MANUAL

Motor control and protection unit

M10x User Guide

ABB low voltage MCC with M10x is the intelligent motor control center solution integrating protection, control, monitoring and communication through single M10x, a signature motor management device of ABB low voltage switchgear business.

Main benefits of ABB MCC with M10x

- **Unmatched safety for protection for personnel and plant**
- **Simplicity and high functionality**
- **Integrated communications**
- **Reliable solution proven by years of market experience**
- **Flexibility in a standardized solution**
- **Less spare starter module types**
- **Rapid fault detection and rectification**
- **Easy integrate and access to digital service**
- **Fully integrated into ABB Ability™ CMES condition monitoring solution**

Contents

01. General

Target group
This manual provides information on the internal parameters of M10x for the purpose of understanding, engineering, testing, system integration or commissioning of the product.

Each chapter consists of brief explanations of the functions, the relevant parameters and the parameter descriptions, along with ranges. Default values of all parameters are listed in appendix: Factory settings for M10x.

Examples and further explanations are provided for user reference in parameterization.

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 listed on the table below.

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.

	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

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 predefined 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 overheated 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 911112 M10x User Guide
1TNC 911507 M10x-P PROFIBUS Protocol Implementation
1TNC 911505 M10x-M Modbus Protocol Implementation
1TNC 911104 MCUSetup User Guide
1TNC928239 M10x -TCP User Guide

Related System Version

The content of this document is related to M10x products (1TNA920xx) with the following hardware and firmware version release:

	HW	FW
M10x-M 24VDC	2.0	3.5
M10x-M 110VAC	1.0	3.5
M10x-M 240VAC	1.0	3.5
M10x-P 24VDC	3.2	5.4
M10x-P 110VAC	1.0	5.4
M10x-P 240VAC	5.2	5.4
MD21	1.0	2.3
MD31	1.0	1.1
EM01	1.0	1.1

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	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
D0207	Add in Phase sequence protection and more DO functions, modify main switch supervision function.	09/2016
D0208	Add in insertion cycle supervision, external VT setting and M10x-TCP with EM01 module	02/2020

New features available in enhanced products (1TNA920xxx)

In comparison with classic products (1TNA911xx)

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 and 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 to be 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.
2	Additional communication option Modbus TCP is added in.
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	Multiple languages are supported including , 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.

02. Product overview

Introduction

M10x is an intelligent motor control and protection device based on current measurement or current measurement and voltage measurement. It is designed to be integrated with with ABB Low Voltage switchgear MNS® and NeoGear™ . ABB Low voltage switchgear with M10x device provides customer a simply but intelligent motor control center solution.

M10x device have measuring, monitoring, motor protection and controlling functions built in one single unit. By configuring of parameters to the device, M10x device is customized and engineered with application specific motor protection, monitoring and controlling features to serve different industry process. Each motor starter is usually managed by one M10x device with standard dimension regardless different available functions.

Available with communication interfaces (PROFIBUS DP, MODBUS RTU and TCP), 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

Product Variants

M101 basic version
M102 advanced version

M10x-M Modbus RTU type
M10x-P Profibus type
M10x-TCP Modbus TCP type

M10x 24VDC
M10x 110VAC
M10x 240VAC

Components Description

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 63A ~6300A, interposing CTs are required. (Fig 01)

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.(Fig 01)

Analogue Output Module AO11
Analogue output module AO11 is an optional add-on module to main unit, providing one channel 0-20mA or 4-20mA analogue output. Details of AO11 module including how to do the configuration is provided in a separate document, 1TNC 920204 M10x AO Module User Guide.

M10x-TCP Ethernet module EM01
Ethernet module EM01 is the dedicated Modbus TCP interface to M10x-TCP. It provides two Ethernet ports. Details of M10x-TCP is described in 1TNC 928239 M10x-TCP User Guide.

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.

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01 M10x and MD21

03. Installation and wiring

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.

Dimensions

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

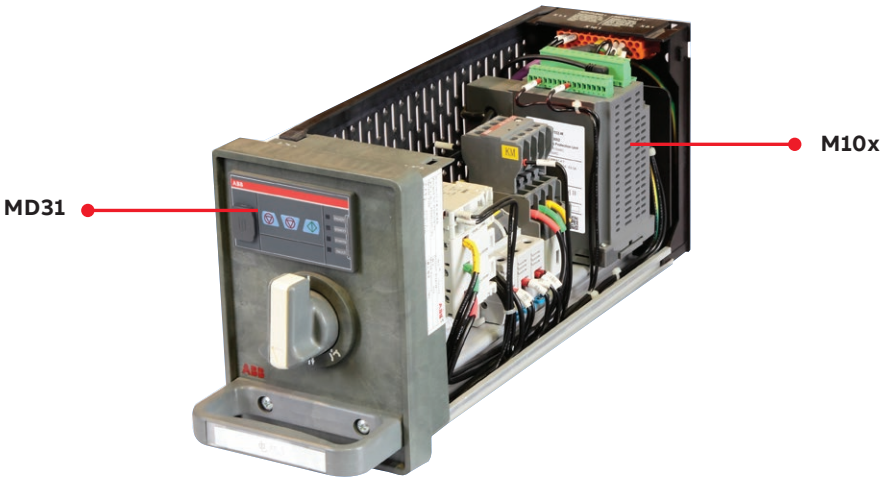
Basic dimension of MD21
W x H x D=91mm x 75mm x 24.3mm

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 installation manual.



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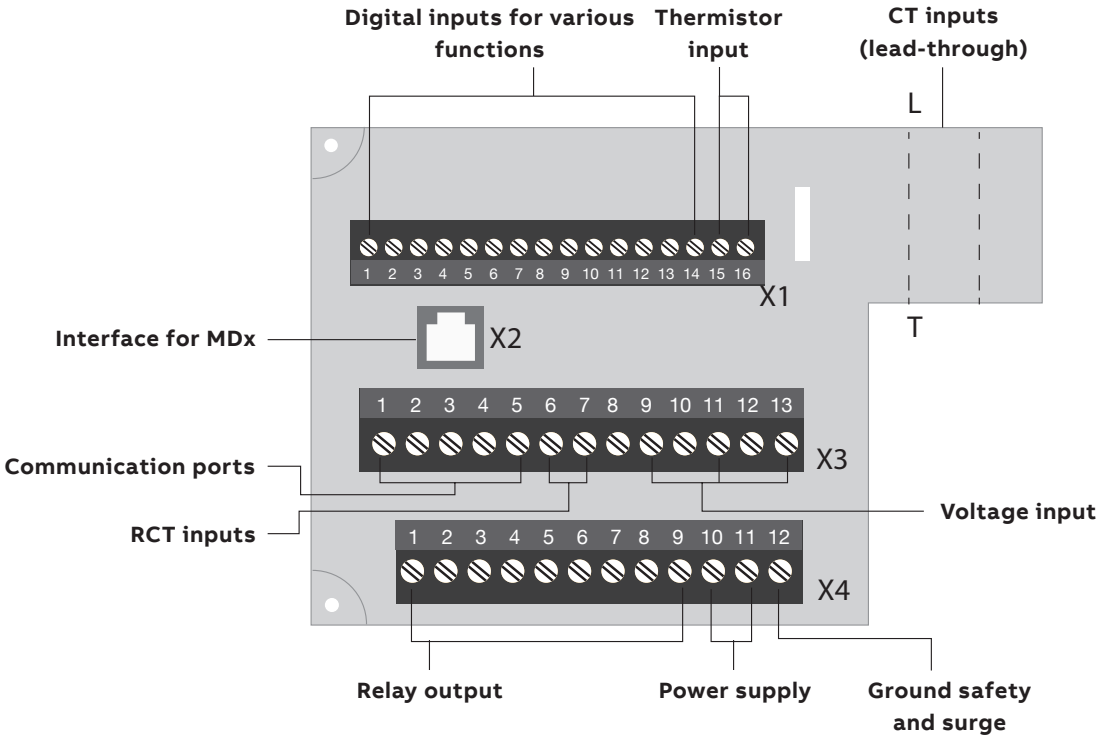
02 M10x in 8E/4 module

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.



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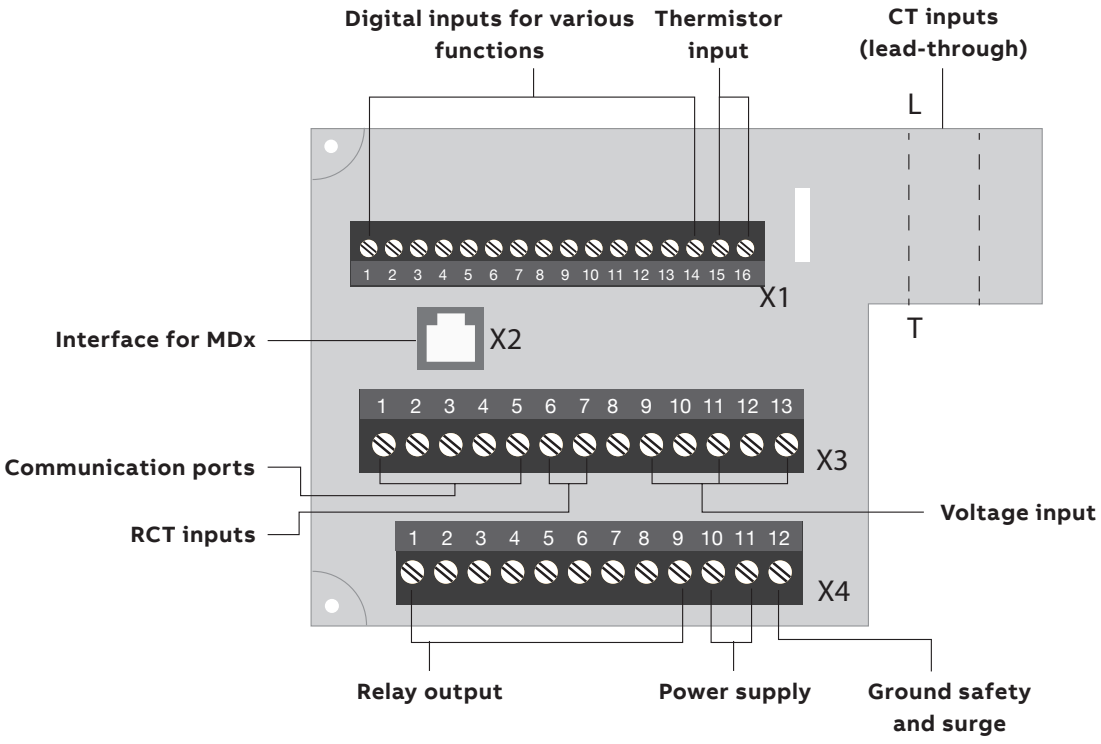
03 Top view terminal layout (24VDC)



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04 Top view terminal layout (110VAC or 240VAC)

Terminal designations
Regardless of different types of M10x product, the definition of the terminal blocks on each type of M10x remain the same. Depends on the selected type, the quantities of the available terminal numbers may be different.

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Table 1 Terminal blocks and definitions

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	
X1	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	110mm Window

Integrated L-T Current Measurement
Current measurement in M10x is via the integrated current transformer which comes with one size measuring from 80mA to 63A. External interposing CT shall be used for measuring from 63~6300A.

To ensure the correct current reading, wiring of three phases should follow the same direction, i.e. either L-T or T-L.

In single phase application, current measurement is based on Phase A or L1. The wiring has to follow L-T direction only.

Current measurement is illustrated in the typical diagram Fig (13)

Wiring Tip:
In the application that motor current is less than 500mA, it is essential to increase the wiring turns on CT primary to avoid possible nuisance reading, also known as ghost current. M10x supports up to 5 turns wiring through parameter configuration.

The parameters are explained in 'M10x parameters description ' manual.

Terminal block X1 Digital Inputs

Terminal block X1:1 ~10 is allocated for digital inputs (DI) wirings. Depending on voltage type, there are 13 sets of DIs in M10x 24VDC type and 9 sets in 110/240VAC type. Actual function of DIs is individually configurable.

Wiring Tip:

As M10x measures the voltage drop through DIs, any unnecessary voltage changes or disturbance on DI circuit should be avoided. e.g. if DIs are to be wired to a remote field from the starter in a DC application, a separate supply from the field may be considered. (Fig 05). If DIs are supplied by AC, an interposing relay may be used to segregate the interference from the field.

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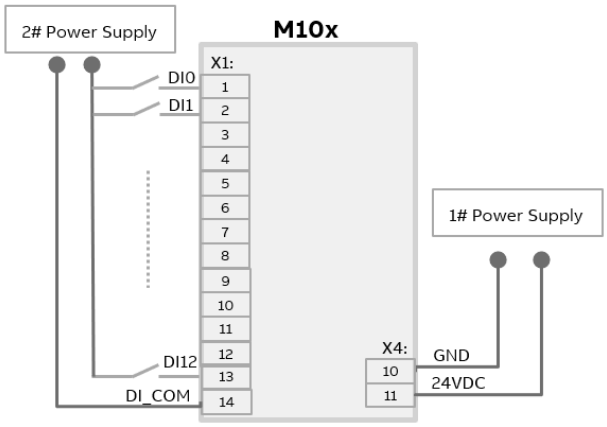
Table 2 Digital inputs definition

Terminal no.	M10x 24VDC	Functions	M10x 110/240VAC	Functions
X1:1	DI0	Configurable	DI0	Configurable
X1:2	DI1	Configurable	DI1	Configurable
X1:3	DI2	Configurable	DI2	Configurable
X1:4	DI3	Configurable	DI3	Configurable
X1:5	DI4	Configurable	DI4	Configurable
X1:6	DI5	Configurable	DI5	Configurable
X1:7	DI6	Configurable	DI6	Configurable
X1:8	DI7	Configurable	DI7	Configurable
X1:9	DI8	Configurable	DI8	Configurable
X1:10	DI9	Configurable	DI_COM	Digital input common terminal
X1:11	DI10	Configurable		
X1:12	DI11	Configurable		
X1:13	DI12	Configurable		
X1:14	DI_COM	Digital input common terminal		



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05 An example of using two sets of power supply

Terminal block X1 PTC input (M102 only)
PTC function is available in M102 only. To ensure the proper reading, type A temperature sensor with a characteristic curve according to IEC 60947-8 shall be used along with the device.

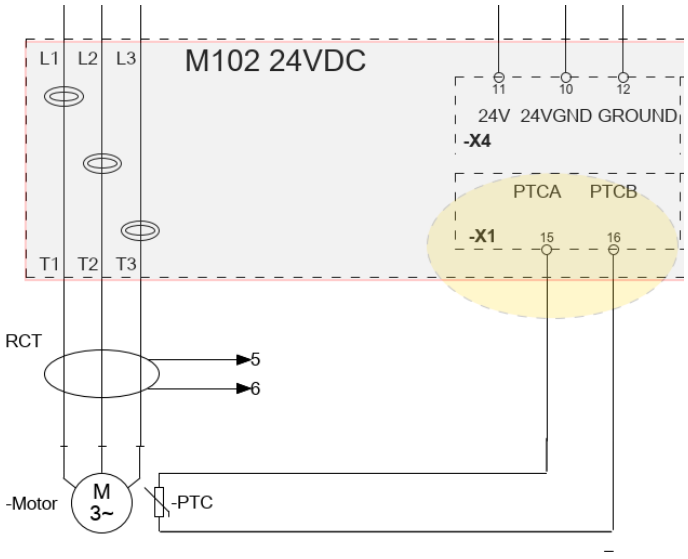
Wiring Tip:
Standard twisted pair should be used for PTC circuit wiring. When PTC function is not in use, X1:15 and X1:16 should be shorted.

Table 3 PTC input terminals (24VDC type)

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

Table 4 PTC input terminals (110/240AC type)

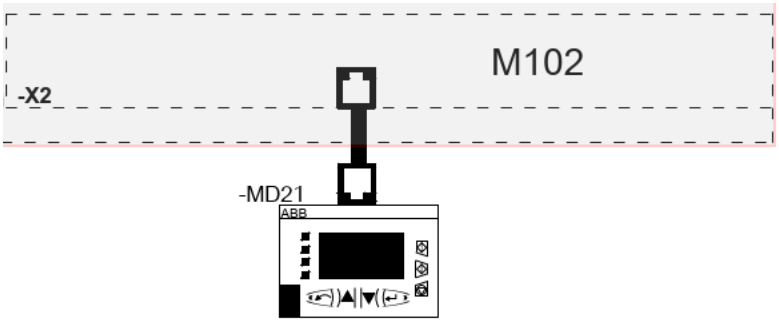
Terminal no.	Name	Description
X1:11	PTCA	PTC measurement input A
X1:12	PTCB	PTC measurement input B



06 PTC wiring for M102 24VDC type

Terminal block X2 Interface for MDx
M10x is connected with operator panel MD21/MD31 using RJ11 interface.

Wiring Tip:
A dedicated cable is used to connect from X2 to MD panel. (Fig 07)



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07 X2 connection with MD21 panel

Terminal block X3 Communication interface
Depending on device type, Modbus RTU interface, Profibus DP interface are available through X3. Modbus TCP interface is available in a seperate EM01 module which connects to X3.

M10x Modbus type has dual RS485 interfaces supporting a complete redundant network setup.

Wiring Tip:
Modbus redundancy feature needs to be enabled if both interfaces are wired to be used. (Fig8)

Profibus network requires dedicated Profibus cable type. 5VDC (X3:1) is reserved to supply for network terminator. (Fig9)

Details of M10x-TCP wiring is in ' M10x-TCP user guide'. When connecting to EM01, either of the RS485 interface may be wired.

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Table 5 MODBUS dual RS485 interfaces

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

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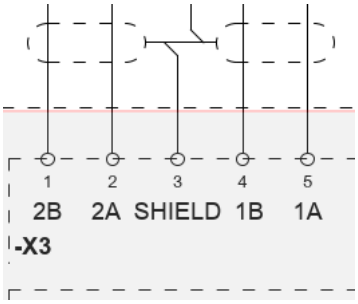
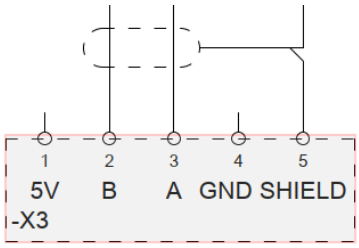
Table 6 PROFIBUS RS485 interface

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



08 M10x-M X3 Modbus Dual ports wiring



09 M10x-P X3 Profibus wiring

Terminal block X3 Residual current input
M10x supports earth fault protection by wiring external residual current transformer(RCT) to X3 :6 & 7. M10x dedicated RCT type is ABB LNG CT. (Fig 10)

Wiring Tip:
Standard twisted pair cable should be used to wire RCT inputs. When earth fault protection function is not required, X3: 6 &7 should be shorted.

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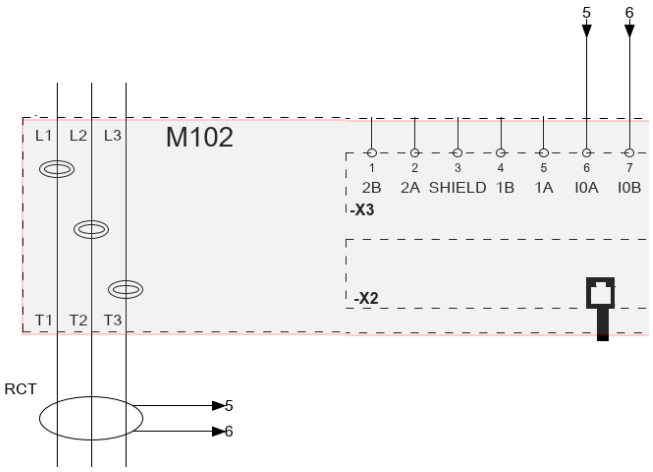
Table 7 Residual current transformer terminals

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



10 RCT circuit wirng

Terminal block X3 Voltage measurement (M102 only)
M102 provide three voltage inputs supporting up to 690V ac direct connection. It can be used for three phases and single phase application.

