



## Motor control and protection unit M10x parameter description

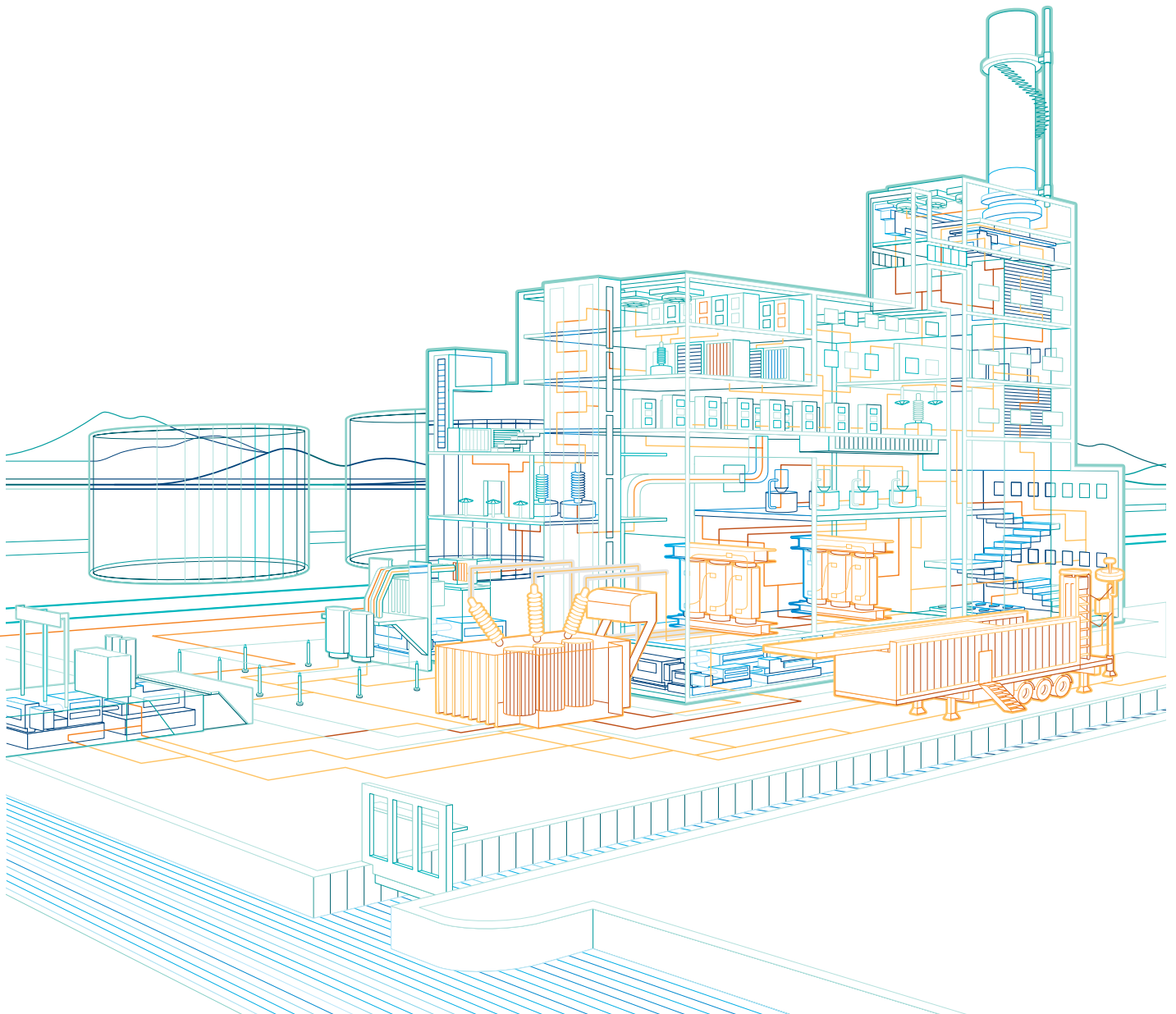
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# Table of contents

