, DI9[iii], DI10[iii], DI11[iii], DI12[iii]
LED3	(default)	Ready, Running, Stop, Fault, Ready to Start, Start1, Start2(default) , DI0, DI1, DI2, DI3, DI4, DI5, DI6, DI7, DI8, DI9iii, DI10iii, DI11iii, DI12iii
LED4	(default)	Ready, Running, Stop, Fault(default), Ready to Start, Start1, Start2, DI0, DI1, DI2, DI3, DI4, DI5, DI6, DI7, DI8, DI9[iii], DI10[iii], DI11[iii], DI12[iii]

Table 44. LED configuration

LED functions	Meaning of the function
Ready	M10x unit is powered up and ready for operation
Start1	Motor is running CW/N1
Start2	Motor is running CCW/N2
Running	Motor is running CW/N1 or CCW/N2 or feeder is closed
Stop	Motor is stopped or feeder is open
Ready to Start	Motor is ready to start, ie, there is no active internal or external trip, motor is not under emergency stop state (if defined) and Main Switch is ON (if defined) or TEST position (if defined)
Fault	Motor is in fault
DIx iii	The status of DIx

Table 45-1. LED indicator function definition

LED Status	Explanation
On	Assigned function is activated
Wink	Alarm active or device is initializing
Off	Inactive or off power *ii)

Table 45-2. LED indicator message

(i) If MDx is under parameterization with parametering cable plugged in or scrolling through setting menus, all LEDs in the front panel wink at the same time.

(ii) DI9~DI12 are only active for M10x 24VDC type.

(iii) Additional label of LED should be prepared, if LED is not assigned to default function.

Control buttons

MD21 provides 7 buttons and MD31 provides 3.

User can control motor via buttons on MD21 and MD31. User can also control motor, monitor and parameterize via buttons on MD21.

Button	Function	Remark
	Start 1 button, to start motor CW/N1	
	Start 2 button, to start motor CCW/N2	
	Stop button, to stop motor	Also used to reset fault trip
	Enter button, to enter selected menu	Only in MD21
	Down button, to show next messages or menus	Only in MD21
	Up button, to show past messages or menus	Only in MD21
	Back button, to exit selected menu or go back one step.	Only in MD21

Table 46. MD21/31 Button Icons

Monitoring value display

After power on, MD21 initially enters monitoring values display stage, during which all values, alarms, trips and control authority can be displayed.

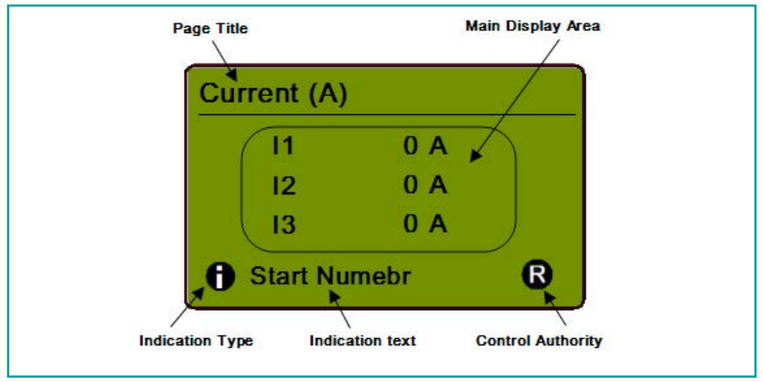


Fig. 44. View of monitoring value display window

- Page title: At the top of the LCD to show the tag name.
- Main display area: Main display area to display process data.
- Indication type: At the left side of the bottom of the LCD to show the type of the indication (alarm/trip).
- Indication text: Following Indication type to show the detail alarm/trip message
- Control authority: show control access

Icon	Meaning
	Alarm
	Trip
	Local control is active
	Remote control is active
	01, highlighted, DI1* status is closed
02	02, not highlighted, DI2* status is open

Table 47. Description of icons displayed on MD21

* The number stands for the port of DI. Status of each DI is available on MD21.