Voltage phase connection shall follow the terminal definition listed in table 8 to ensure correct power factor and phase sequence reading.

In case of single phase, the voltage connections are X3:9 & 13 as listed in table 9.

Voltage measurement circuit is included in typical wiring diagram Fig 13.

Wiring Tip:
In case external voltage transformer (VT) is used,take care of the connections from VT secondary which should be wired according to table 8. (Fig 11)

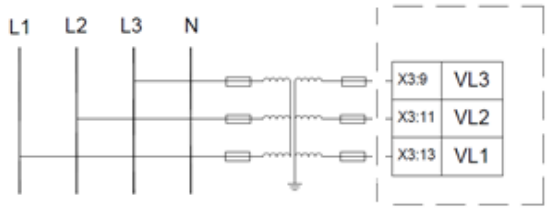
VT type may be a single-phase type or a three-phase transformer with Yy0 connection.

Table 8 Voltage input terminals (3 phases)

Terminal no.	Name	Description
X3:9	VL3	Phase L3 voltage input
X3:11	VL2	Phase L2 voltage input
X3:13	VL1	Phase L1 voltage input

Table 9 Voltage input terminals (single phase)

Terminal no.	Name	Description
X3:9	N	Neutral input
X3:13	VL	Phase voltage input



11 Voltage inputs via 3 phase VT

Terminal block X4 Digital output relays
Two sets of output relays are available from X4:1~5 in M102. Relay 1 (GR1) provides one pair of NC and NO outputs which is configurable as different functions, e.g. trip, alarm indication. Relay 2 (GR2)provides one set of NC output which is also configurable.

Only relay 1 is available in M101 version.

Digital output relays are indicated in typical wiring diagram Fig (13).

Wiring Tip:
Take note of the rating operational current and load type of digital outputs which are listed in technical data section in case a external load is connected.

Spark suppression is necessary for connecting contactor (except AF type) to ensure a reasonable service life of output relays.

GR1 & GR2 contact status may change according to the assigned function. For example, if GR1 is assigned as "trip", NO contact close under healthy condition and open under trip. contact status resets during power loss.

Table 10 Digital output terminals

Terminal no.	Name	Description	M101	M102
X4:1	GR1_A	Programmable relay output 1 (NO+NC)	√	√
X4:2	GR1_B			
X4:3	GR1_C			
X4:4	GR2_A	Programmable relay output 2 (NO)		√
X4:5	GR2_B			

Terminal block X4 Contactor control relays
Three sets of contactor control relays are available in M102, i.e. Relay A (CCA), relay B (CCB) and relay C (CCC). Three relays are pre-configured to respond to different motor starter control logic. For example, in a direct on line (DOL) starter control, CCA is dedicated to be used as open and close the contactor.

CCA and CCB are internally interlocked through hard-wired.

Only relay CCA and CCB are available in M101.

Wiring Tip:
Take note of the rating operational current and load type of digital outputs which are listed in technical data section in case a external load is connected.

Spark suppression is necessary for connecting contactor (except AF type) to ensure a reasonable service life of output relays. (Fig 13)

Table 11 Contactor control terminals

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		√

Terminal block X4 -Power Supply
Depending on the selected product type, the power supply may be 24Vdc, 110Vac or 240Vac . Regardless of the voltage type, the power supply should always be supplied from an uninterrupted and reliable supply source to ensure the operation reliability of the device.

Power supply inputs are not phase restricted which means in a 3 phase AC power supply, any phase may be wired to the inputs in any phase sequence.

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Table 12-1 Power supply input terminals

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

Terminal block X4 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.

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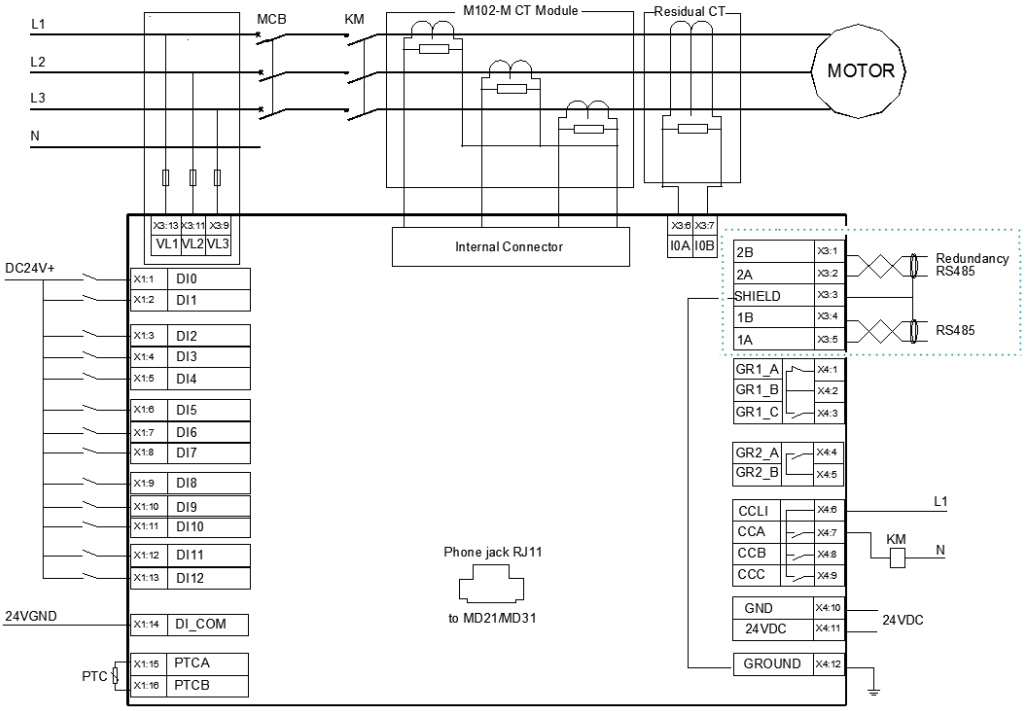
Table 12-2 Ground terminal

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

Terminal layout example

The terminal layout of M102-M 24VDC product type is shown as an example in Fig 12. The terminal blocks may have different definitions and available terminals depending on the selected product type. The details are explained in terminal designations above.

Shield and Ground (X4:12) are connected internally in all M10x types.



12 Typical wiring diagram for M102-M (24VDC type)

M10x device is certified to work under EMC environment according to relevant IEC standards. However a network exposed to high electromagnetic disturbance may still cause an unstable system and malfunction devices.

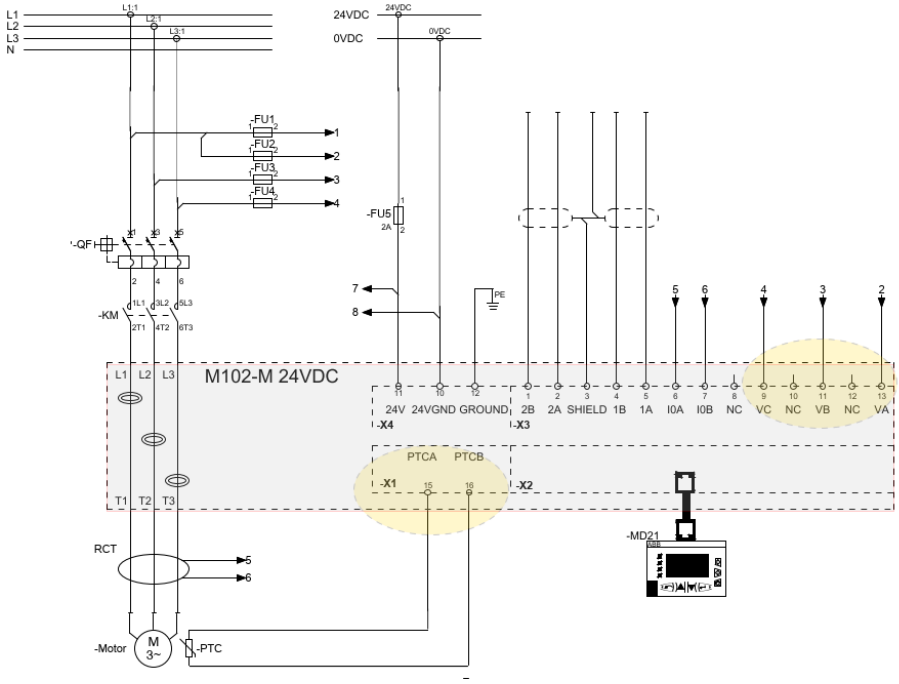
In applications that variable speed drives are used in a large scale, harmonic filter devices shall be required in system design to reduce impact to the network.

Typical Wiring Diagram M102-M 24VDC

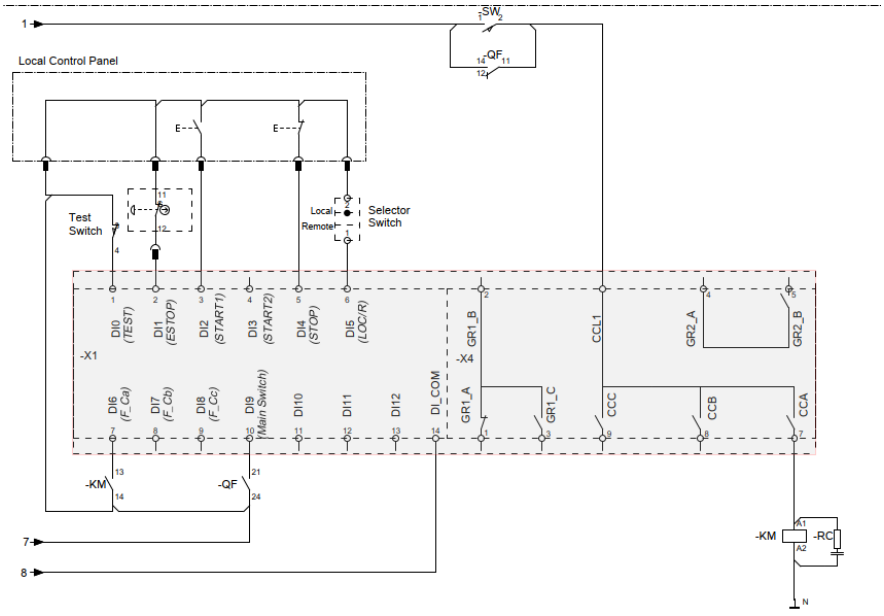
The terminal layout of M102-M 24VDC product type is shown as an example in Fig 12. The terminal blocks may have different definitions and available terminals depending on the selected product type. The details are explained in terminal designations above.

Wiring Tip:

Using an interface relay between contactor control output relay and contactor coil will improve the performance and service life of M10x relay. For a contactor load A75 and above, it is recommended to use an interposing relay.



13-1 Typical wiring diagram for M102-M 24VDC DOL PART 1/2



13-1 Typical wiring diagram for M102-M 24VDC DOL PART 2/2

04. Motor starters control

M10x offers a wide range of pre-configured motor starter control logic to support various control applications.

Table 13 Starter types supported by M10x

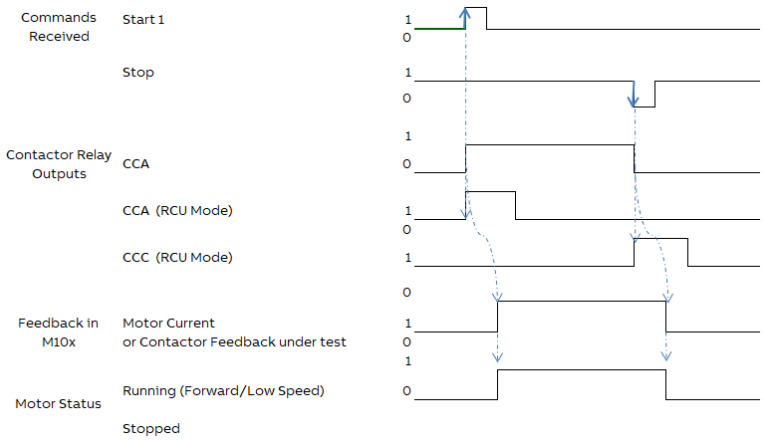
Starter type	M101	M102
NR_DOL: non reversing direct online	√	√
REV_DOL: reversing direct online	√	√
NR_DOL/RCU: non reversing direct online with remote control unit	√	√
REV_DOL/RCU: reversing direct online with remote control unit	√	√
Actuator: actuator with limit switch input		√
NR_S/D: non reversing star-delta		√
NR_2N: two-speed driver for non reversing starter with separate winding		√
NR_2N Dahlander: two-speed driver with Dahlander connection		√
Autotransformer: starter with autotransformer starting method		√
NR_softstarter: non reversing starter using softstarter		√
REV_softstarter: reversing starter using softstarter		√
Contactor feeder: a general load controlled by a contactor	√	√
Contactor feeder/RCU: a general load controlled by a contactor with remote control unit	√	√
Feeder: a customized logic for loads controlled by circuit breaker directly	√	√

The pre-configured starter control follows the same control sequence, i.e. from receiving the command, executing control via output relays CCA, CCB and CCC, monitoring motor status through current feedback or contactor status feedback and confirm the completion or issue the alarm in case of in-completion of the control sequence.

The following Fig 14 explains the difference between NR_DOL and NR_DOL/RCU concerning the operation of CCA and CCC relays after receiving the commands. The relation between feedback and motor status is also explained.

Contactor feedback and current feedback

Contactor feedback and current feedback are both used for verification of the motor status. Any unexpected feedback results in alarm or fault.
Contactor feedback may be disabled in NR_DOL and contactor feeder starter control.
Current feedback is a built in feature except for contactor feeder and contactor feeder_RCU starters. Current feedback function can not be disabled in other starters.
Feedback time is adjustable.



—
14 Timing diagram of control sequence NR-DOL

NR-DOL STARTER

NR_DOL starter is a basic starter type for driving motor in one direction. When start command has been received from fieldbus 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.

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

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

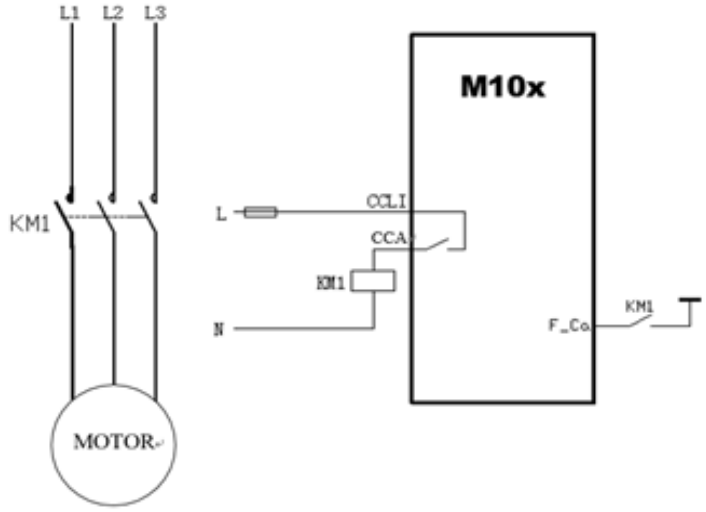
*** The assigned DI and PIN code may change in actual design**

Operating sequence

- Starting Sequence: Motor is stopped and ready to start → START command (Start 1) received → Internal CCA contact closed and remain closed → Feedback received
- Stopping Sequence: Motor is running → STOP command received → Internal CCA contact open → Feedback received

Contactor feedback and current feedback are both used for verification of the motor status. Any unexpected feedback results in alarm or fault.

Contactor feedback can be disabled through parameter. Current feedback r is always on the background to ensure the completion of an expected operation sequence. The feedback time is adjustable.



—
15 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.

—
Table 15 NR-DOL/RCU starter contactor control interface (for 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	

*** The assigned DI and PIN code may change in actual design**

Operating sequence

Control through M10x-

- Starting Sequence: Motor is stopped and ready to start → START command is received → Internal contact CCA closed and remain closed for 1s → Feedback is received
- Stopping Sequence: Motor is running → STOP command received → internal CCC (M102) or GR1_C(M101) contact closed and remain closed for 1s → Feedback received

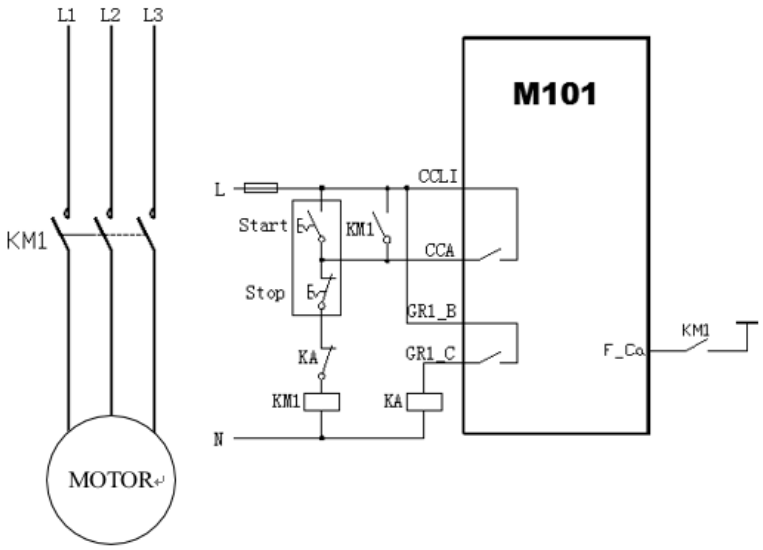
Control through RCU

When the motor is operated by RCU, M10x is by-passed still verify the motor state through feedbacks.

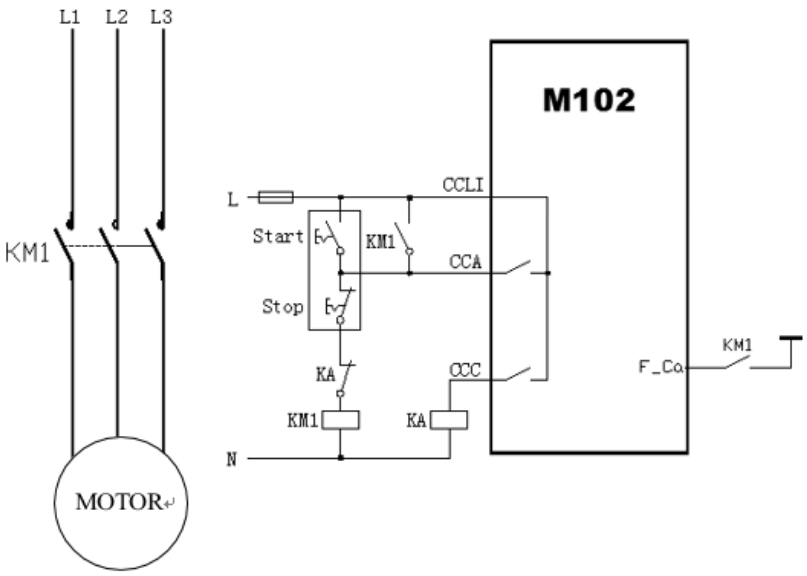
Contactor feedback and current feedback are both used for verification of the motor status. Any unexpected feedback results in alarm or fault.

Contactor feedback is a must parameter and can not be disabled as M10x also requires contactor feedback to sychronize with external RCU control.

Current feedback of a DOL-RCU starter is always on the background to ensure the completion of an expected operation sequence and the confirmation of the motor state during RCU control. The feedback time is adjustable.



16 Control circuit for NR-DOL/RCU starter (for M101)



17 Control circuit for NR-DOL/RCU starter (for M102)

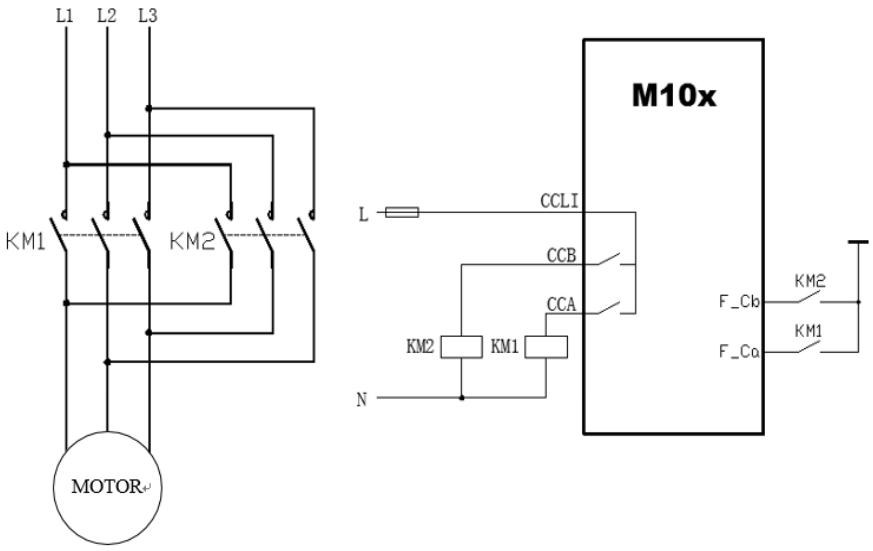
REV-DOL STARTER

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.

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

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

*** The assigned DI and PIN code may change in actual design**



18 Control circuit for REV-DOL starter (for M10x)

Operating sequence under REV-DOL

- Running forward Sequence: Motor is stopped and ready to run forward → Forward command (Start 1) received → Internal CCA contact closed and remain closed → Feedback received
- Reversing Sequence: Motor is stopped and ready to reverse → Reverse command (Start 2) received → Internal CCB contact close and remain closed → Feedback received
- Stopping Sequence: Motor is running → STOP command received → Internal CCA & CCB contact open → Feedback received

Contactor feedback is used for acknowledge the running direction hence can not be disabled through parameter in a REV-DOL starter. Current feedback is always on the background to ensure the completion of an expected operation sequence. The feedback time is adjustable.

Take note of the CT location for the application. CT location should be on the line side of both K1 and K2 to ensure correct current phase sequence reading.

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

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

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	

*** The assigned DI and PIN code may change in actual design**

Operating sequence under REV-DOL/RCU

Control through M10x-

- Running forward Sequence: Motor is stopped and ready to run forward → Forward command (Start 1) received → Internal CCA contact closed and remain closed for 1s → Feedback received
- Reversing Sequence: Motor is stopped and ready to reverse → Reverse command (Start 2) received → Internal CCB contact close and remain closed for 1s → Feedback received
- Stopping Sequence: Motor is running → STOP command received → internal CCC (M102) or GR1_C(M101) contact closed and remain closed for 1s → Feedback received

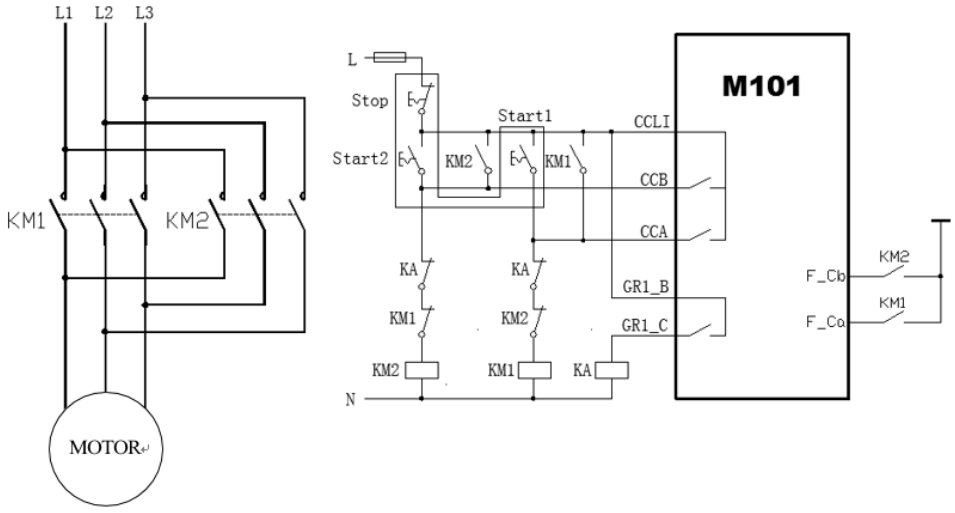
Control through RCU-

When the motor is operated by RCU, M10x is by-passed still verify the motor state through feedbacks.

Contactor feedback is a must parameter and can not be disabled as M10x also requires contactor feedback to sychronize with external RCU control.

Current feedback of a RCU starter is always on the background to ensure the completion of an expected operation sequence and the confirmation of the motor state during RCU control. The feedback time is adjustable.

Take note of the CT location for the application. CT location should be on the line side of both K1 and K2 to ensure correct current phase sequence reading.



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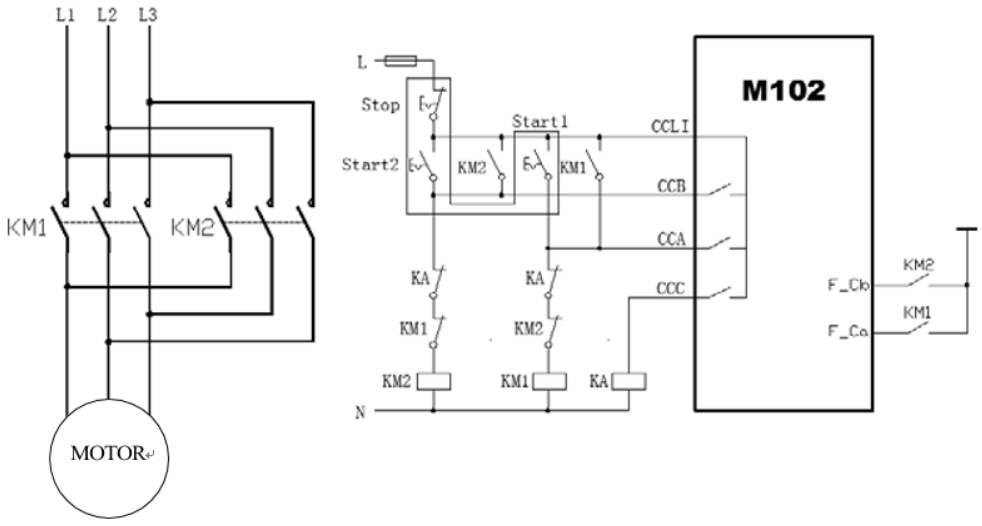
19 Control circuit for REV-DOL/RCU starter (for M101)



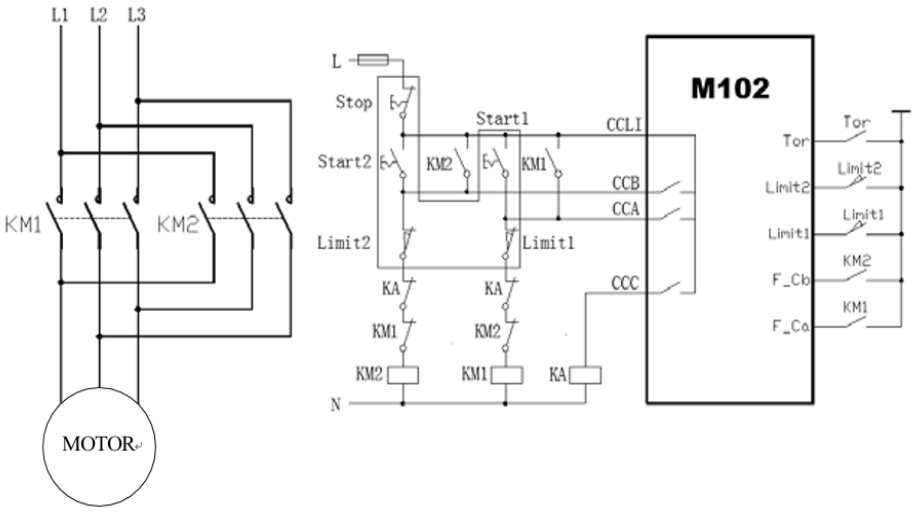
—
20 Control circuit for REV-DOL/RCU starter (for M102)

Actuator starter (M102 only)
This starter type is for controlling valves and actuators by using limit switches

—
Table 18 Actuator starter contactor control interface

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

*** The assigned DI and PIN code may change in actual design**



—
21 Control circuit for actuator starter

Operating sequence in Actuator

- Motor is stopped & Limit 1&Torque is not triggered → Start1 → CCA closes and remains for 1 second only
- Motor is stopped & Limit 2&Torque is not triggered → Start2 → CCB closes and remains for 1 second only
- Motor is running forward → Limit 1/Stop → CCC closes and remains for 1 second only
- Motor is running reversing → Limit 2/Stop → CCC closes and remains for 1 second only
- Motor is running → Torque → CCC closes

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

Take note of the CT location for the application. CT location should be on the line side of both K1 and K2 to ensure correct current phase sequence reading.

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.

—
Table 19 NR_S/D starter contactor control interface

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
DI7 (F_Cb)	X1:8	Contactor control B feedback
DI5 (Loc/R)	X1:6	Local/remote control switch input

*** The assigned DI and PIN code may change in actual design**

Star-to-delta starting sequence is based on the presented control logic (Fig22).The changeover condition is time.

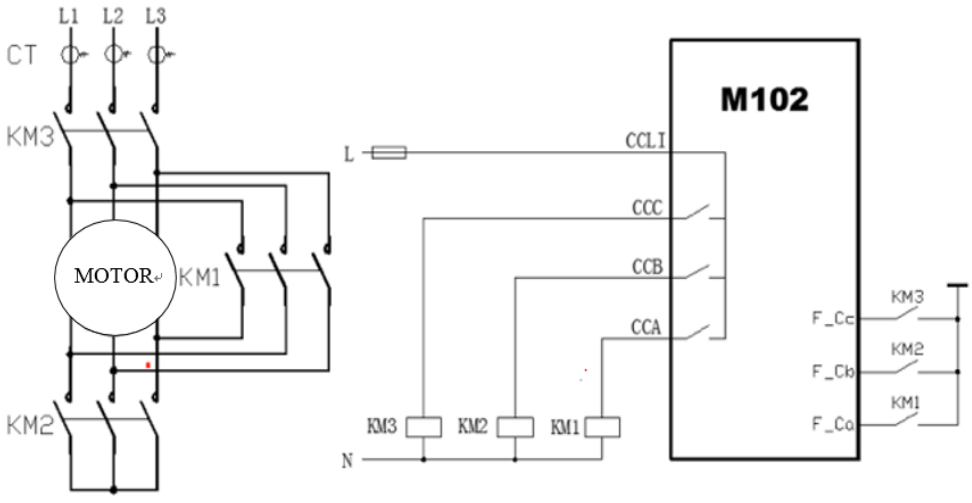
Operating sequence in NR-S/D

Motor is stopped → Start1 → CCB&CCC close → changeover time → CCB opens & CCA closes

Motor is running → Stop → CCA&CCB&CCC open

Take note of changeover time and motor startup time setting

Changeover time < Motor startup time



—
22 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.

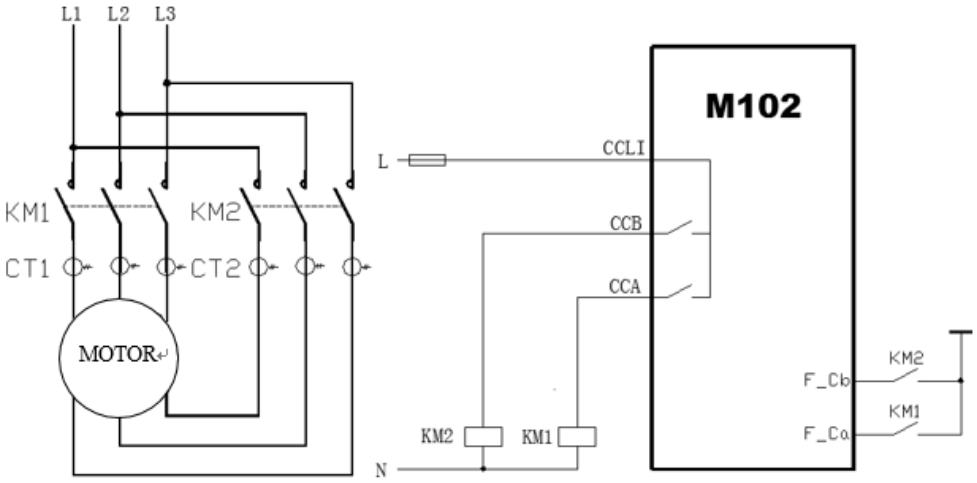
Table 20 NR-2N starter contactor control interface

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

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

The following control sequence are supported:
- Stop → Start1 → Stop
- Stop → Start2 → Stop
- Stop → Start1 → Start2 → Stop
- Stop → Start2 → Changeover delay → Start1 → Stop



23 Control circuit for NR_2N starter, separate windings

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.

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

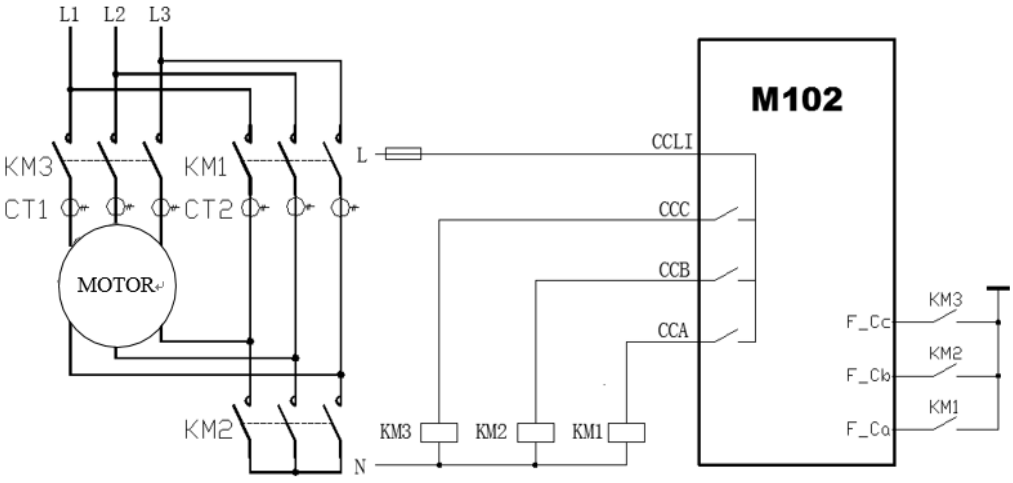
Name	Pin	Description
CCLI	X4:6	Contactor control voltage input
CCA	X4:7	Contactor control A
CCB	X4:8	Contactor control B
CCC	X4:9	Contactor control C
DI5 (Loc/R)	X1:6	Local/remote control switch input
DI6 (F_Ca)	X1:7	Contactor control A feedback
DI7 (F_Cb)	X1:8	Contactor control B feedback
DI8 (F_Cc)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

*** The assigned DI and PIN code may change in actual design**

Operating sequence in NR-2N Dahlander

- 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

The following control sequence are supported:
- Stop → Start1 → Stop
- Stop → Start2 → Stop
- Stop → Start1 → Start2 → Stop
- Stop → Start2 → Changeover delay → Start1 → Stop



—
24 Control circuit for NR_2N Dahlander starter

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,

Take note of changeover time and motor startup time setting

Changeover time < Motor startup time

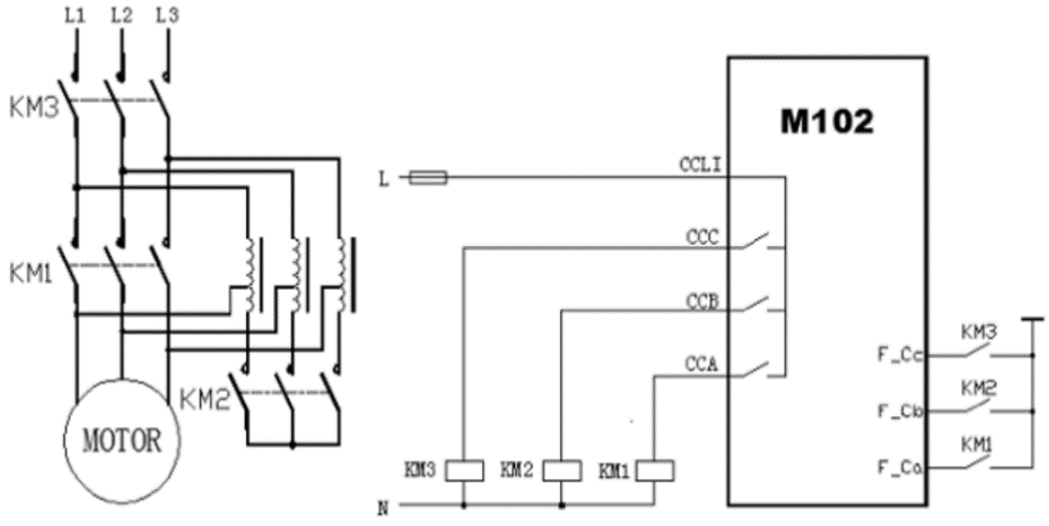
Table 22 Autotransformer starter contactor control interface

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

*** The assigned DI and PIN code may change in actual design**

Operating sequence in Autotransformer

- Motor is stopped → Start1 → CCB&CCC close → changeover time → CCB opens & CCA closes
- Motor is running → Stop → CCA&CCB & CCC open



25 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. Current feedback function is suppressed under soft-starter control.

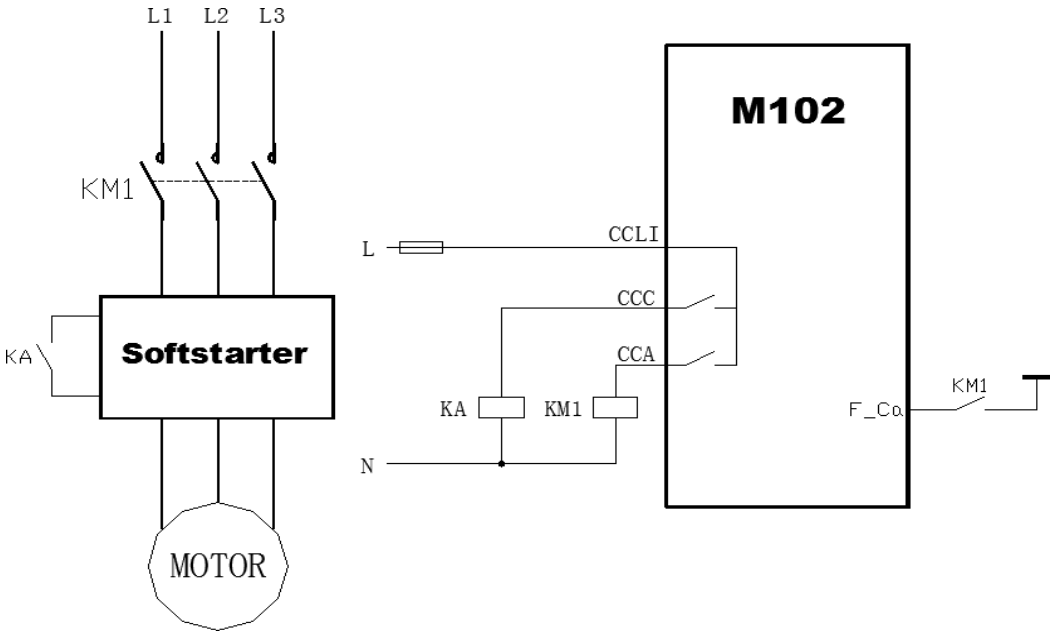
—
Table 23 NR_softstarter starter contactor control interface.

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

*** The assigned DI and PIN code may change in actual design**

Operating sequence in NR-softstarter

- Motor is stopped → Start1 → CCA closes → CCC closes
- Motor is running → Stop → CCC opens → ramp down time → CCA opens



—
26 Control circuit for NR-softstarter

REV-softstarter (M102 Only)
This starter is of similar functionality as the NR-softstarter starter, with additional function to support reversing the motor.