Displaying parameters

MD21 supports up to 13 running parameter windows/pages. Users are free to choose any or all of the parameters to be shown on MD panel and mask out unwanted information.

User can navigate through displaying pages by pressing up or down button.

Page no.	Page title	M101	M102
1	Current (A)	✓	✓
2	Current (%)	✓	✓
3	Line Voltage	-	✓
4	Power related (include power, apparent power, power factor)	-	✓
5	Thermal capacity	✓	✓
6	Frequency	-	✓
7	Energy	-	✓
8	Ground current	✓	✓
9	PTC	-	✓
10	Time to TOL trip/reset	✓	✓
11	DI status	✓	✓
12	Startup time	✓	✓
13	Current unbalance	✓	✓

Table 48. Parameters on different displaying page

i) Enter button is NOT active when scrolling through running parameter windows.
ii) Table 48 shows the actual sequence of displaying pages on MD21.

Alarm message

Alarm message will come up on the bottom of the display window as shown in Fig. 44 with indication icon whenever an alarm is active. Possible alarm messages include the following:

Thermal capacity	Overload	Phase failure
Phase unbalance	Underload	Noload
Earth fault	PTC *	Undervoltage *
Autoreclose *	Feedback	Welded contactor
PTC short circuit*	PTC open circuit*	Start limitation
Serial communication	Running time	Start number
Watchdog	Ready to trip reset	DI

* M102 only.

Trip message

Trip message will come up on the bottom of the display window as shown in Fig. 44 with indication icon whenever a trip is active. Possible trip messages include the following,

TOL	Stalled rotor	Phase failure
Phase unbalance	Underload	Noload
Earth fault	PTC *	Undervoltage *
Feedback	Serial communication failure	Start limitation
Feeder trip	Long start	Emergency stop
External trip	DI	Current feedback
Main switch off		

*M102 only.

The menu tree

Press the back button at monitoring value display window to enter the main configuration menu.

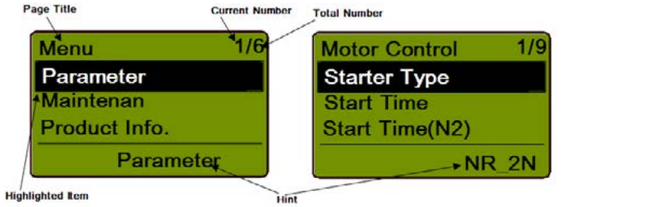


Fig. 45. View of menu

Press the back button at the main configuration menu to enter running parameter window.

- Page title: At the top of the LCD to show the tag name or submenu table.
- Highlighted item: The current active menu item.
- Current number: At the right of the top of the LCD to show the number of the current selected menu item.
- Total number: At the right of the top of the LCD to show total menu item numbers in the current page.
- Hints: At the bottom of the LCD to describe the current highlighted item or the related value of the highlighted item.

Press up/down button, can move the highlight to previous/next items.

Press enter button to enter next level of menu.

Press back button to go back to previous level of menu.

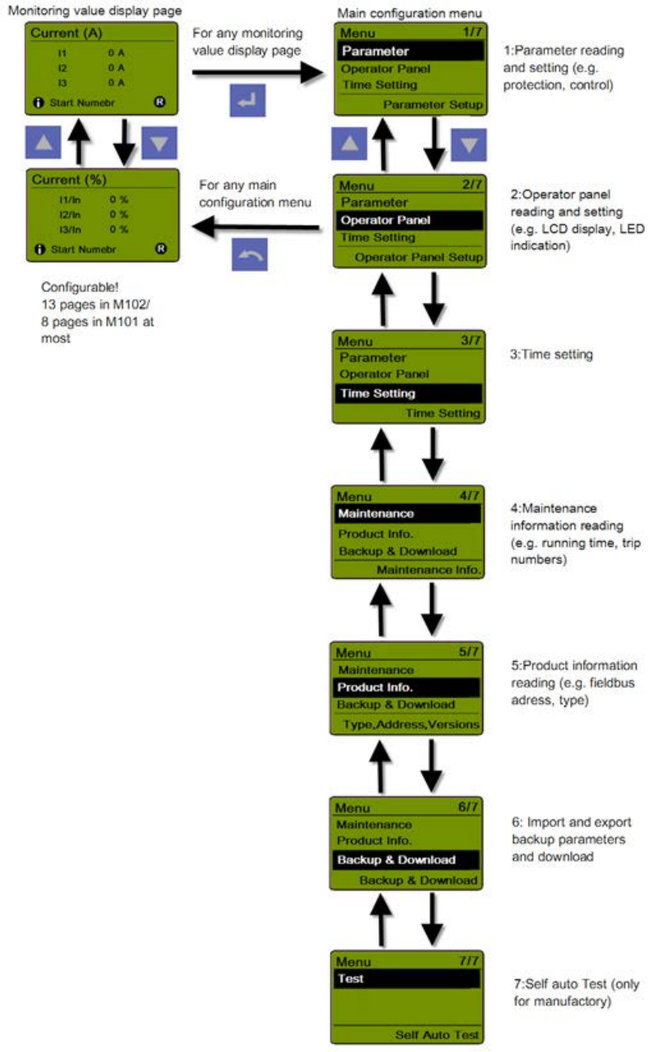


Fig. 46. View of main configuration menu tree

Parameter

Within this submenu, all motor related parameters can be configured. Table 49 shows the organization of the different parameter masks in the menu tree.

For more details about parameters, please refer to the document: M10x parameter description.

Level 1	Level 2	Level 3	Level 4	Level 5
Parameter[1]	Protection	TOL[2]	Function	
			Disabled duration start[9]	
			Reset mode[9]	
			Thermal mode[9]	
			TOL bypass[9+10]	
			T6[9+10]	
			Cool coe. [9]	
			Te[9+11]	
			Ia/In[9+11]	
			Alarm level[9]	
			Trip level[9]	
			Reset level[9]	
			Ambient temperature[9]	
		Stall[2]	Function	
			Reset mode[9]	
			Trip level[9]	
			Trip delay[9]	
		Phase failure[2]	Function	
			Reset mode[9]	
			Alarm level[9+12]	
			Trip level[9]	
			Trip delay[9]	
		Unbalance[2]	Function	
			Reset mode[9]	
			Alarm level[9+12]	
			Trip level[9]	
			Trip delay[9]	
		Underload[2]	Function	
			Reset mode[9]	
			Alarm level[9+12]	
			Trip level[9]	
			Trip delay[9]	

Level 1	Level 2	Level 3	Level 4	Level 5
Parameter[1]	Protection	Long start[2]	Function	
			Reset mode[9]	
			Alarm level[9+12]	
			Trip level[9]	
			Trip delay[9]	
		Earth fault	Function	
			Enabled duration start[9+12]	
			Reset mode[9]	
			Alarm level[9+12]	
			Trip level[9]	
			Trip delay[9]	
		PTC[2+3]	Function	
			Reset mode [9]	
			Alarm level[9+12]	
			Trip level[9]	
			Trip delay[9]	
			Reset level[9]	
			SC Alarm level[9+12]	
		UV&AR[2+3]	Function	
			Reset mode[9]	
			Autorestart[9]	Function
				Mode[9]
				MAT[9]
				MPDT[9]
				Delay[9]
			Alarm level[9+12]	
			Trip level[9]	
			Trip delay[9]	
			Reset level[9]	
		Start limit	Function	
			Mode[9]	
			Interval[9]	
			Start number[9]	
		Long start[2]	Function	
			Reset mode[9]	
			Rotor level[9]	
			Rotor delay[9]	