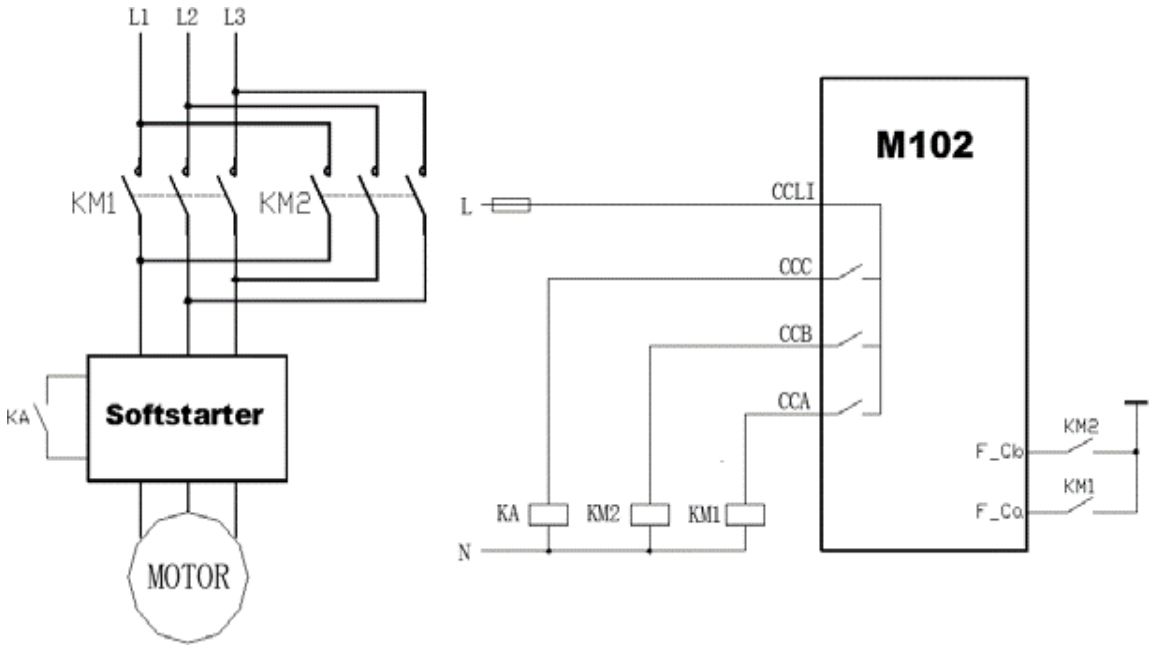
—
Table 24 REV-softstarter starter contactor control interface

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

*** The assigned DI and PIN code may change in actual design**

Operating sequence in REV-softstarter

- Motor is stopped → Start1 → CCA closes → CCC closes
- Motor is stopped → Start2 → CCB closes → CCC closes
- Motor is running → Stop → CCC opens → ramp down time → CCA & CCB opens



—
27 Control circuit for REV-softstarter

Contactor feeder
Contactor feeder in M10x is designed for symmetric 3 phase load or single phase load. All measurement, control and protection features which are available to NR-DOL are available to contactor feeder load.

Unlike the NR-DOL logic in which current feedback is a built in feature, current feedback is no longer required for motor status verification in contactor feeder control.

—
Table 25 Contactor feeder contactor control interface

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

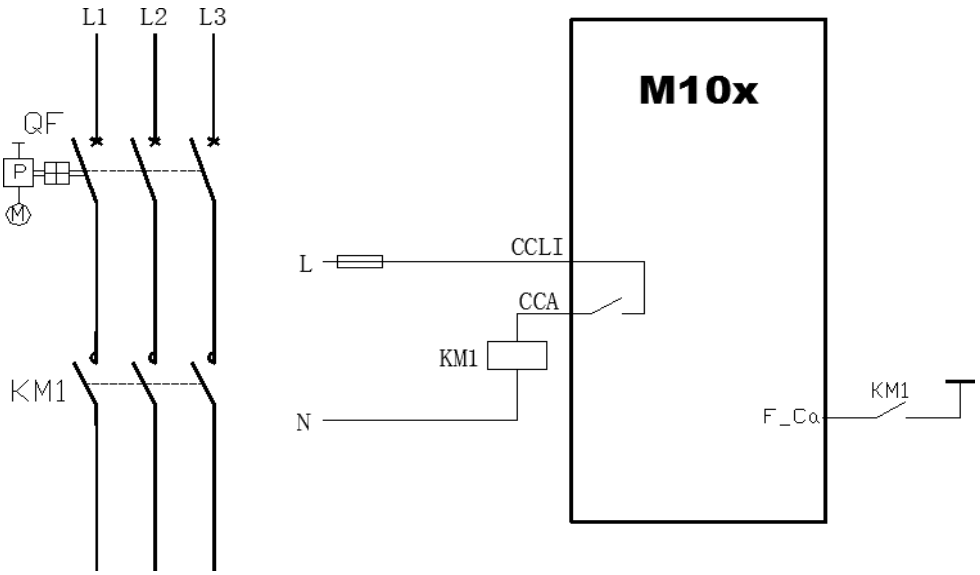
*** The assigned DI and PIN code may change in actual design**

Operating sequence

- Starting Sequence: Motor is stopped and ready to start → START command (Start 1) received → Internal CCA contact closed and remain closed → Feedback received
- Stopping Sequence: Motor is running → STOP command received → Internal CCA contact open → Feedback received

Contactor feedback is used for verification of the motor status. Any unexpected feedback results in alarm or fault.

Contactor feedback can be disabled through parameter. The feedback time is adjustable.



—
28 Control circuit for contactor feeder

Contactor feeder/RCU
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.

Contactor feeder in M10x is designed for symmetric 3 phase load or single phase load. All measurement, control and protection features which are available to NR-DOL/RCU are available to contactor feeder/RCU load.

Unlike in NR-DOL/RCU control, current feedback is no longer required in contactor feeder/RCU control. Contactor feedback is used for motor status verification and can not be switched off. Feedback time is adjustable.

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

Name	Pin	Description	Remarks
Contactor	feeder/RCU	contactor	control
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	
DI5(Loc/R)	X1:6	Local/remote control switch input	

*** The assigned DI and PIN code may change in actual design**

Operating sequence

Control through M10x-

- Starting Sequence: Motor is stopped and ready to start → START command is received → Internal contact CCA closed and remain closed for 1s → Feedback is received

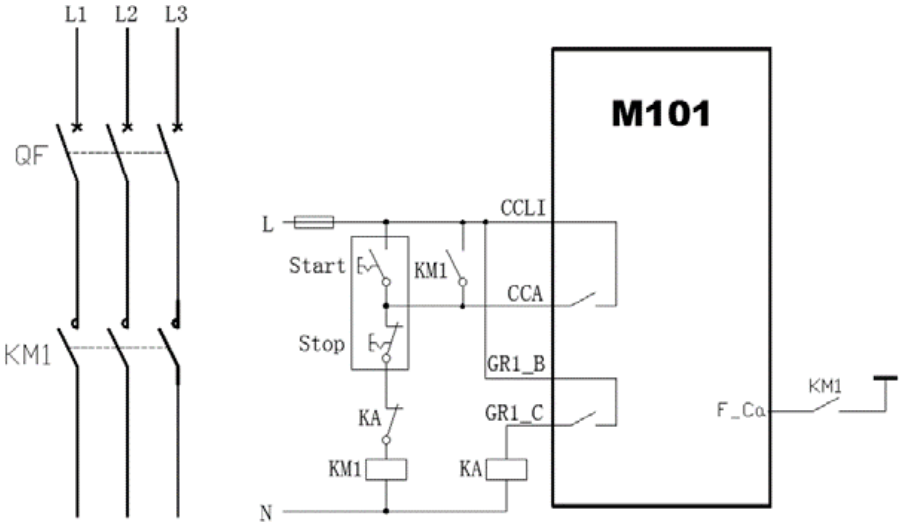
- Stopping Sequence: Motor is running → STOP command received → internal CCC (M102) or GR1_C(M101) contact closed and remain closed for 1s → Feedback received

Control through RCU

When the motor is operated by RCU, M10x is bypassed still verify the motor state through feedbacks.

Contactor feedback is used for verification of the motor status. Any unexpected feedback results in alarm or fault.

Contactor feedback is a must parameter and can not be disabled as M10x also requires contactor feedback to synchronize with external RCU control.



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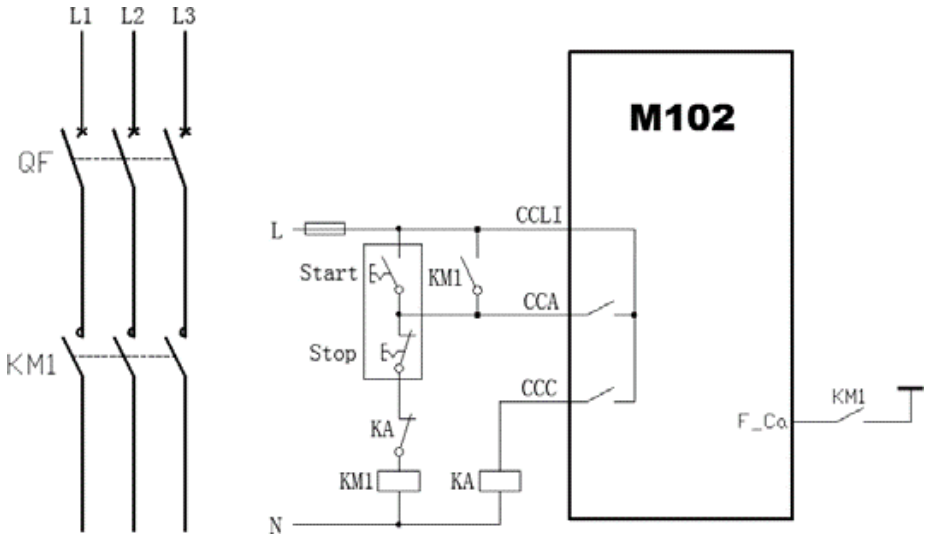
29 Control circuit for contactor feeder/RCU (for M101)



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30 Control circuit for contactor feeder/RCU (for M101)

Feeder
Feeder is the control logic customized for the load controlled by circuit breaker directly without using a contactor. The feeder application in M10x provide measurement and control functionality only.

Depending on the type of the load, protection functions which are designed for motors in M10x may not be suitable for feeder load and shall be carefully selected or switched off.

—
Table 27 Feeder control interface

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*

*** The assigned DI and PIN code may change in actual design**

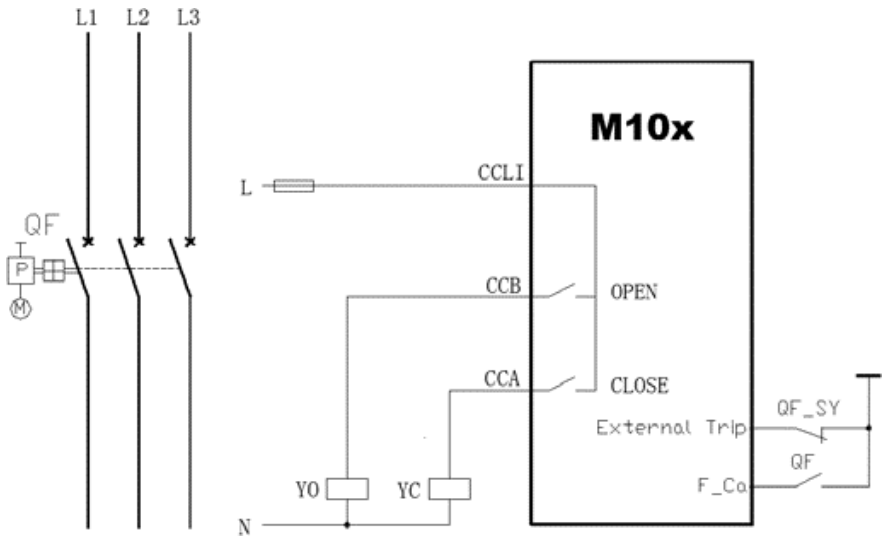
Feeder application is customized as following,

• **Operating:**
Start 1 command activates contactor output relay CCA for 2 seconds. Start 2 command activates contactor output relay CCB for 2 seconds.
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.



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31 Control circuit for feeder

05. 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.

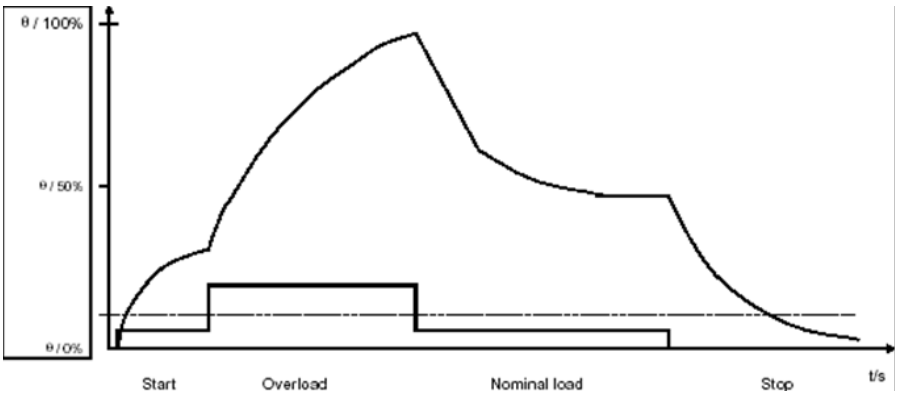
According to the application, all kinds of protection can be enabled, disabled by the upper level system or MCU setup tool, and the protection characteristics can be adjusted. Protection module offers the following protection and supervisory functions:

Table 28 Protection functions in M10x

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	√	√
Phase sequence Protection	√	√

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, principle presented below. Thermal increase and decrease are simulated by TOL protection function for running and stopped motor.



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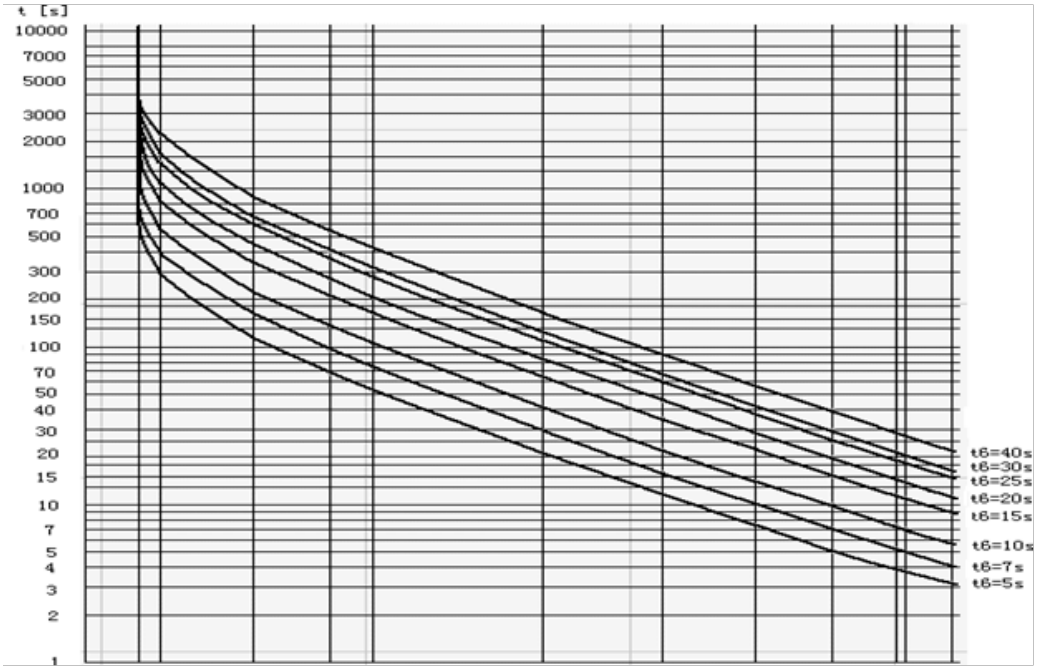
32 Principle picture of motor thermal simulation

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 and 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 IL max=6xIn from the cold state).



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33 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.

—

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

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

If motor is in overload condition, i.e. ILmax > 1.14 x TFLC (thermal full load current multiplier reduced by motor ambient temperature), the overload alarm is activated to indicate overload.

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 function is designed for this reason. If a TOL bypass is activated,

- when the motoring is running, the thermal capacity is allowed to rise to 200% before a trip occurs;
- when the motor is already taken off line due to TOL, the motor is ready for an emergency start as long as the thermal level is below 200%.

More details refer to 'TOL bypass' function under digital input functions section.

—

Table 30 TOL protection parameters

Function	
Setting range	0=Disabled 1=Enabled
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
T6 (standard mode)	
Setting range	3-40sec
Default value	6sec
Step value	1
Cool coefficient	
Setting range	1-10
Default value	4
Step value	1
Ia/In(Eexe mode)	
Setting range	1.2-8.0
Default value	5.0
Step value	0.1
Te(Eexe mode)	
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

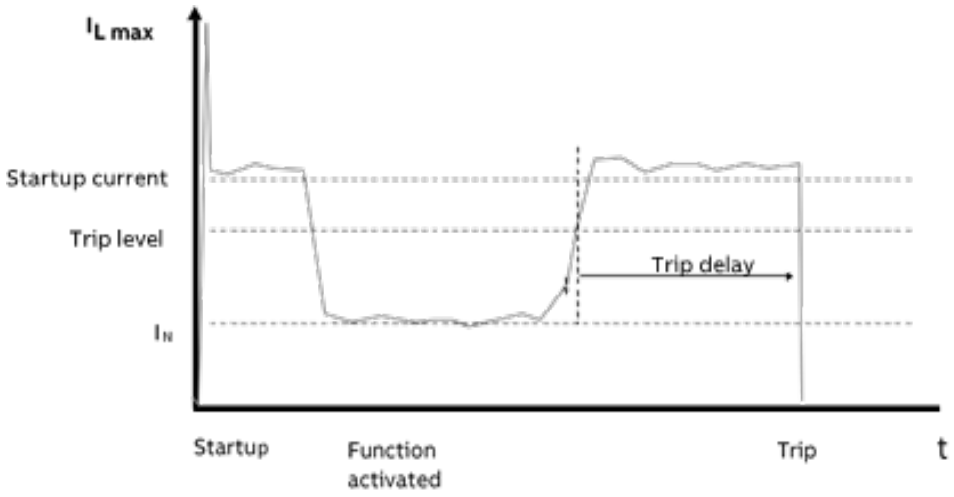
See ' M10x parameters description' manual for parameters explanation.

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 follows:

—
Table 31 Stall protection parameters

Function	
Setting range	0=Disabled 1=Enabled
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

See ' M10x parameters description' manual for parameters explanation.



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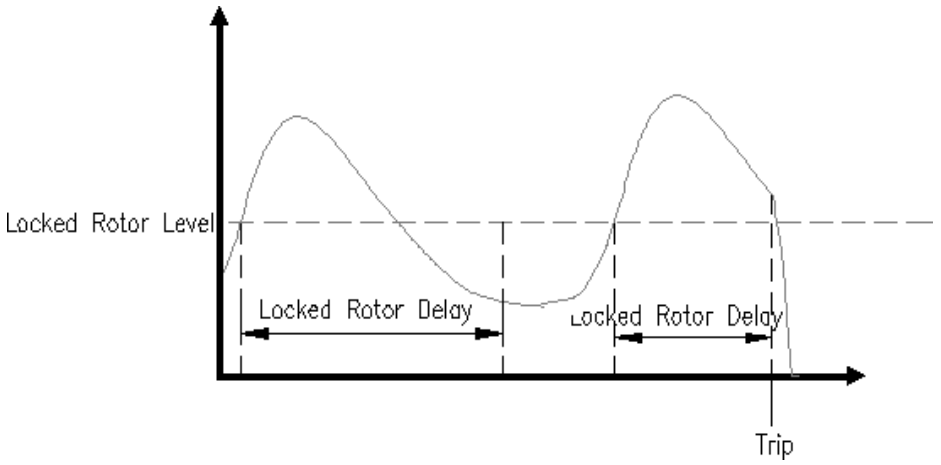
34 Stall protection

Stall function activates after motor nominal startup time has elapsed.