Level 1	Level 2	Level 3	Level 4	Level 5
Parameter[1]	Control	Motor Control	Starter type	
			Start time[14]	
			Start time (N2) [6]	
			Change over[15]	
			Ramp up[16]	
			Ramp down[16]	
			Earth fault primary[17]	
			Internal CT	
			Communication failure delay	
			Fail safe[18]	
			Feedback	
			Feedback timeout[25]	
			Soft test switch	
			External CT used	
			External CT1 primary[20]	
			External CT2 primary[20+6]	
			External CT secondary[20]	
		Control authority	Profibus option[19]	Auto mode active
			Soft local/ remote[19]	L hardwiring
				R fieldbus
			MD control[19]	MD operator panel
				MD in local
				MD in remote
				MD in auto Mode 0
				MD in auto Mode 1
		Grouping	Function	
			Direction[9]	
			Group number[9]	
			Start delay[9]	
			Stop delay[9]	

Level 1	Level 2	Level 3	Level 4	Level 5
Parameter[1]	Communication	MODBUSRTU[4]	Address	
			Parity	
			Redundancy	
			Baud rate	
		ProfibusDPV[15]	Address	
			Mode	
			Block DP	
	Motor info.	Motor type		
		Voltage[3]		
		Frequency		
		Rated power		
		In		
		In (N2) [6]		
	DI	Type		
		DI0	Function	
			Contact type	
			Delay[21]	
			Operation[22]	
		DI1	Function	
			Contact type	
			Delay[21]	
			Operation[22]	
		DI2	Function	
			Contact type	
			Delay[21]	
			Operation[22]	
		DI3	Function	
			Contact type	
			Delay[21]	
			Operation[22]	
		DI4	Function	
			Contact type	
			Delay[21]	
			Operation[22]	

Level 1	Level 2	Level 3	Level 4	Level 5
Parameter[1]	DI	DI5	Function	
			Contact type	
			Delay[21]	
			Operation[22]	
		DI6	Function	
			Contact type	
			Delay[21]	
			Operation[22]	
		DI7	Function	
			Contact type	
			Delay[21]	
			Operation[22]	
		DI8	Function	
			Contact type	
			Delay[21]	
			Operation[22]	
		DI97	Function	
			Contact type	
			Delay[21]	
			Operation[22]	
		DI107	Function	
			Contact type	
			Delay[21]	
			Operation[22]	
		DI117	Function	
			Contact type	
			Delay[21]	
			Operation[22]	
		DI127	Function	
			Contact type	
			Delay[21]	
			Operation[22]	

Level 1	Level 2	Level 3	Level 4	Level 5
Parameter[1]	DO	DO1	Function	
			Delay[23]	
			Principle[24]	
		DO23	Function	
			Delay[23]	
			Principle[24]	
	Maintenance	Running hour	Function	
			Alarm level[9]	
		Start number	Function	
			Alarm Level[9]	

Table 49. Menu tree of parameter

Note: Items with marks will only display when they meet corresponding conditions shown below.

1: MD21 is connected with New Series M10x-x.

2: Starter type is NOT set to be Feeder.

3: MD21 is connected to M102-x.

4: MD21 is connected to M10x-M.

5: MD21 is connected to M10x-P.

6: Starter type is set to be NR_2N|NR_2N Dahlander.

7: MD21 is connected to M10x-x with 24V DI ports.

8: Backup parameter has ever been performed at least once.

9: Related Function is set to be On.

10: TOL Thermal mode is set to be Standard.

11: TOL Thermal mode is set to be EExe.

12: Related Function is set to be Alarm only.

13: MD21 is connected to M101-x.

14: Starter type is NOT set to be NR_softstarter|REV_softstarter.

15: Starter type is set to be NR_S_D|NR_2N|Dahlander|Autotransformer.

16: Starter type is set to be NR_softstarter|REV_softstarter.

17: Earth fault Function is set to be “On|Alarm only.

18: “Comm. F Delay” is NOT set to be “255”.

19: Details refer to Control Authority chapter

20: Ex CT Used is set to be Yes.

21: Related Function is set to be “Start1/Start2/Stop/Process interlock1/Process interlock2”.

22: Related Function is set to be Process interlock1/Process interlock2/Emergency stop.

23: Related “Function” is set to be EnSaD/DeSoD/EFTrip.

24: Related Function is set to be Trips/EFTrip/TOL/WDog/Comm_Failure/CTRWelded”.

25: Feedback is set to Enabled.

Operator panel

Within this submenu, LCD display and LED indication can be configured. Table 50 shows the organization of the different parameter masks in the menu tree.

For more details about parameters, please refer to the document: M10x Parameter Description.

Level 1	Level 2	Level 3	
Operator panel	LCD display	Current (A)	
		Current (%)	
		Line voltage[1]	
		Power related[1]	
		Thermal capacity	
		Frequency[1]	
		Energy[1]	
		Ground current	
		PTC[1]	
		Time to TOL trip/reset	
		DI status	
		Startup time	
		Current unbalance	
	LED indication	LED1	Function
			Color
		LED2	Function
			Color
		LED3	Function
			Color
		LED4	Function
			Color
	Language		
	Password setup		

Table 50. Menu tree of operator panel

* M102 only.

Time setting

Within this submenu, actual time can be configured. Table 51 shows the organization of the different parameter masks in the menu tree.

Level 1	Level 2
Time setting	Year
	Month
	Day
	Hour
	Minute
	Second
	Week

Table 51. Menu tree of time setting

▪ Maintenance

Within this submenu, all motor related maintenance can be configured. Table 52 shows the organization of the different parameter masks in the menu tree.

Level 1	Level 2
Maintenance	SOE*
	Running time
	Stop time
	Start number
	Stop number
	Trip number
	Last trip current

Table 52. Menu tree of maintenance

* M102 only.

Product information

Within this submenu, information of M10x and MD21 can be read. Table 53 shows the organization of the different parameter masks in the menu tree.

Level 1	Level 2
Product information	Fieldbus address
	Type of M10x
	Firm version of M10x
	Firm version of MD

Table 53. Menu tree of product information

Backup and download

The backup feature is for reading parameters from the M10x device and creating a backup file in the MD panel. The download feature is for downloading backup files from MD panel to M10x device.

This feature is easy to operate onsite, and is quite useful when similar parameters are required for several M10x devices.

Table 54 shows the organization of the different parameter masks in the menu tree.

Level 1	Level 2
Backup and download	Backup parameter
	Download backup1

Table 54. Menu tree of backup and download

1) The download backup option is not available until the backup parameter function has been executed.

2) Remember to change slave address after copying parameters from other devices to avoid communication problems.

Backup parameter: Saves current parameter to backup register in MD21.

Download backup: Downloads the parameter in backup register into M10x.

Test

Select this submenu, M10x will test itself for a few seconds and feedback.

Test function is only for the manufacturer.

Adjusting parameters

Select the item at the last parameter level and press enter. A password window will appear. Input the correct password to enter the parameter adjusting window.

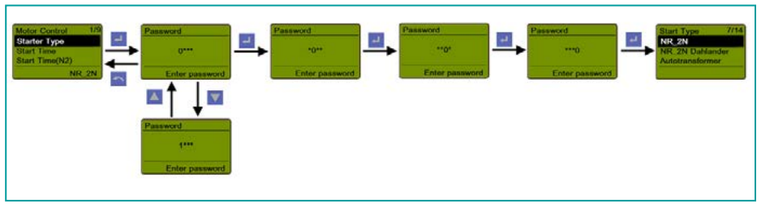


Fig. 47. Process of entering parameter adjusting window

1) Default password is 1111.

It is recommended to change the default password after first login.

There are two types of parameter adjusting window: numerical value adjusting, and option selecting.

When finished, press the back button to return to the confirmation window. Select confirm and press enter to download the new parameter to the M10x.

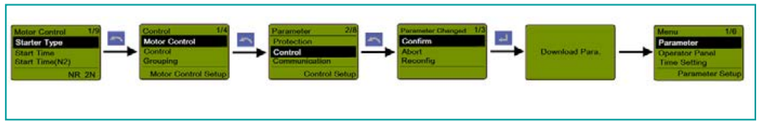


Fig. 48-1. Confirm parameter adjustment

The slave address can be revised and downloaded to M10x via MD21.