The highest measured phase current (ILmax) is compared against the trip level. When ILmax 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.



—
35 Long start protection

—
Table 32 Long start protection parameters

Function	
Setting range	0=Disabled 1=Enabled
Default value	Disabled
Step value	1
Long start trip level (Locked rotor level)	
Setting range	120-800%
Default value	120%
Step value	10%
Long start trip 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

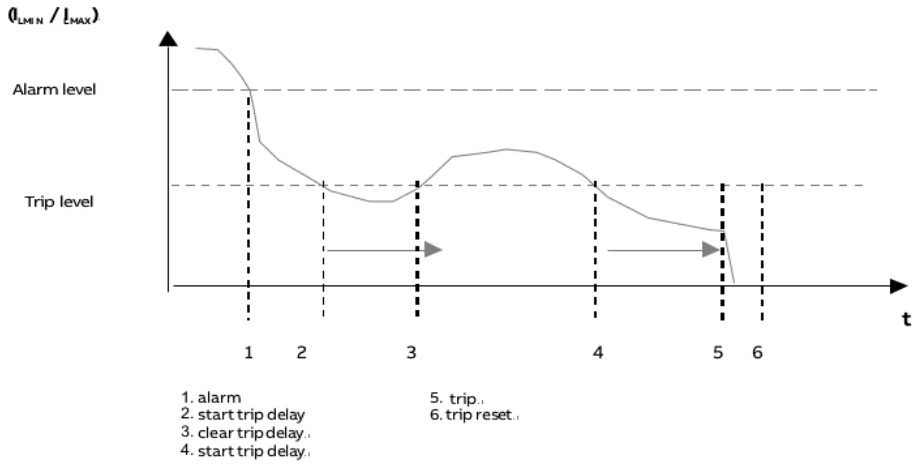
See ' M10x parameters description' manual for parameters explanation.

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.

—
Table 33 Phase failure parameters

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

See ' M10x parameters description' manual for parameters explanation.



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36 Phase failure protection

I_{Lmin}/I_{Lmax} is compared against the phase failure alarm level. When I_{Lmin}/I_{Lmax} decreases below the Alarm level, a “Phase failure alarm” alarm is issued.

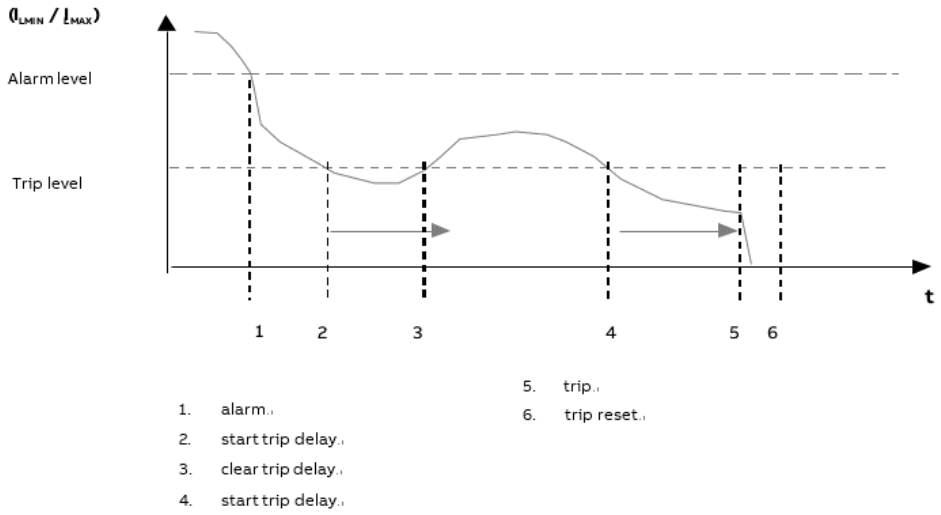
I_{Lmin}/I_{Lmax} is compared against the phase failure trip level. When I_{Lmin}/I_{Lmax} remains below the trip level at a time longer the trip delay, a “Phase failure trip” alarm is issued and the contactor tripped.

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.

—
Table 34 Unbalance protection parameters

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	5-90%
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

See ' M10x parameters description' manual for parameters explanation.



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37 Unbalance protection

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

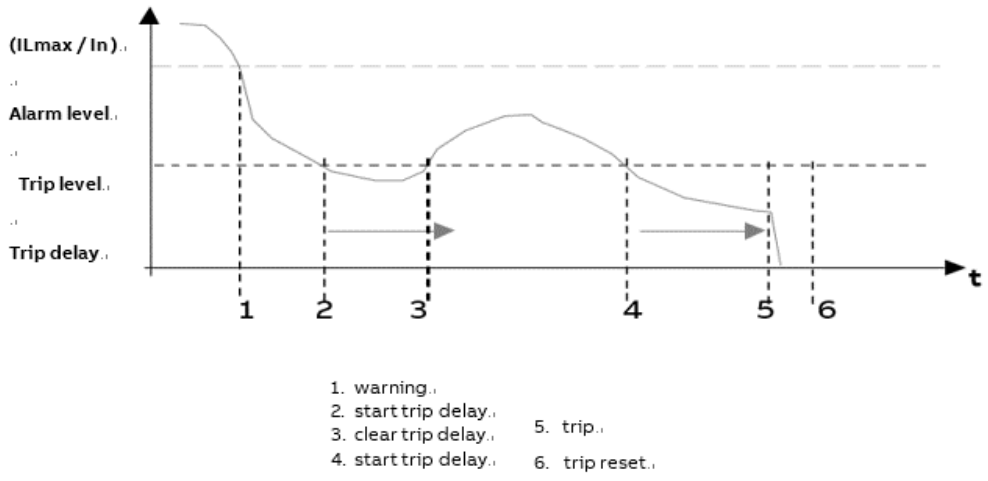
I_{Lmin}/I_{Lmax} is compared against the unbalance trip level. When I_{Lmin}/I_{Lmax} remain below the trip level at a time longer the trip delay, an unbalanced trip alarm is issued and the contactor tripped.

Underload protection
M10x protects the motor against underload conditions. Underload protection function uses I_{Lmax}/In (the ratio of highest measured phase value ILmax 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:

—
Table 35 Underload protection parameters

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%
Setting range	
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

See ' M10x parameters description' manual for parameters explanation.



—
38 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.

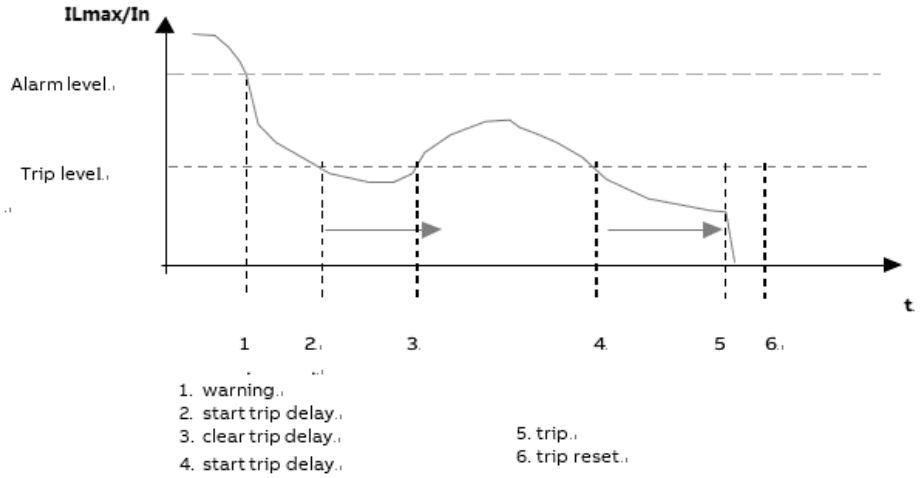
The I_{Lmax}/In is compared against the underload trip level. When I_{Lmax}/In remains below the trip level at a time longer than underload trip delay, an underload trip alarm is issued and the contactor tripped.

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.

—
Table 36 Noload protection parameters

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

See ' M10x parameters description' manual for parameters explanation.



—
39 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.

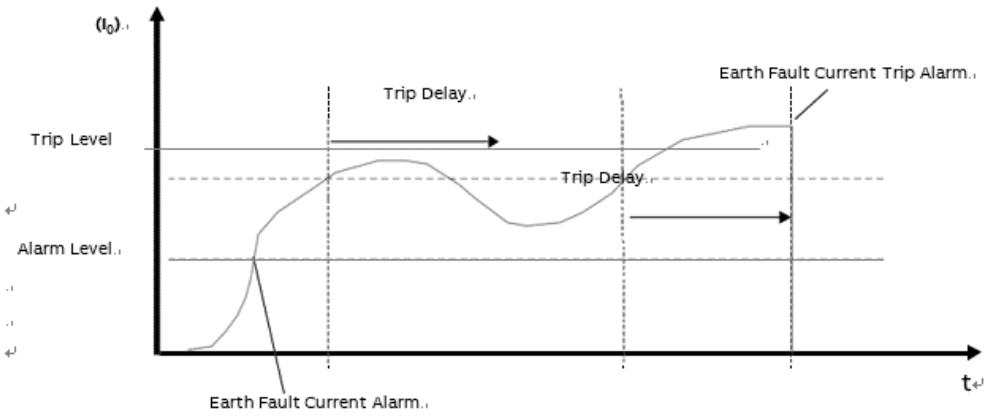
The function is by default suppressed by parameters motor startup time and softstarter ramp up time to avoid nuisance tripping due to harmonics caused by saturation of the current transformers. It can be manually switched on when it is required.

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).

—
Table 37 Earth fault protection 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	0.1-60.0sec
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

See ' M10x parameters description' manual for parameters explanation.



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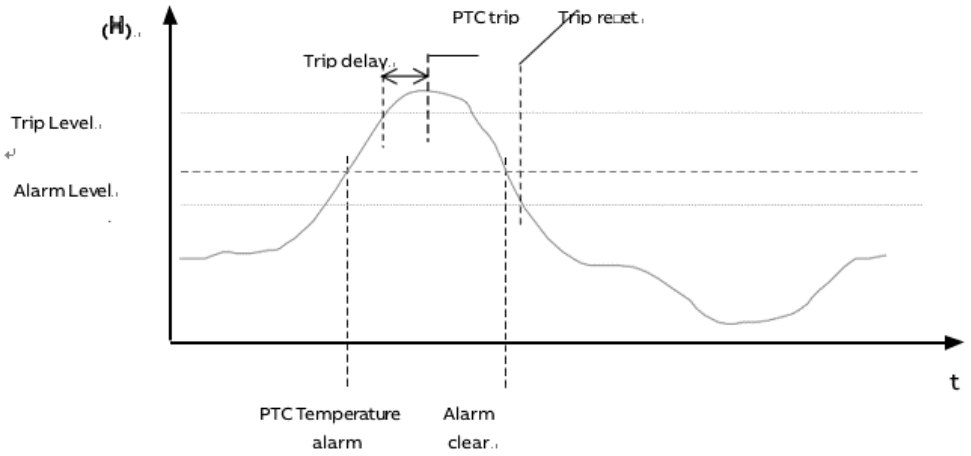
40 Earth fault protection (I0 = measured earth fault current)

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.

—
Table 38 PTC protection parameters

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
Function	
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

See ' M10x parameters description' manual for parameters explanation.



—
41 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.

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

—
Table 39 PTC Sensor distance vs cable size

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

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

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.

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.

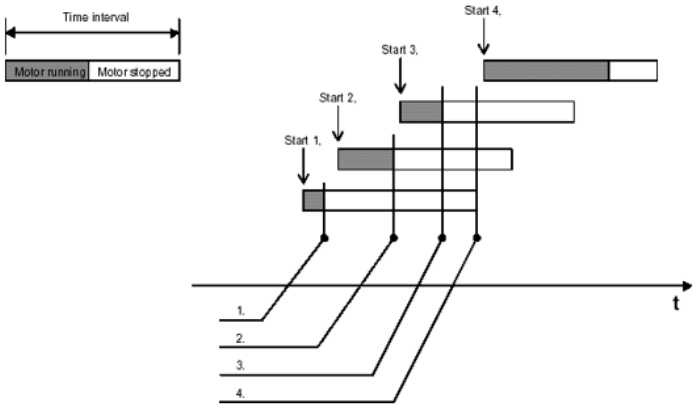
Functionality is presented in the following example. The next Figure 42 illustrates the start limitation protection with 3 starts allowed.

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.



42 Start limitation protection

Table 40 Start limitation parameters

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

Phase Sequence
M10x protects the motor against connection in wrong phase sequence. Before motor startup, M10x detects the phase sequence of voltage continuously and after startup M10x will detect the phase sequence of current. The definition of correct phase sequence:

- Voltage: L1, L2, L3
- Current: Ia, Ib, Ic

If enable phase sequence protection, when M10x detects the voltage or current is different from the definition M10x will release a phase sequence trip signal.

—
Table 41 Phase sequence protection parameters

Function Enable/Disable	
Setting range	0=Disable 1=Enable
Default value	Disabled
Step value	1
Trip Reset Mode	
Setting range	2=Local 3=Remote 4=Remote&Local
Default value	4
Step value	1

See ' M10x parameters description' manual for parameters explanation.

Undervoltage protection (M102 Only)
M102 protects the motor against undervoltage conditions such as voltage dip.

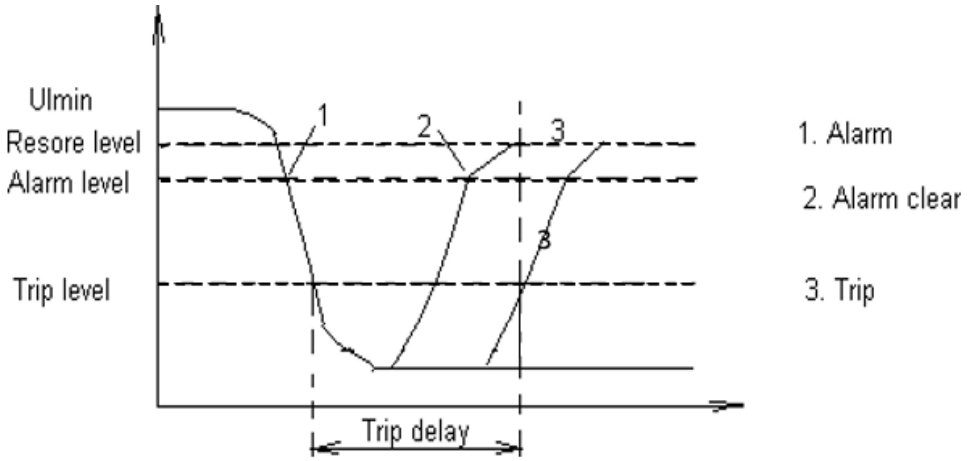
The undervoltage protection function uses ULmin as the criterion. There are other parameters to be determined, such as alarm level, trip level and trip delay, and reset voltage level. The protection characteristic is as follows:

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

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

If “main switch” is detected on ‘powered off’ position, undervoltage alarm/tip function is suppressed to avoid unnecessary annunciation while the voltage measurement is still active.

When autorestart function is active, undervoltage trip delay time is no longer required to be configured as it is the same as the setting value of maximum power down time.



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43 Undervoltage protection

—
Table 42a Undervoltage protection parameters

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

See ' M10x parameters description' manual for parameters explanation.

Autorestart

After a sudden voltage dip , M102 may restart the motor in 4 different ways depending on the type and duration of the dip(s) through two setting modes, i.e. standard mode and enhanced mode.

Voltage dip trigger level and reset level correspond to the settings of undervoltage trip level and reset level .

—

Table 42b Auto restart function parameters

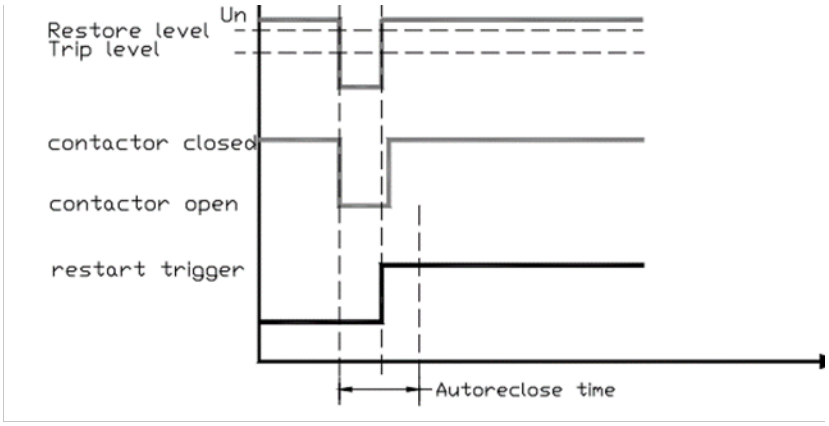
Function	
Setting range	0=Disabled 1=Enabled
Default value	Disabled
Step value	1
Function mode	
Setting range	0=standard 1=enhanced
Default value	0
Step value	1
Maximum autoreclose time	
Setting range	0-5000msec
Default value	200msec
Step value	100msec
Maximum powerdown time	
Setting range	0-1200sec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

See ' M10x parameters description' manual for parameters explanation.

Standard mode

Under standard mode, the reaction of the auto restart function depends on the length of the voltage dip. Three scenarios (cases) are considered,

Case 1: Voltage dip< autoreclose time.



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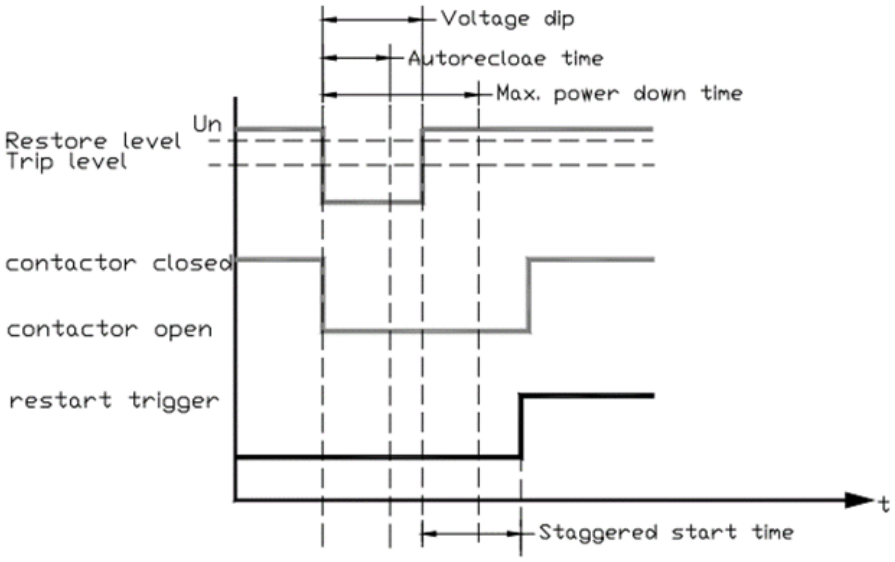
44 Autorestart (Voltage dip< autoreclose time)

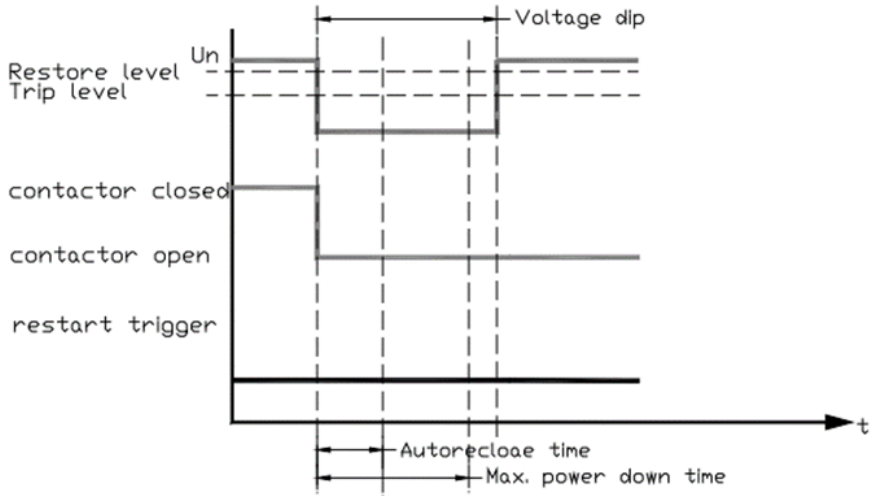
Case 2: Autoreclose time<voltage dip< Maximum powerdown time.



—
45 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.



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46 Restart (Voltage dip> Maximum powerdown time)

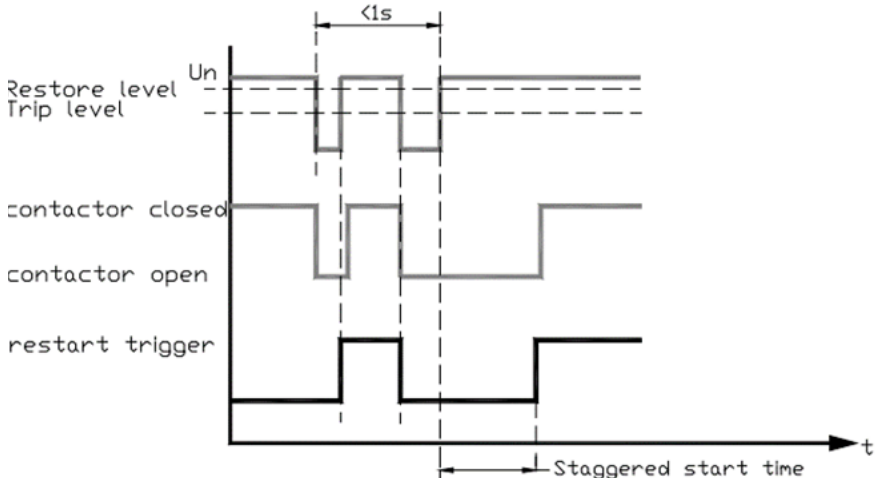
If supply voltage remains below restore level long enough and exceeds maximum powerdown time, no automatic restart will be initiated.

Enhanced Mode

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.

Enhanced mode includes all 3 cases listed in standard mode. In addition, case 4 is supported.

Case 4: 2xdip<200ms within 1sec



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47 Restart (2xdip<200ms within 1sec)

Under case 4 scenario, two voltages dips may occur within 1 seconds. Each dip is shorter than 200ms. The device shall be able to react and trigger a delay restart after the second voltage dip recovers.

Failsafe functionality

M10x failsafe function supervises the communication network interface and connection to the remote devices controlling the motor/starter equipment. The network supervision on M10x is based on no data exchange detected within the pre-configured delay time (1~25s) which may be different from the network supervision on control system level.

If the device falls into failsafe mode, the pre-configured failsafe action will be followed. The options of the failsafe action are,

- Motor stay as it is (No operation);
- Start the motor (Start 1);
- Start the motor in reverse direction (Start2);
- Trip the motor (Trip).

Under failsafe mode, the motor control access falls to local control regardless of previous settings. Both control from hardwiring (to local control panel or on starter) and MDx panel are active under failsafe mode. Once the network is restored, the control access recovers to the previous setting, the tripping message 'communication failure' is automatically reset.

To disable the network supervision function from M10x, set the communication failure delay time as '255"

Main switch status protection functionality

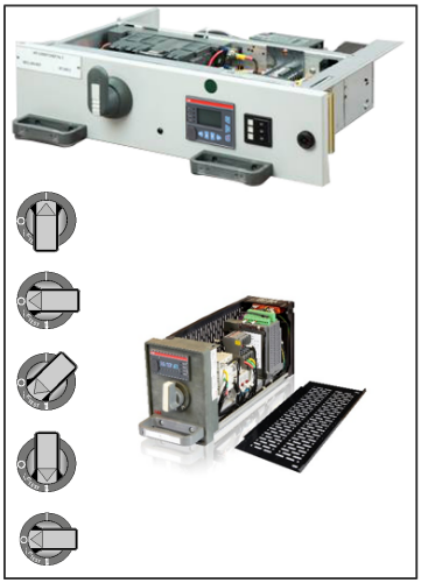
Main Switch Supervision function is the customized control feature to respond to different operation position of a MNS withdrawable module and ensure a safe operation with MNS switchboard.

The rotary handle of a MNS module has built in position indications which include main switch ON/ OFF and test position ON. The positions are one or another and not impossible to overlapped. (FIG 48)

Main switch status function in M10x provides interacting protection features during module operation, e.g. turning from ON to OFF or turning from OFF to test position.

To have a complete main switch protection function, the main switch status indication and test switch position status are expected to be hardwired through digital inputs of the device.

There may be scenarios that only one indication is available, either main switch status or test switch status, M10x responds in different ways under such conditions.



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48 Operation position of a MNS module

Scenario 1 Main switch status and test switch position are both monitored by M10x

When motor is under running state (current detected), if the main switch status is observed changing from ON to OFF before a stop command is received, M10x trips the motor with ' Main switch status message. If test switch position ON is observed, M10x also trips the motor with ' current feedback trip' message.

When motor is under test running state (under test with no current detected), if main switch status is observed changing from OFF to ON, M10x trips the motor with ' main switch status' message. If test switch position changes to 'OFF', M10x stops the motor.

When motor is under stopped state, if both main switch status ON and test switch ON are observed, a trip message 'main switch status' is issued.

Scenario 2 Only main switch status is monitored with no test switch hardwired

When motor is under running state (current detected), if the main switch status is observed changing from ON to OFF before a stop command is received, M10x trips the motor with ' Main switch status message. If the soft test switch function is enabled during motor running, M10x also trips the motor with ' current feedback trip' message.

When motor is under test running state through soft test switch function, , if main switch status is observed changing from OFF to ON, M10x trips the motor with ' main switch status' message. If test switch position changes to 'OFF', M10x stops the motor.

When motor is under stopped state, if both main switch status ON and test switch ON are observed, a trip message 'main switch status' is issued.

Scenario 3 Main switch status is not monitored, test switch is monitored

This becomes a test position feature only.

Aligned with MNS module handle design, under test position means that the control circuit is powered up while the power circuit being disconnected so that the control functions testing can be conducted. Once ‘test’ position is detected through the DI, M10x switches off current and voltage based protection functions regardless the protection settings. A ‘T’ symbol is displayed on MD panel when ‘test’ position is detected. Once ‘test’ position is off, all protections restore automatically.

Soft test switch is the function available through parameter configuration. It is used to simulate module in test position. Similar as ‘Test Switch’ function, when ‘Soft test switch’ parameter is selected, M10x switches off current and voltage based protection functions regardless the protection settings. A ‘T’ symbol is displayed on MD panel when soft test switch is selected.

Under main switch OFF position, undervoltage alarm/tip function is suppressed to avoid unnecessary annunciation

06. Control Access

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 groups
There are three control access groups defined in M10x:

- Local hardwiring: M10x accepts its start1/ start2/stop commands from the hardwired inputs
- Remote fieldbus: M10x accepts its start1/ start2/stop commands from a PLC or higher control system via fieldbus, ie, MODBUS or PROFIBUS.
- MDx control: M10x accepts its start1/start2/ stop commands from operator panel MDx located on the front panel of each starter unit on switchgear.

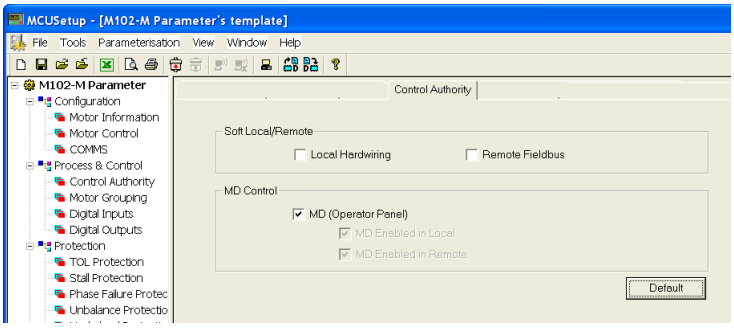
Assign control access
To decide which of above 3 control groups may have the control access , the selector switch function will have to be used. There are two type of selector switch functions in M10x, the local selector switch and the soft selector switch function.

When soft selector switch is used, the control access is assigned to the control groups through configuration. Which means the control access have to be pre-configured and can only be changed via parameters.. (Fig 49).

In Profibus version, i.e. M10x-P, M10x also supports the soft selector switch from Profibus. (Fig 50).

In most applications, a physical local selector switch is installed beside motor or on the starter to select the control access. In M10x, the local selector switch is supported via hardwiring into DIs. (Fig 51). Local selector switch always has the highest control privilege out of all.

Soft selector switch via parameter setting
When using soft selector switch, users define the control access directly through configuration. No actual switch is used.



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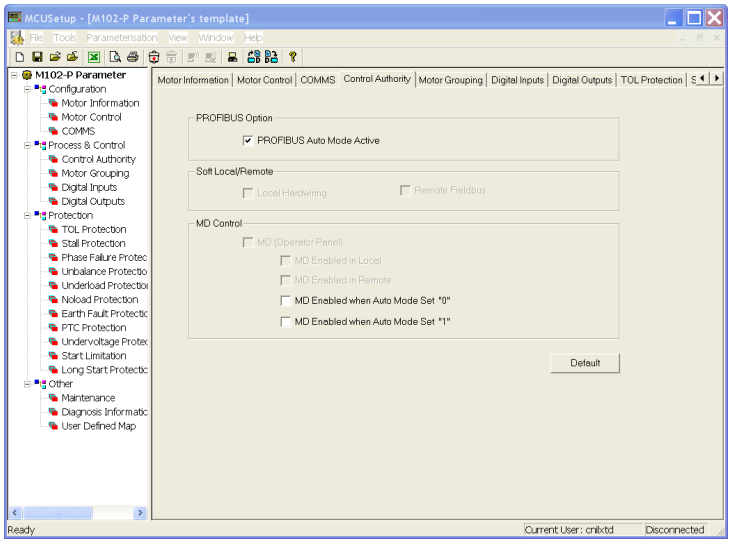
49 Parameter setting of local/remote of control authority

Soft selector switch via Profibus DP

Once the 'Profibus Auto Mode Active' option is selected through parameter configuration, the control access is decided by the auto bit through Profibus cyclical data exchange.

MDx control can be pre-assigned to either local control or remote control. (Fig 50)



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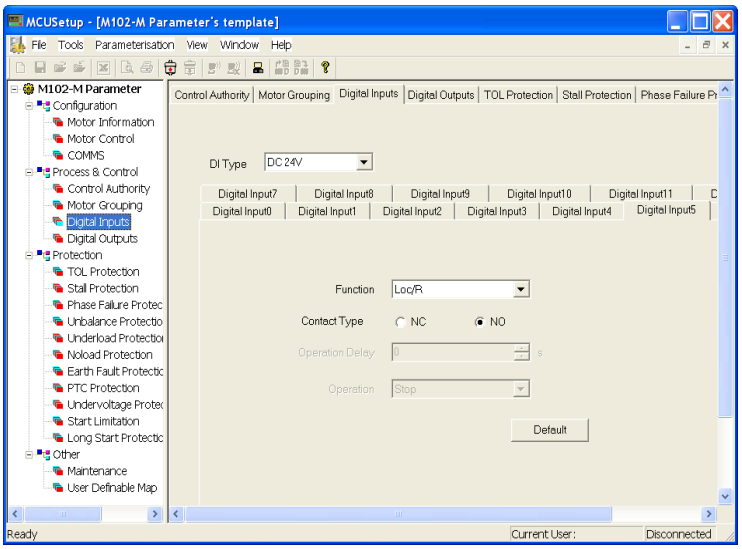
50 Enable PROFIBUS option

Local selector switch
M10x supports hardwired local 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. 51).



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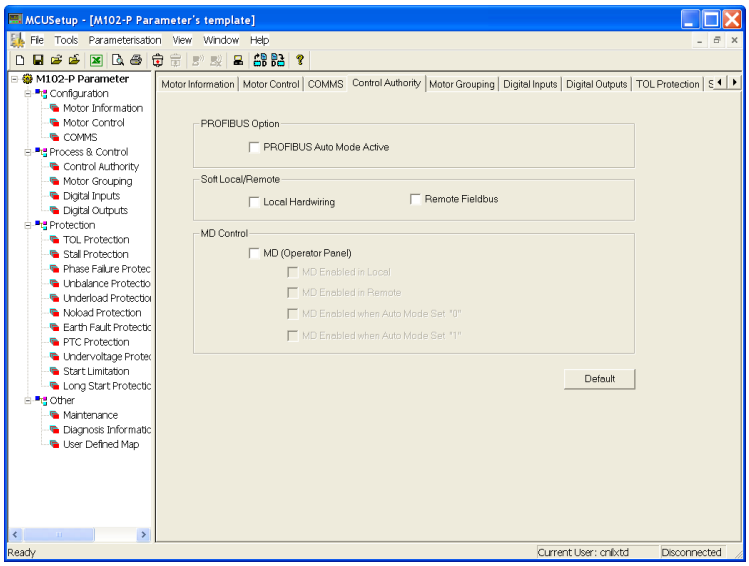
51 Enable local selector switch

When "Loc/R" selector switch function is assigned to the DI, soft selector option is no longer available.

MD control access

MD control is independent of either local or remote control mode in M10x. However MD control can be further assigned under local group or remote group or even to both.

Assigning MD control can be through parameter configuration (Fig 52) or through a hardwiring switch connected to the DI. (Fig 53)



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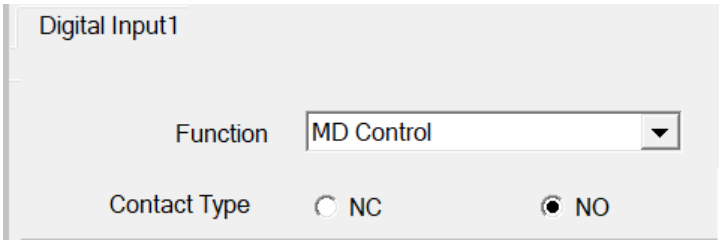
52 MD control access assigned via configuration



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53 MD control access assigned via hardwiring switch to DI1

07. Configurable inputs and outputs

Configurable inputs
There are 13 separate 24VDC configurable digital inputs (DIs) or 9 separate 110VAC or 230VAC DIs in M10x. These digital inputs can be assigned to any 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/Start2**
Local hardwiring start control. To activate the function, control access should be assigned to 'local'. Start 1 is used for start control in one direction starters. It is also used for forward start control in reversing starter control and low speed start in 2 speed starter. Start 2 is used for reverse start in reversing starter control and high speed in 2 speed starter control. Local start control works on edge trigger, i.e. 0->1 or 1->0.

• Stop
Local hardwiring stop control. To activate the function, control access should be assigned to 'local'. Stop control works on either edge trigger (0->1 or 1->0) or level trigger (continuous 1 or 0).

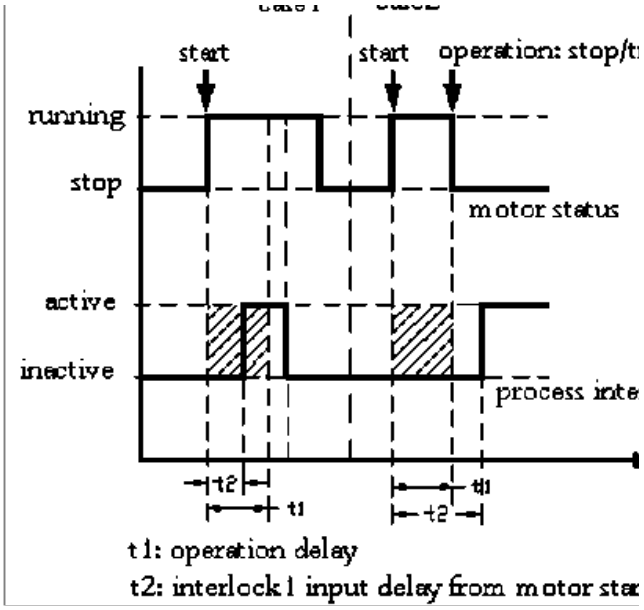
• Limit1/Limit2
This function is used for applications where limit switches are installed. When the input is activated, motor stops and read for starting from different direction.
Limit1 is usually used for stopping the motor from running forward (CW); Limit2 is used for reversing. (CCW).
Limit switch input works on level trigger, i.e. continuous 1 or 0.

• **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.

If the hard-wiring signal comes from the field or other remote source external of the switchboard, it is recommended to wire through an interposing relay internal of the starter before wired to digital inputs of M10x relay, 110/240VAC type in particular.

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.



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54 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.

Process interlock works on level check mode which means once the interlock is activated, motor is locked down until the interlock changes to deactivated.

Process interlock may cause motor to trip when activated. Once it is deactivated, the trip is reset automatically.

• Process interlock2
Similar as process interlock 1, process interlock 2 provides a time dependent trip/alarm/stop features based on a switch input. Different from process interlock 1, process interlock works on the complete motor operation process which include starting period, running period and stop.

The related parameters to process interlock 2 are the same as process interlock 1.

• **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).

Emergency stop function is not used for functional safety.

• **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.

Once the DI is assigned as loc/R function, a local selector switch function is activated. The local selector switch has the highest privilege to assign control access.
This input works in level check mode.

• **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 start/stop forward control (CW) or first speed control in two speed starters.

'PLC control 2' is designed for start/stop 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.

• **Main Switch Supervision**
When ‘main switch status‘ input is selected, main switch protection function will be enabled. Refer to the description of main switch protection function.
This input works in level check mode.

• **External trip**
The input is used for tripping motor from external triggers. For example, a trip signal from short circuit protection device. The input requires to be reset after external trip, either from local or from remote. The input works on level trigger, i.e. continuous '0" or "1".

In feeder mode, ‘External trip’ function only occurs a message and details refer to ‘Feeder’ chapter on page 38.

• **TOL Bypass**

When DI is defined as ‘TOL Bypass’, the input is used to decide when to activate or deactivate ‘TOL Bypass Function’.

TOL bypass function is the function that allow TOL tripping level rise temporarily to 200% when it is activated. That is, when TOL bypass function is activated, a motor is allowed to continue running until thermal capacity level reaches 200% without tripping on TOL and a motor tripped on TOL is allowed to be restarted immediately in case of emergency, regardless the thermal level.

To activate TOL bypass function, the parameter ‘TOL bypass” is required to be enabled. The operation of TOL bypass function is from a special "TOL Bypass " command either through local control signals (via digital input hard-wiring) or given by fieldbus.

If the command comes from local control DIs, depending on the DI setting, a continuous "0" or "1" activate the TOL bypass function. A reserve signal de- activate the function.

If the command comes from PROFIBUS, a continuous "1" from PROFIBUS activate the function until a '0" is received.

If the command comes from MODBUS, an "activate TOL bypass" command activate the function and a 'deactivate TOL bypass' command deactivate the function.

A sequence of activating and deactivating a TOL bypass function via DI is described as following,

- Select parameter ‘TOL bypass’ under TOL protection section if the motor is expected to be run exceeding 100% thermal level in case of emergency;
- Wire a ‘TOL bypass’ control switch to the DI and define the DI as ‘TOL bypass’;
- Switch on motor and run normally;
- In case of emergency, activate TOL bypass function through the DI and increase the TOL level;
- After the emergency situation, de-activate the function through DI to recover TOL protection.

TOL bypass function increases thermal capacity level and can cause equipment overheating and fire. The function must be limited to applications where temporarily thermal increase or immediate restart are vital.

• **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.

Although above listed functions are available to all 13 DI configuration, there are certain functions which should only be assigned once to one of the DIs only. These functions include, Limit1,Limit2, PLC control1/2, F_CA, F_CB, F_CC, Loc/ R, and Main switch status

•Configurable inputs type definition

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Table 43 Operation character of configurable inputs

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	
		External trip	
		Stop *	
		TOL Bypass	
		NOP	Only detects the input status.