▪ Adjusting a numerical value

This type of window allows a numerical value to be specified within given limits. Pressing up/down buttons will increase/decrease the digit. Once the value is set, press enter to acknowledge.

i) The information of given limits of parameters is provided in the document: M10x Parameter Description.

ii) Continuing to press the up/down button to change the speed of increase/decrease.

iii) When the value reaches the limit, it will automatically count backwards even if the same button is pressed.

The following example shows how to set the startup time to 10sec:

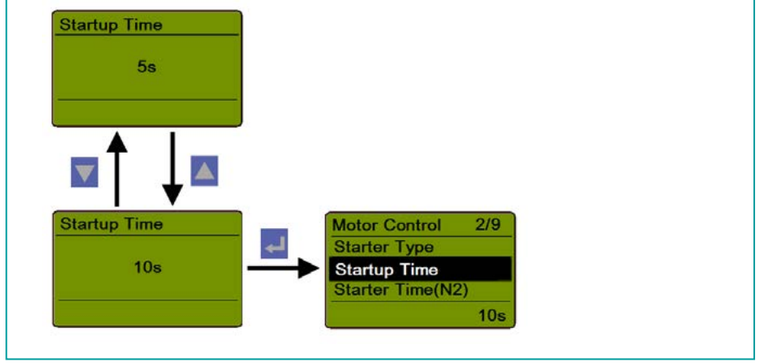


Fig. 48-2. Example of numerical value adjusting

Start editing the value by pressing the up button. When it reaches 10, press enter.

▪ Selecting an option from a list

This type of window allows an item to be selected from a given list of options. With the up/down keys you can scroll through the list. The highlighted selection shows current position within the list. Press enter to confirm, then press back to exit.

Pressing the back button exits the dialog and discards the selection.

i) The details of given options of parameters can be found in the document: M10x Parameter Description.

The following example shows how to set the starter type to NR_2N Dahlander:

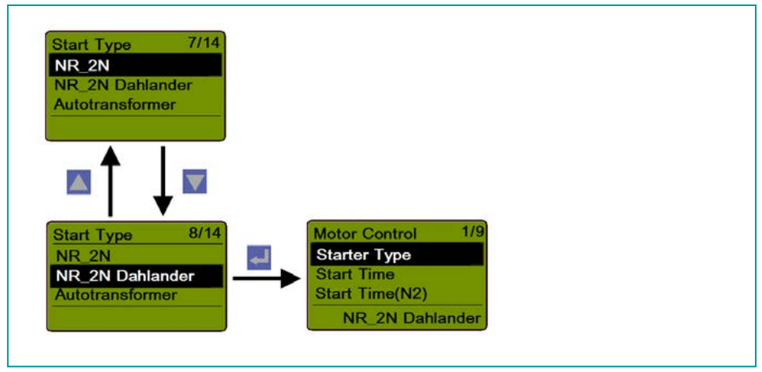


Fig. 49. Example of options selecting

Parameterization port

The parameterization port on MD panel is a mini USB type of interface. Once this port is connected with parametering cable, the communication between M10x main device and MD panel is temporarily stopped with a parameterizing status message shown on LCD. No operation is allowed during parameterizing.

M10x parameters can be uploaded and downloaded from the parameterization device via the interface.

Remember to cover up the mini USB port after parameterization is finished.

Connection

Operator panel is connected to the X2 terminal on M10x via RJ11 interface. The connection shown below includes power supply and communication.

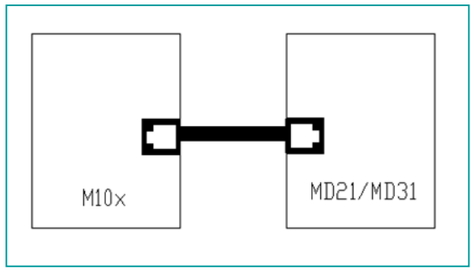


Fig. 50. Connection between M10x and MDx

If MD21 cannot receive information from M10x, a No Comm. message will appear on the LCD display.

If MD21 receives incorrect information from M10x, a comm. Error message will appear on the LCD display.

Parameterization software: MCUsetup

MCUsetup software is used to set parameters. It exchanges data with M10x via RS485.

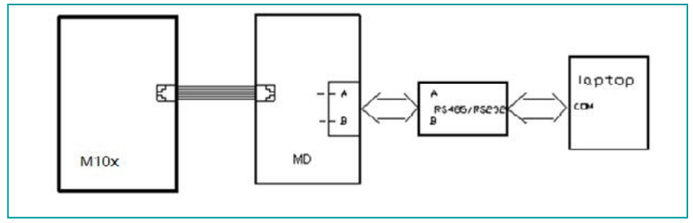


Fig. 51. Parameterization interface

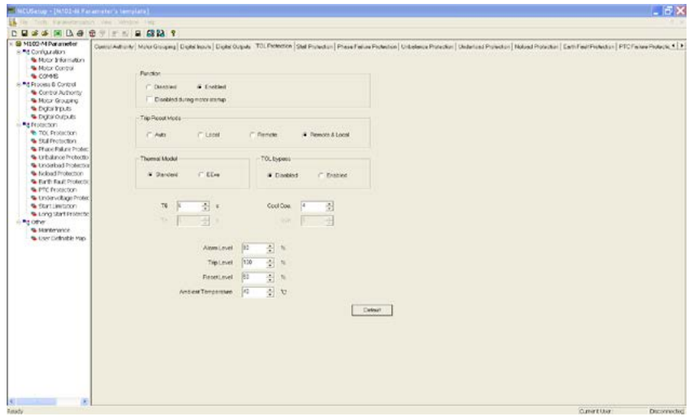


Fig. 52. MCUSetup window

The parameterization software includes the following functions:

- Edit parameters
- Export parameter to a file
- Import parameter from a file
- Update M10x's parameters
- Download M10x's parameters
- Read M10x's parameters
- User management

The parameterization software can run on all of the following PC operation systems: Windows 2000, Windows XP, Win 7 and Win 8.

For more information on how to set parameters with MCUSetup software, please refer to separate document: MCUSetup User Guide.

Appendix A: Technical data

Technical data

Main circuit	
Rated operation voltage (Ue)	up to 400/690VAC
Rated insulation voltage (Ui)	690VAC
Rated impulse withstand voltage (Uimp)	6KV, overvoltage category II in IT network, Category III in other networks.
Degree of pollution	3
Rated operation current (Ie)	0.24-63A
Rated frequency	50/60Hz

Control circuit	
Rated operational voltage (Ue)	24V DC ,110 or 240 VAC
Rated insulation voltage (Ui)	-250VAC
Rate impulse withstand voltage (Uimp)	4kV for AC circuit
Rated operational current (Ie)	
Contactor control relay output (CCA,CCB,CCC)	2A /24VDC(DC-13) 4A/120VAC(AC-15) 2A/240VAC(AC-15)
Rated frequency	50/60 Hz

Response timing accuracy	
TOL protection	5% of tolerance of tripping time
Stall protection	200 ~ 350ms
Earth fault protection	-30~+30ms
PTC protection	400 ~ 500ms
Others	0 ~ 150ms

Power supply	
Rated operational voltage (Ue)	24VDC , 110 or 240VAC
Voltage operation range	85%-110% Ue

Power consumption	24VDC	110VAC	240VAC
Typical	5W	6VA	12VA
Maxium	8W	-	-
Maximum starting current	600mA	-	-

Digital input(DC)	
Number of digital inputs	13 with one common connection
Logic 1	15…30V
Logic 0	0…5V

Digital input (AC)	
Number of digital inputs	9 with one common connection
Logic 1	110VAC type, 79…110V 240VAC type, 164…240V
Logic 0	110VAC type, 0…20V 240VAC type, 0…40V