*** Options of edge trigger type or level trigger type are available for 'stop' command.**

Configurable outputs

In addition to three contactor control relays, there are another two sets of configurable output relays available in M102 model. As for M101 product type, two sets of contactor control relays and one set of configurable output relay are provided.

Similar as for configurable digital inputs, a wide range of functions are available to be configured to any of the digital outputs.

The contact status of the output relays are not monitored by M10x

• **Alarms:**
This is a general alarm function. The relay is energized or de-energized whenever an alarm occurs.

• **Specific alarm function:**
The output can be assigned with specific alarm function including TOL, Earth fault alarm, over-load alarm, Phase failure alarm. Phase unbalance alarm, Under-load alarm, No-load Alarm, PTC alarm, PTC short circuit alarm, PTC open circuit alarm, Under-voltage alarm, Start limitation alarm, Under-voltage alarm, Auto-reclose alarm.

• **Trips:**
This is a general trip indication function which include the trips initiated across different motor states, i.e. motor running, stopped and at fault. The relay is activated when a trip occurs while motor is running. The relay is also activated to the faults which are detected during motor stopped, e.g. undervoltage happens while motor is stopped or an external trip (through DI) which is received during motor stopped. The relay remains activated while motor is at fault and will not recovered until the trip source is removed. The relay is configurable as energized type or de-energized type.

• **Specific trip function:**
The output can be assigned with specific trip function including TOL, Earth fault trip, Stalled rotor trip, Phase failure trip. Phase unbalance trip, Under-load trip, No-load trip, PTC trip, Under-voltage trip, Start limitation trip, Long start trip, Phase sequence trip.

• **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.

• **DI9 /DI 10/DI 11 status (M10x 24VDC type):**
The relay energizes on DI9/DI 10/DI11 status "1"

• **DI0/DI1/DI2 status(M10x AC type):**
The relay energizes on DI0/DI 1/DI2 status "1"

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

• **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.

• **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 not at fault, not running and ready for a start.

08. Monitoring and reporting

Metering, Monitoring and Reporting functions

Table 44 Parameters monitored by M10x

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	√	√
Number of insertion cycles	√	√
Parameter change counter	√	√
Pre trip phase A/B/C current	√	√
Pre trip earth fault current	√	√
SOE		√

Remark: 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%
3. If phase current measured is below 5% of nominal current, 0 amp is displayed.
4. Power factor measurement in M102 is based on phase A (L1). Active power, apparent power, energy, are calculated based on power factor measurement.

Maintenance and reporting functions
M10x monitors motor and motor starter service condition to assist users to schedule service and maintenance of the equipment.

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.

Insertion cycles supervision
M10x gets the value of insertion cycles via counting control power cycles. When times of Insertion cycles exceeds alarm level, M10x issues an alarm.

M10x records operation and events to assist in trouble shooting and reporting.

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

Parameter change counter
M10x counts times of parameter change and updates them in a memory map.

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

M102 has an internal clock which provides a time stamp during event recording. To ensure a correct time stamping, the internal clock shall be set correctly before operation starts.

There are three methods to set the clock- 1) Manually set the time via MD21 panel; 2) Synchronize the time using MCUSetup software; 3) Synchronize the time through communication network.

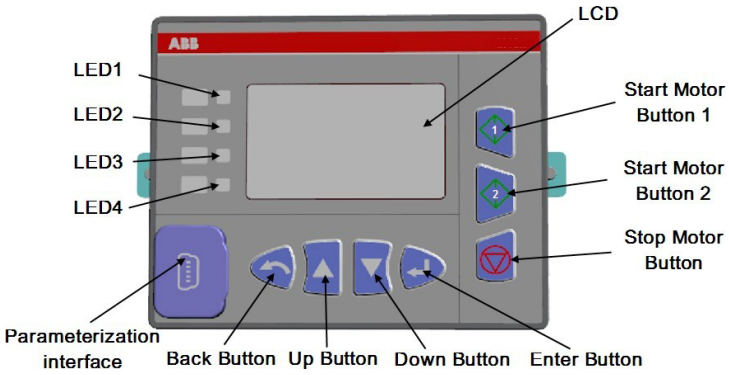
In case of M10x-TCP, time synchronizing is expected from SNTP server to EM01 interface before further broadcasting to M10x.

09. Operator panel MDx

MD21/MD31 operator panel

Overview
M10x devices provide operator panels as optional accessories for local operation and setting parameters for individual motor starters.Two types are available MD21 (Fig 55) and MD31(Fig 56).

The operator panel is connected to the main M10x device via RJ11 interface (RS485 port).



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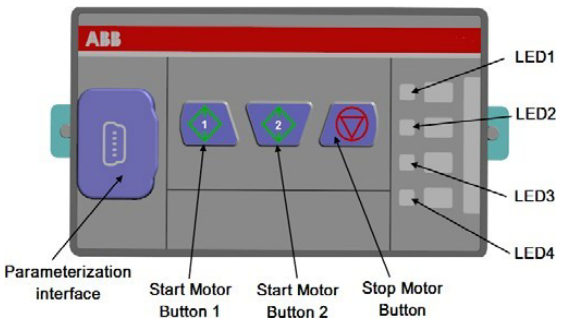
55 MD21 operator panel



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56 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:

1. All LED lights wink at the same time during changing parameters.
2. LED function is configurable through MCUSetup software. LED label can be customized and replaceable.

Table 45a LED configuration

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, DI9iii, DI10iii, DI11iii, DI12iii
LED2	(default)	Ready, Running, Stop, Fault, Ready to Start, Start1(default), Start2, DI0, DI1, DI2, DI3, DI4, DI5, DI6, DI7, DI8, DI9iii, DI10iii, DI11iii, DI12iii
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, DI9iii, DI10iii, DI11iii, DI12iii

Remark: 1. DI9~DI12 are available for M10x 24VDC type only.

Table 45b LED indicator function definition

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 45c LED indicator message

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

Control buttons

MD21 provides 7 control buttons while MD31 has 3 only.

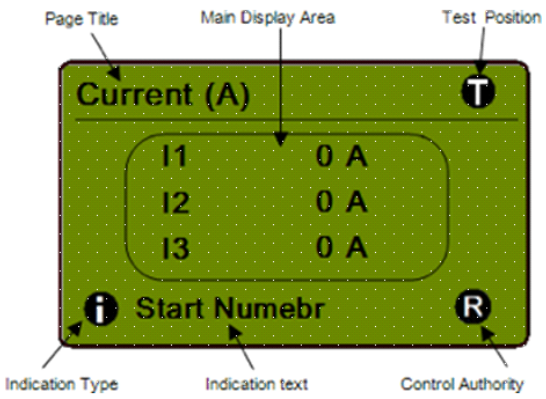
—

Table 47 MD21/31 Button Icons

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

MD21 display window

ⓘ	Alarm
⚠	Trip
Ⓛ	Local control is active
Ⓡ	Remote control is active
Ⓣ	Test Position On
01	01, highlighted, DI1* status is closed
02	02, not highlighted, DI2* status is open



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57 MD21 display window

Selectable display pages
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.

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

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	√	√

Alarm list
Alarm message will come up on the bottom of the display window as shown in Fig. 57 with indication icon whenever an alarm is active. Alarm messages include the following:

Follow section“fault messages and troubleshooting” for the explanation of individual alarm.

TOL	Insert cycle	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
Insert cycle		

Remark: the alarms with * are only available in M102 product version.

Trip message list
Trip messages include the following,

Follow section“fault messages and troubleshooting” for the explanation of individual trip message.

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

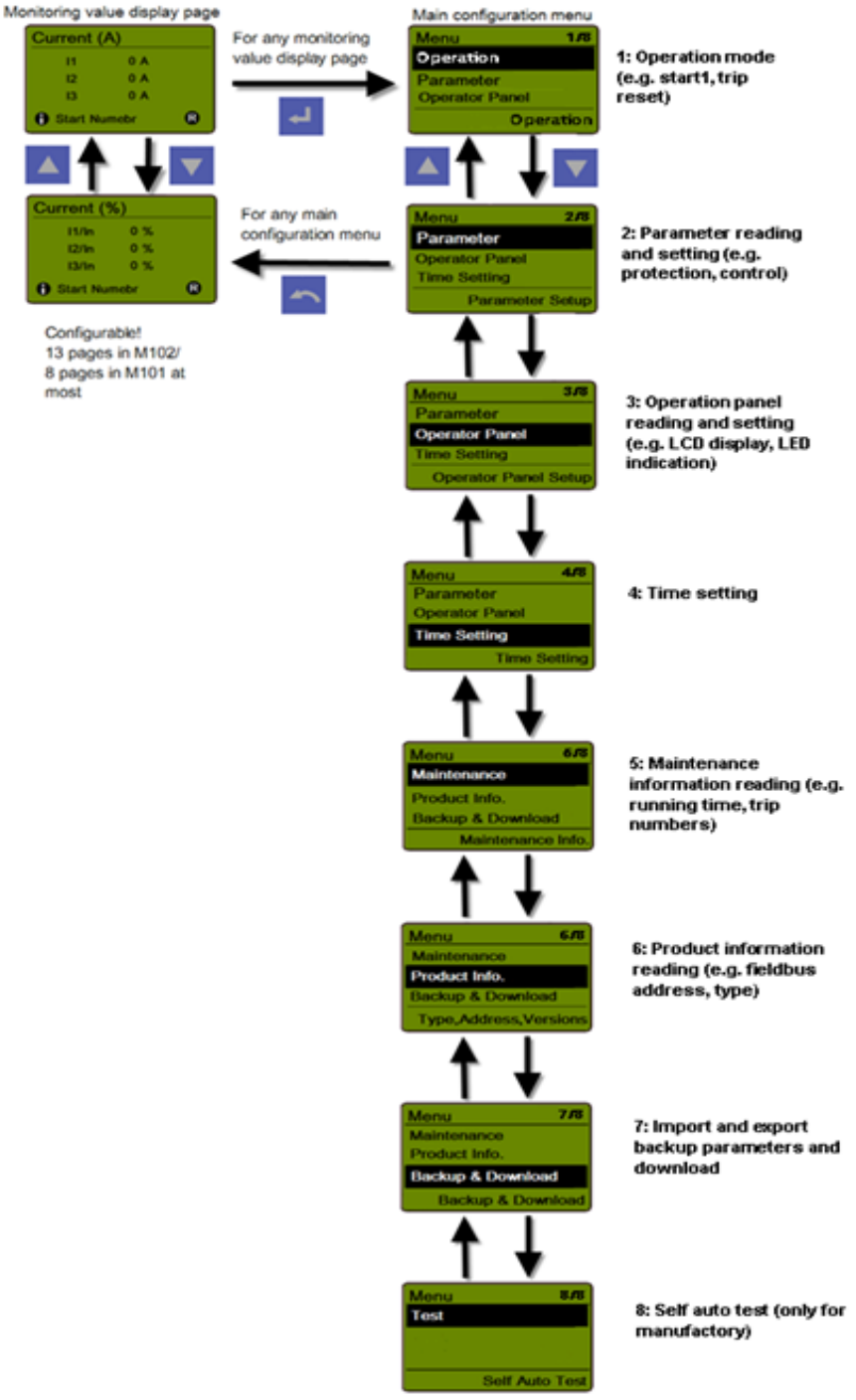
Remark: 1. the trip message with * are only available in M102 product version.
2 “Trips” function is not only the indicator after a motor is tripped but also indicate that a mo-tor is ready to trip before tripping or during mo-tor stopped. e.g. an undervoltage or external trip (via DI) can activate the ‘Trips’ function while the motor is stopped.

The menu trees

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

Press up/down button, can move the highlight to previous/next items. Press enter button to enter next level of menu.

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



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58 View of main configuration menu tree

Password protection from MD panel
Password protection can be activated on MD21 panel to avoid unauthorized operations from switch-board front.

The operations which can be password protected include start, stop, trip reset, alarms. The password protection may also be activated for acknowledging trip messages only when necessary.

Only one set of password is required for all operations and parameter settings/changes. The password should be reset and managed by the end users according to individual plant management policy. The initiate password is "1111".

1) Password protection function is related to the operations via MD21 panel only! In case operations are from hardwiring or fieldbus, they are not bonded by this feature.

Activate password protection function:

Pressing  button > Select 'Operator panel'>

'StartPwOn' – select 'On' to turn on password for 'start' control

"StopPwOn'- select 'On' to turn on password for 'stop'control

"TripAlarmPwOn'- select 'On' to turn on password for 'trip reset' and acknowledging alarm/trip mes-sages.

Operating Start/stop with password
Option 1: Press start1/2/stop button, MD21 will prompt up password window. Once the correct pass-word is entered, press again 'start1/2/stop" to initiate the operation. Fail to press 'start1/2/ stop' but-ton within 30 seconds after entering the password will bring up password window again.
Option 2: Go to the main menu and select "Operation "Select desired operation from the list.

If motor is tripped, start/stop command will be latched. That means password window will not prompt up when start/stop command is given via MD21.

Operating Trip Reset with password
Step 1: Activate 'TripAlarmPwOn' on MD21.
Step 2: Select trip reset mode parameter as 'local' or 'local &remote' via MD21 panel
Step 3: When motor trips, trip message comes up on MD21, "fault' LED switches ON. There are two possibilities to reset the trip message:
a) Press stop button, then "reset trip?" message comes up.
b) Press back button to enter setting menu. Select 'Operations' > 'Reset Trip' to enter "reset trip?" window.
Step 4: Press enter button at 'reset trip?' window.
Step 5: Enter the password. If password is correct, M10x will execute trip reset command. If password is wrong, MD21 will go back to "reset trip?" message following 'Invalid password' message.

If reset mode is set to 'remote', trip reset with password is not available.

If the cause of trip is removed, trip will be reset. If the cause of trip persists, 'Remove the cause before reset' message comes up with no further response. It goes back to trip message win-dow after 3s.

In case that 'TripAlarmPwOn function' is activated, password input is always needed for every trip reset function

Acknowledge Alarm message with/without password
When there is an alarm, alarm message comes up on MD21, "fault' LED flashing. The alarm message displayed is a real time message and disappear when the cause of the alarm is removed. Users may refer to SOE list for history alarms.

When an alarm or multiple alarms are present but not critical to the process, it is also possible to sup-press the alarms temporally after acknowledging the alarm with or without password protection. Once the alarm is acknowledged, a '*" mark is removed from the message description while the message remains on the alarms list until the cause is removed. The LED stops flashing after all the alarms are acknowledged but remains ON after acknowledgement.

Acknowledge with password

Step 1: Activate 'TripAlarmPwOn' on MD21.

Step 2: Select 'Operations' > 'Alarm Acknowledge' to prompt a password window.

Step 3: Enter the password. If password is correct, all active alarms are listed. If password is wrong, MD21 will go back to previous menu following 'Invalid password' message.

Step 4: Select the alarm to be acknowledged via up/down button, then press enter button to acknowledge the message.

Acknowledge without password

Skip step 1 above and select 'Alarm Acknowledge' will display active alarms without asking for password. Then carry on from Step4.

Operation

Within this submenu, start/stop can be triggered, trip can be reset, and alarm can be acknowledged. Below table shows the organization of the different parameter masks in the menu tree.

—

Table 48 Menu tree of operation

Level 1	Level 2
Operation	Trip Reset
	Alarm Acknowledge
	Start1
	Start2
	Stop

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.

Table 49 Menu tree of parameter

Level 1	Level 2	Level 3	Level 4	Level 5
Parameter	Protection	TOL[2]		Function
				Disabled during 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]
		Long stop[2]		Function
				Reset mode[9]
				Alarm level[9+12]
				Trip level[9]
				Trip delay[9]
		Earth fault		Function
				Enabled duration stop[9+12]
				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	PTC[2+3]		Function
				Reset mode[9]
				Alarm level9[+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]
		Phase Sequence		Function
				Reset Mode[9]
		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[7]
				Soft test switch
				External CT used
				External CT1 primary[20]
				External CT2 primary[20+6]

Level 1	Level 2	Level 3	Level 4	Level 5
Parameter[1]	Control	Motor Control	External CT secondary[20]	
		Control authority	Profibus option[19]	Auto mode active
		Soft local/ remote[19]	Soft local/ remote[19]	L hardwiring
				R fieldbus
		MD control[19]	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]	
			Start delay[9]	
	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 ~DI12 (24VDC) or DI0-DI8 (110V or 240VAC)	Function	
			Contact type	
			Delay[21]	
			Operation[22]	
	DO	DO[1]	Function	
			Delay	
			Principle	
		DO[23]	Function	
			Delay	
			Principle	
	Maintenance	Running hour	Function	
			Alarm level[9]	
		Start number	Function	
			Alarm Level[9]	

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

1: MD21 is connected with M10x.
2: Starter type is NOT set to be Feeder.
3: MD21 is connected to M102.
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: Feedback function set as "Enabled".
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.
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.

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.

Table 50 Menu tree of operator panel

Level 1	Level 3	Level 2	Level 4
Operation	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		
	TripAlarmPwOn		
	StartPwOn		
	StopPwOn		
	Password setup		

Remark: 1 available in M102 product version 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.

Table 51 Menu tree of time setting

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

Maintenance
Within this submenu, all motor related maintenance can be configured.

Table 52 Menu tree of maintenance

Level 1	Level 2
Maintenance	SOE*
	Running time
	Start time
	Start number
	Start number
	Trip number
	Last trip current(%)
	Last trip current(A)
	Last trip EF current
	Insertion cycle
	Parameter change counter

Remark: * available in M102 product version only.

Product information
Within this submenu, information of M10x and MD21 can be read.

Table 53 Menu tree of product information

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

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 useful when similar parameters are required for several M10x devices.

Backup parameter: Saves current parameter to backup register in MD21.
Download backup: Downloads the parameter in backup register into M10x.

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.

—
Table 54 Menu tree of backup and download

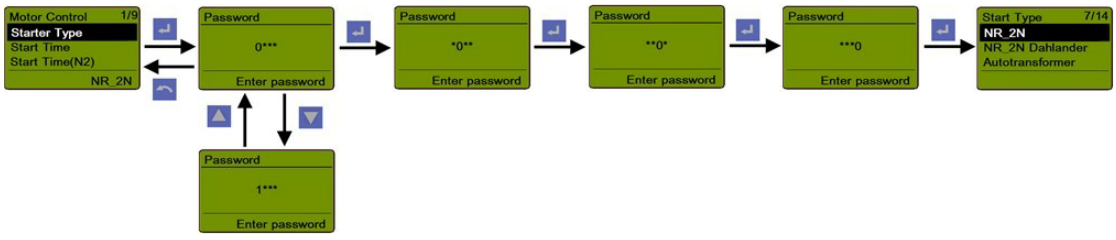
Level 1	Level 2
Backup and download	Backup parameter
	Download backup1

Test
Select this submenu, M10x will conduct a self-diagnosis to health check hardware circuits, firmware programs and operation functions.

Adjusting parameters
Select the item at the last parameter level and press enter. A password window will appear. Always change the default password after first login for secure operation purpose

After changing the parameters, press the back button to return and confirm before downloading the new parameter..

1. Default password is 1111.
2. The slave address can be revised and downloaded to M10x via MD21.



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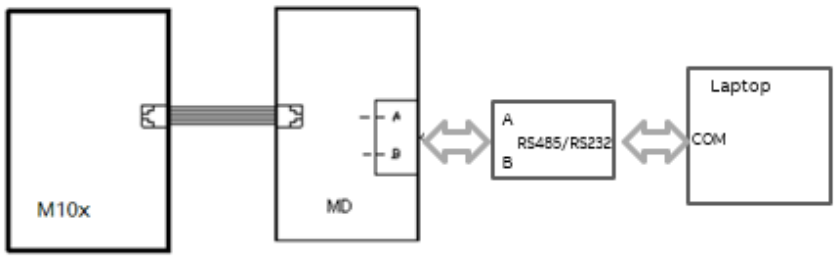
59 adjusting parameters

Connection ports

There are two connection ports available on MDx panel. RJ11 port which locates on the back of the panel connects to M10x main unit. A mini USB port is available on the front for parameterization connection.

A dedicated parameterization cable is required to connect between MDx panel and the laptop.

If MD21 cannot read the information from M10x, a "No Comm" message appears. This may refer to a bad connection between MD21 panel and M10x or a possible failure in M10x main unit.



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60 MD21 connection ports

MDx adaptor

MDx adaptor is the adaptor kit which is designed to connect M10x main unit to an external MDx control panel. MDx adaptor kit include a compact IP65 socket which is to be installed on the front panel of the each starter and a couple of connection cables. The connection between M10x and MDx is shown in Fig61. Details of ordering, please refer to M10x ordering guide.

—
61 Connection between M10x and MDx

10. Communication interface

Overview
M10x supports three types of communication protocol: MODBUS RTU, PROFIBUS DP and MODBUS TCP.

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.

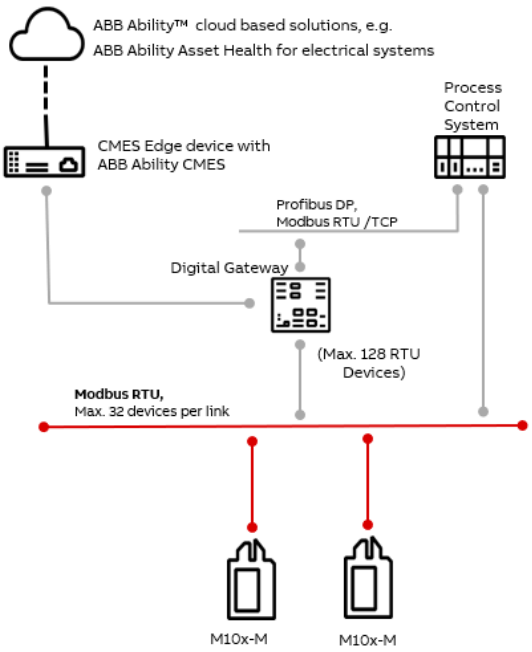
The M10x-M implements a subset of the Modicon MODBUS RTU serial communication standard. MODBUS is a single master/multiple slave type of protocol suitable for a multi-drop configuration as provided by RS485 hardware. The M10x-M is always a MODBUS slave, and cannot be programmed as a master. Commonly,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

Modbus RTU network
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.

Function description
The following functions are supported by the M10x-M: (FC=Function code)
FC02 Read settings and actual values
FC03 Read settings and actual values
FC04 Read settings and actual values
FC05 Execute operation
FC06 Store single setting
FC08 Loop back test
FC10 Store multiple settings

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



62 Network connection of M10x-M

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.

PROFIBUS Network
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 description

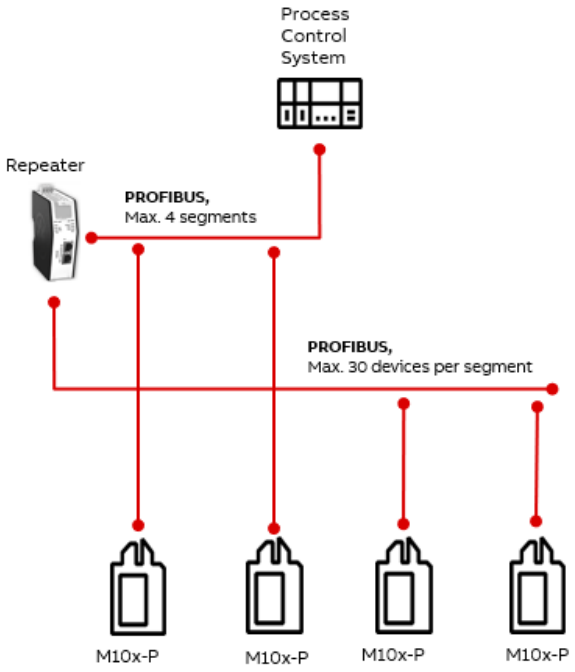
PROFIBUS-DP is a distributed I/O system that enables the master to use a large number of peripheral modules and field devices. The data transfer is mainly cyclic: the master reads the
input information from the slaves and sends the output information back to the slaves. PROFIBUS-DPV1 is an extension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

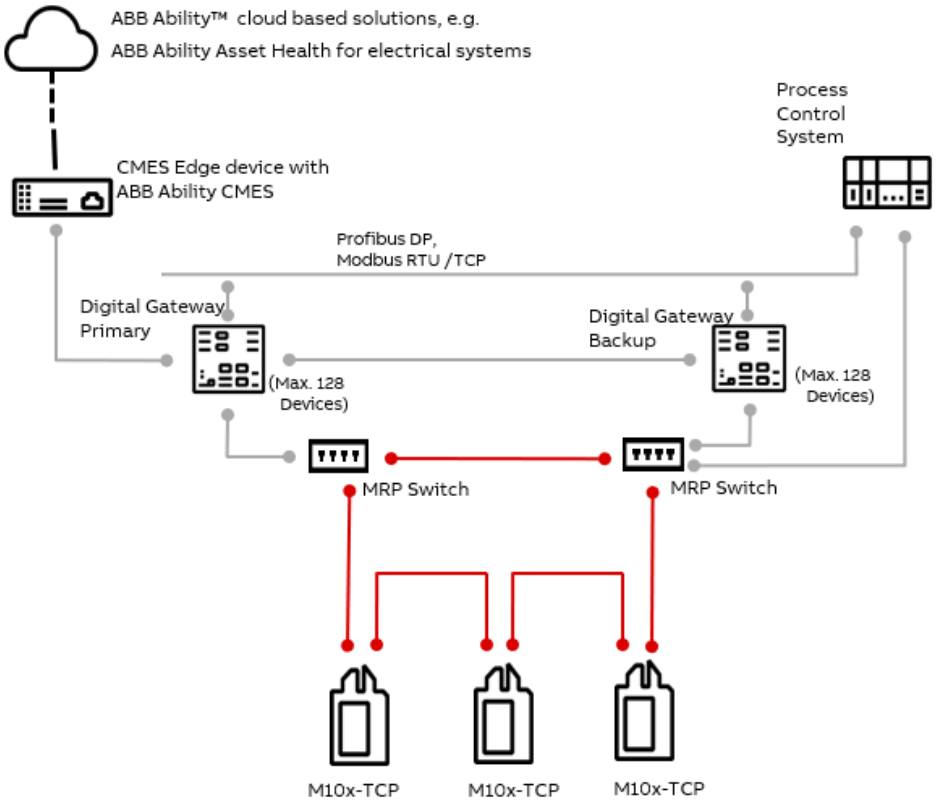


63 Bus (line) network

MODBUS TCP

M10x-TCP is connected to Ethernet network via its EM01 interface. M10x-TCP supports star, daisy chain network connection and supports network redundancy through ring topology using MRP configuration.

For detail information, please refer to M10x-TCP user guide.



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64 M10x-P Ring network

11. 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: Operator panel.

Parameterization via MCUSetup software
Users can complete parameter settings by connecting a computer with installed MCUSetup software to MD21 or MD31 via a dedicated setting cable.

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.

65 Parameter setting via software

MCUSetup 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 runs on windows environment.

Step by step instruction on how to install MCUSetup software and configure parameters are given in document ' MCUSetup user guide.

12. Fault Messages and Troubleshoot

Self-diagnosis feature
M10x has built in self-diagnosis program to actively health check the internal hardware circuits and software programs. The 'test' function through MD21 panel can also activate the health checking pro-gram on request.

• **Watchdog**
A hardware watchdog is designed to supervise the health checking program. In case any hardware or software failure is detected by the program, a reset is triggered from the watchdog to restart the program. In the meantime, a watch-dog alarm message is generated.

A watchdog alarm is a warning of one time health check failure. The cause of the failure may be tem-porary due to external disturbance/EMC environ-ment and may not necessarily be severe. However once a watchdog alarm message occurs, it is necessary to be closely monitored. If the watchdog alarm is trigger frequently, a follow-up service and maintenance shall be scheduled shortly..

In case of severe hardware or firmware failure, the relay will no longer be resettable and required to be replaced immediately.

The watchdog can be configured to one of the digital output relays and monitored through hardwiring.

• **Test**
Selecting TEST option under the main menu of MD21 panel activates a comprehensive health checking of M10x and MD21 including hardware circuits, firmware programs and operation functions.

Fault messages and trouble shoots

Condition	Description	Possible Cause	Suggested Action
Thermal Capacity Alarm	Motor is about to be stopped. the motor thermal level reaches thermal capacity level alarm level	The motor is under thermal overload condition. Unacceptable heating-up of motor winding.	Check the process conditions:> If it is extreme starting conditions, high overload or intermittent operation; Check the motor condition:> Cooling problem, ambient temperature too high; mechanical problem; Check the thermal model relevant parameters: the Ie setting, T6 time and ambient temperature setting, the thermal level setting etc.
Overload Alarm	Motor is about to be stopped. The motor is in overload condition, i.e. measured current ILmax > 1.14 x TFLC (thermal full load current multiplier reduced by motor ambient temperature)	The motor is in overload condition	Check the process conditions; Check motor load; Check parameter settings.
Phase Failure Alarm	Motor is about to be stopped. The maximum imblance current of any phase reaches the phase failure alarm level.	Phase failure in motor phase currents generally occurs because of pitted contacts in the contactor or SCPD, imbalance in the mains supply, loose connections, blown fuse, and faults within the motor.	Check for blown fuse Check for pitted contacts in contactor or SCPD Check for loose connection on power supply Check the motor connection

Condition	Description	Possible Cause	Suggested Action
Phase unbalance Alarm	Motor is about to be stopped. The maximum imblance current of any phase reaches the unbalance alarm level.	phase unbalance in motor phase currents generally occurs because of pitted contacts in the contactor or SCPD, imbalance in the mains supply, loose connections, blown fuse, and faults within the motor.	Check for pitted contacts in contactor or SCPD Check for loose connection on power supply Check the motor connection
Underload Alarm	Motor is about to be stopped. The highest of the measured phase currents is below the alarm level.	Motor current is below the alarm setting; motor running idle, dry running pump, conveyor belt broken; fan with no air flow	Check motor load and motor / process conditions. Check parameter settings.
Noload Alarm	Motor is about to be stopped. The highest of the measured phase currents is below the alarm level.	Motor current is below the alarm setting; motor running idle, dry running pump, conveyor belt broken; fan with no air flow	Check motor load and motor process conditions. Check parameter settings.
Earth Fault Alarm	Motor is about to be stopped. Residual current for cable(s), motor and connection box above alarm level . Measured Earth Fault Current exceeds above the Alarm level	Insulation problems for cable(s), motor and connection box or reduced insulation strength due to extreme ambient conditions.	Check parameter settings. Check Earthing system. Check motor or connected load.
PTC Alarm *	Motor is about to be stopped. The resistance corresponding to the high temperature at one or more of the thermistors exceeds alarm level	Excessive temperature rise in the windings and reaches alarm level	Check motor environmental and load condition
Undervoltage Alarm *	Motor is about to be stopped. The lowest of the measured voltages is below the alarm level.	Voltage dip below the alarm level	Check parameter settings. Check main supply
Autoreclose Alarm *	Motor is about to restart after the voltage dip	Voltage dip is measured and the autorestart function is active	N/A
Feedback Alarm	Motor is about to be stopped. Contactor feedback or current feedback is not as expected.	Contactor feedback is not detected or the current is not measured during motor starting or running.	Check for loose connection of contactor feedback Check for contactor control Check motor load and motor process condition
Welded Contactor Alarm	Motor is stopped. Contactor feedback is not as expected.	Contactor welded fault	Check parameter settings.Check contactors Check motor
PTC short circuit *	The resistance of PTC input is lower than the alarm level	PTC short circuit	Check parameter settings. Check PTC wiring between motor and relay
PTC open circuit *	The resistance of PTC input exceeds 12kΩ	PTC open circuit	Check parameter settings. Check PTC wiring between motor and relay
Start limitation Alarm	Motor is about to be stopped and one more start is allowed	motor starts too frequent	Check parameter settings.
Serial Communication Alarm	Before the permitted time delay elapse, M10x considers loss of communication	communication interruption between m10x and upper control system	Check parameter settings. Check network interface
Running time Alarm	The Running timer exceeds the preset running time alarm level	This helps to lubricate and maintain the bearings of the motor within the correct service interval.	Check parameter settings. Check motor
Start number Alarm	The start counter exceeds the set value of cycles in preset start number alarm level	This help in carrying out preventive maintenance of power contacts.	Check parameter settings. Check contactors

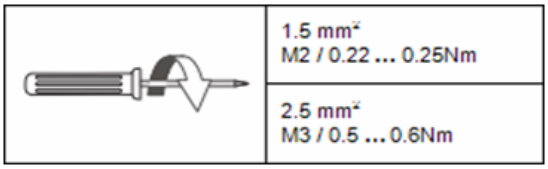
Condition	Description	Possible Cause	Suggested Action
DIx Alarm	Motor is about to stop if the DIx changes status from healthy to unhealthy during running ; Motor is prevented from starting if the DIx input is unhealthy.	The process interlock1 switch remain inactive on the occurrence of a motor start or the process interlock2 switch remain active when motor is in running.	Check DI settings on process interlock. Check DIx wirings
Watchdog Alarm	Internal hardware watchdog activated	Hardware fault or internal program running fault (if it is a temporary fault, it is recoverable after power cycling).	Check if it is recoverable (by cycling the power) Change hardware if it is not recoverable
No Comm	The communication between MDx display and M10x main unit is interrupted or M10x simply stops functioning.	Physical connection is damaged between MDx display and M10x. M10x is no longer in working mode.	Check if the cable connection is in good condition; Check if MDx or M10x relay is in working condition (by swapping with spares)
TOL Trip	Motor is stopped. The motor thermal level reaches thermal capacity trip level	The motor is under thermal overload condition. Unacceptable heating-up of motor windings.	Check the process conditions:> If it is extreme starting conditions, high overload or intermittent operation. Check the motor condition:> Cooling problem, ambient temperature too high; mechanical problem; Check the thermal model relevant parameters:> Check the Ie setting, T6 time and ambient temperature setting, the thermal level setting etc.
Stalled rotor Trip	Motor is stopped. The highest of the measured phase currents remains above the trip level for a trip delay time	The driven mechanical system from jams and excessive overloads	Check parameter settings. Check motor connected load and process condition.
Phase Failure Trip	Motor is stopped. the ratio between the lowest phase current to the highest phase current (ILMIN / ILMAX) from the measured currents of all three phases is below the trip level	Phase failure in motor phase currents generally occurs because of pitted contacts in the contactor or SCPD, imbalance in the mains supply, loose connections, blown fuse, and faults within the motor.	Check for blown fuse Check for pitted contacts in contactor or SCPD Check for loose connection on power supply Check the motor connection
Phase unbalance Trip	Motor is stopped. the ratio between the lowest phase current to the highest phase current (ILMIN / ILMAX) from the measured currents of all three phases is below the trip level.	Phase failure in motor phase currents generally occurs because of pitted contacts in the contactor or SCPD, imbalance in the mains supply, loose connections, blown fuse, and faults within the motor.	Check for blown fuse Check for pitted contacts in contactor or SCPD Check for loose connection on power supply Check the motor connection
Underload Trip	Motor is stopped.The highest of the measured phase currents is below the trip level.	Motor current is below the alarm setting; motor running idle, dry running pump, conveyor belt broken; fan with no air flow	Check motor load and motor / process conditions. Check parameter settings.
Noload Trip	Motor is stopped. The highest of the measured phase currents is below the trip level.	Motor current is below the alarm setting; motor running idle, dry running pump, conveyor belt broken; fan with no air flow	Check motor load and motor process conditions. Check parameter settings.
Earth fault Trip	Motor is stopped. Residual current for cable(s), motor and connection box above trip level.	Insulation problems for cable(s), motor and connection box or reduced insulation strength due to extreme ambient conditions. Consider whether starpoint of IT-networks may have moved.	Check parameter settings. Check Earthing system. Check motor or connected load.
PTC Trip *	Motor is stopped. The resistance corresponding to the high temperature at one or more of the thermistors exceeds trip level	Excessive temperature rise in the windings	Check parameter settings. Check PTC input Check motor

Condition	Description	Possible Cause	Suggested Action
Undervoltage Trip *	Motor is about to be stopped. The lowest of the measured voltages is below the trip level.	Voltage dip below the trip level	Check parameter settings. Check main line voltage
Contactor Feedback Trip	Motor is stopped. Contactor feedback is not as expected.	Contactor feedback fault	Check for loose connection of contactor feedback Check for contactor control Check motor load and motor process condition
Serial Communication Trip	After the permitted time delay elapse, M10x considers loss of communication and activates failsafe	communication interruption between m10x and upper control system	Check parameter settings.(change the setting to "255" will disable the communication supervision); Check network interface
Start limitation Trip	Motor is stopped and a new start is prevented.	The motor starts too frequent and the number of starts in a given interval is reached start limitation	Check parameter settings.
DIx Trip	Motor is tripped because the DIx changes status from healthy to unhealthy during running ; Motor is prevented from starting because the DIx input is unhealthy.	The process interlock1 switch remain inactive on the occurrence of a motor start or the process interlock2 switch remain active when motor is in running.	Check DI settings on process interlock. Check DIx wirings
Long start Trip	Motor is stopped. After a start signal, when the measured phase currents remain above the set value for a locked rotor delay time during the startup time	motor locked or stalled in start state and signals a fault when current continuously exceeds a separately set threshold after a start command for the same period of time.	Check parameter settings. Check motor or connected load.
Feeder trip	Motor is stopped because of external trip input of feeder starter type.	The input is defined as ‘external trip’, M10x will trip the motor after a high input is detected.	Check parameter settings. Check Digital input wiring.
Emergency stop trip	Motor is stopped because of emergency stop input.	The input is defined as ‘emergency stop’, M102 will stop or trip the motor after a high input is detected.	Check parameter settings. Check Digital input wiring.
External Trip	Motor is stopped because of external trip input.	The input is defined as ‘external trip’, M10x will trip the motor after a high input is detected.	heck parameter settings. Check Digital input wiring.
Main switch off trip	Motor is stopped because of main switch input.	The input is defined as ‘Main switch status’, M10x will trip the motor after a low input is detected.	Check parameter settings. Check Digital input wiring.
Current feedback trip	Motor is stopped. Current feedback is not as expected.	Current is not measured during motor starting or running. Or current is measured while starter is detected in test position.	Check parameter settings if 'soft test' is enabled. Check motor connected load and process condition.

13. Appendix A: Technical data

Technical data

Main circuit			
Rated operation voltage (U_e)	up to 400/690VAC		
Rated insulation voltage (U_i)	690VAC		
Rated impulse withstand voltage (U_{imp})	6KV, overvoltage category II in IT network, Category III in other networks.		
Degree of pollution	3		
Rated operation current (I_e)	0.24-63A		
Rated frequency	50/60Hz		
Control circuit			
Rated operational voltage (U_e)	24V DC ,110 or 240 VAC		
Rated insulation voltage (U_i)	-250VAC		
Rate impulse withstand voltage	4kV for AC circuit		
Rated operational current (I_e)			
Contactor control relay output (CCA,CCB,CCC) Digital output	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 (U_e)	24VDC , 110 or 240VAC		
Voltage operation range	85%-110% Ue		
Power consumption			
	24VDC	110VAC	240VAC
Typical	5W	6VA	12VA
Maximum	8W		
Maximum inrush 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
	110/240VAC type	Vertical mounting: -10 ~ +60°C Horizontal mounting: -10 ~ +55°C
Humidity	15% up to 95% without dew	
Derating accepted operating altitude	4500m	
Without derating operating altitude	2000m	
EMC environment	Equipment in the system complies with EMC requirement of CE/CCC certificate. 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 measurement range: 100V - 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	
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		

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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 supply, 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

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1TNC911112D0209 05.2021