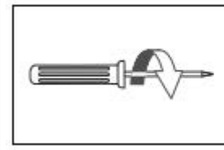
Fieldbus interface	
Protocol	PROFIBUS-DP/MODBUS RTU
Baud rate	PROFIBUS DP 9.6kbps/19.2kbps/45.45kbps/93.75Kbps/ 187.5Kbps/500Kbps/1.5Mbps MODBUS RTU 1200/4800/9600/19200/38400/57600 bps
Fieldbus capacity	32 nodes per segment

Degree of protection	
M10x	IP20
MD21/MD31	IP54 from module front

Environmental conditions		
Storage	-40 ~ +85°C	
Normal operation	24VDC type	-10 ~ +60°C Vertical mounting: -10 ~ +60°C Horizontal mounting: -10 ~ +55°C
	110/240VAC type	
Humidity	15% up to 95% without dew	
Derating accepted operating altitude	4500m	
Without derating operating altitude	2000m	
EMC environment	1) Equipments in the system complies with EMC requirement of CE/CCC certificate. 2) Power supply system complies with IEC61000-2-1, IEC61000-2-2, especially the system in which VSD/frequency converters are used.	

Metering accuracy	
Phase current	Range: 0.4-8 ×phase CT primary amps Accuracy: ±2% or ±0.01A, whichever is greater
Earth fault current	Full scale: 1.2 × RCT nominal current Accuracy: ±2% RCT primary
Line voltage (M102 only)	Voltage metering range: 110V - 690V Accuracy: ±2%
Power (only for M102)	Accuracy: ±5% or ±0.1kW, whichever is greater
Thermistor input (only for M102)	Sensor type: positive temperature coefficient PTC R_{HOT}=100-10,000 Ω Accuracy: ±2% or 10Ω which is greater

Installation		
Mounting	MCU	On TS35 DIN rail
		With 3 screws ST4.2 (tightening torque 4.5Nm)
		With 2 screws (tightening torque 0.1Nm)
Mounting position (MCU)	Vertical	(DIN and screw)
	Horizontal	(screw only)
Dimension	MCU	110mm X 140mm X 75mm
	MD21	91mm X 75mm X 24.3mm
	MD31	88mm X 50mm X 24.3mm
Wiring size	Terminal X1	DC type 1.5mm²
		AC type 2.5mm2
	Terminal X3	2.5mm²
	Terminal X4	2.5mm²

Tightening torque		1.5 mm² M2 / 0.22 ... 0.25Nm 2.5 mm² M3 / 0.5 ... 0.6Nm

Metering accuracy	
Phase current	Range: 0.4-8 ×phase CT primary amps Accuracy: ±2% or ±0.01A, whichever is greater
Earth fault current	Full scale: 1.2 × RCT nominal current Accuracy: ±2% RCT primary
Line voltage (only for M102)	Voltage metering range: 110V - 690V Accuracy: ±2%
Power (only for M102)	Accuracy: ±5% or ±0.1kW, whichever is greater
Thermistor Input (only for M102)	Sensor type: positive temperature coefficient PTC RHOT=100-10,000 Ω Accuracy: ±2% or 10Ω which is greater

Standards

Low voltage switchgears	
IEC60947-1	Low voltage switchgear and control gear" Part1: General rules
IEC60947-4-1	Low voltage switchgear and control gear" Part4: Contactors and motor-starters, Section one-Electromechanical contactors and motor-starters

EMC		
Electrostatic discharge	IEC61000-4-2,	Level 3
Electromagnetic field immunity	IEC61000-4-3,	Level 3
Electrical fast transient/burst immunity	IEC61000-4-4	Power suply, Level 4 Others, Level 3
Surge immunity	IEC61000-4-5,	Level 3
Conducted disturbance immunity	IEC61000-4-6,	Level 3
Radiated disturbance	EN55011/CISPR 11,	Class A

*Refer to section "Earth fault protection" on page 51

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