<b>General</b>	<b>6</b>
Target group	6
Use of warning, caution, information and tip icon	6
Terminology	7
Related documentation	8
Related system version	8
Document revision history	8
New features available in enhanced products	9
 <b>Document overview</b>	 <b>10</b>
Motor Information	11
Motor ID	11
Motor type	11
System supply voltage(M102 only)	12
System frequency	12
Motor power rating	12
Motor nominal current (N1)	12
Motor nominal current (N2)	13
 <b>Motor control</b>	 <b>14</b>
Starter ID (M10x-M only)	14
Starter type	15
Startup time	19
Startup time (N2) (M102 only)	20
Changeover time (M102 only)	20
Ramp up time (M102 only)	20
Ramp down time (M102 only)	21
Earth fault primary	21
Internal CT primary	22
Communication failure delay	22
Failsafe mode	22
Feedback	23
Feedback timeout	23
External CT used	23
External CT1 primary	24
External CT2 primary	24
External CT secondary	25
 <b>COMMS.</b>	 <b>26</b>
Modbus communication	26
PROFIBUS DP communication	28
 <b>Control authority</b>	 <b>29</b>
Motor control mode	29
 <b>Motor grouping</b>	 <b>30</b>
Function enable, disable	30
Group start direction	31
Group ID (M10x-M only)	31
Group number	31
Group start delay	31
Group stop delay	31

<b>Digital inputs</b>	<b>32</b>
Function	32
Contact type	34
Operation delay	35
Operation	35
<b>Digital outputs</b>	<b>36</b>
Function	36
Start/stop delay	37
Operation principle	37
<b>Thermal overload protection (TOL)</b>	<b>38</b>
Function enable, disable	39
Thermal mode	40
Trip class (T6)	41
Trip class (Te)	44
Ia/In	46
TOL alarm level	46
TOL trip level	46
TOL reset level	46
Trip reset mode	47
TOL bypass enable/disable	47
Cooling coefficient (Mt6)	48
Ambient temperature	49
<b>Staff protection</b>	<b>51</b>
Function enable, disable	52
Trip level	52
Trip delay	53
Trip reset mode	53
<b>Phase failure protection</b>	<b>54</b>
Function enable, disable	55
Alarm level	55
Trip level	55
Trip delay	56
Trip reset mode	56
<b>Unbalance protection</b>	<b>57</b>
Function enable, disable	57
Alarm level	58
Trip level	58
Trip delay	58
Trip reset mode	59
<b>Underload protection</b>	<b>60</b>
Function enable, disable	61
Alarm level	61
Trip level	61
Trip delay	62
Trip reset mode	62
<b>Noload protection</b>	<b>63</b>
Function enable, disable	64
Alarm level	64
Trip level	64
Trip delay	65
Trip reset mode	65

<b>Earth fault protection</b>	<b>66</b>
Function enable, disable	67
Enable earth fault protection during motor startup	67
Alarm level	67
Trip level	68
Trip delay	68
Trip reset mode	68
<b>PTC protection (M102 only)</b>	<b>69</b>
Function enable, disable	70
PTC alarm level	70
PTC trip level	70
PTC trip delay	71
PTC reset level	72
PTC short circuit alarm level	72
PTC trip reset mode	72
<b>Undervoltage protection (M102 only)</b>	<b>73</b>
Function enable, disable	74
Alarm level	74
Trip level	74
Trip delay	75
Reset level	75
Trip reset mode	75
<b>Autorestart function (M102 only)</b>	<b>76</b>
Function enable/disable	78
Maximum autoreclose time	79
Maximum power downtime	79
Staggered start delay	79
<b>Start limitation protection</b>	<b>80</b>
Function enable, disable	81
Time interval	81
Number of starts	81
<b>Long start protection</b>	<b>82</b>
Function enable, disable	83
Locked rotor level	83
Locked rotor delay	83
<b>Phase sequence protection</b>	<b>84</b>
<b>Maintenance</b>	<b>85</b>
Running time alarm level	85
Start number alarm level	85
<b>Diagnosis information (M10x-P) only</b>	<b>86</b>
<b>User definable map (M10-M only)</b>	<b>87</b>
<b>User definable data (M10x-P only)</b>	<b>88</b>
<b>MD LED</b>	<b>90</b>
Color	90
Function	90
<b>MD21 display option</b>	<b>92</b>

# 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 follows:

	The electrical warning icon indicates the presence of a hazard that could result in electrical shock.
	The warning icon indicates the presence of a hazard that could result in personal injury.
	The caution icon indicates important information or warnings related to the concept discussed in the text. It might indicate the presence of hazard that could result on corruption of software or damage to equipment/property.
	The information icon alerts the reader to pertinent facts and conditions.
	The tip icon indicates advice on, for example, how to design your project or how to use a certain function

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

## Terminology

List of terms, acronyms, abbreviations and definitions used in the document:

Abbreviation	Term	Description
	Alarm	Alarm is defined as status transition from any state to abnormal state. Status transition to abnormal state can be data crossing over the pre-defined alarm limit.
DCS	Distributed control system	High level distributed control system
	Hardware 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
	PROFIBUS-DP	Fieldbus communication protocol with cyclic data transfer (V0)
	Modbus	Fieldbus communication protocol
	Modbus RTU	Fieldbus communication protocol
	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 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

### Related System Version

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

	HW	FW
M10x-M 24VDC	2.0	3.3
M10x-M 110VAC	1.0	3.3
M10x-M 240VAC	1.0	3.3
M10x-P 24VDC	3.2	5.2
M10x-P 110VAC	1.0	5.2
M10x-P 240VAC	5.2	5.2
MD21	1.0	2.1
MD31	1.0	1.1

Until further notice, this document is also applicable for future firmware versions.

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
M0201	Initial Edition	10/2003
M0202	Change Earth Fault Setting; Revise the Terminology of Control Authority; Revise DI Function Description	04/2008
M0203	Template Changed as per BU Guideline	10/2010
M0204	Released for M10x products with new hardware, suitable for both M10x-M and M10x-P	01/2013
M0205	Add feedback timeout and DO function	07/2013
M0206	Add in Phase sequence protection and more DO functions, main switch supervision function.	09/2016



## New features available in enhanced products

In comparison with previous firmware and hardware revisions:

General features	
1	One single type of integrated CT ranging from 0.24~63A replaces all 6 types of CTs in previous products.
2	Products with options for 110VAC or 240VAC power supply and DI types are available in addition to 24VDC option.
3	Additional SOE function in M102 provides event recorder data up to 256 events with time stamp.
4	Products in the same categories are made with the same features and functionalities and are only different in power supply and communication interface from each type. For example, M101's range of products has identical functionalities regardless of different types of power supply and interfaces, such as M101-M 24VDC, M101-P 240VAC, etc.
Physical dimension	
1	Main unit dimension remains the same as previous revision. MDx panel is slightly larger in width and length (both 3mm extra) while cutout dimension remains the same.
Control features	
1	Contactor feeder 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.
Measuring and monitoring	
1	Additional running data are monitored, such as current phase unbalance, thermistor resistor, time to TOL trip, time to TOL reset, startup time, DI status.
2	Phase-to-phase instead of phase-to-neutral voltage is directly measured.
Maintenance	
1	More maintenance features are implemented, including providing number of trips, SOE with time stamp, etc.
Operator panel MDx	
1	MDx is provided as IP54.
2	Color and function of LEDs are selectable.
3	Messages on MD21 are selectable.
4	Two languages are supported, ie, English and Chinese.
5	Parameter setting via MD21 is available.
6	Parameter setting port on MDx is mini USB connector in lieu of USB connector.

# Document overview

M10x parameterization can be done from a several laptop/workstation with MCUSetup software, or via operation panel MD21.

The motor related parameters and the protection function are set based on the motor manufacturer's data sheet.

M10x parameterization is mainly classified into the following functions:

- Motor information
- Motor control
- COMMS (communication)
- Control authority
- Motor grouping
- Digital inputs
- Digital outputs
- TOL protection
- Stall protection
- Phase failure protection
- Unbalance protection
- Underload protection
- Noload protection
- Earth fault protection
- PTC protection (M102 Only)
- Undervoltage protection & sutorestart (M102 only)
- Start limitation protection
- Long start protection
- Maintenance
- Diagnosis information (M10x-P only)
- User defined map (M10x-M only)
- User defined data (M10x-P only)
- MD LED
- MD Display option (MD21 only)

Functions are further subdivided into parameters, to be set individually. Above functions and their related parameters are covered in each of the subsequent chapters.

### Motor information

Motor information consists of parameters that mainly reflect the motor ratings.

Parameters involved with the motor Information are as below:

Motor ID  
Motor type  
System supply voltage (only for M102)  
System frequency  
Motor power rating  
Motor nominal current  
Motor nominal current (N2) (only for M102)

### Motor ID

Function : Motor information  
Range : space ! # \$ % & ' ( ) + , - . 0... 9 ; = @ A...Z [ ] ^ \_ ' a...z { }  
~  
Default setting : MOTOR1  
Related parameters: --  
Description :  
A maximum length of 20 characters (ASCII) can be assigned to an identifier to describe the location or function of the motor.



M10x-P supports only maximum 4 characters (ASCII).

### Motor Type

Function : Motor information  
Range : 1 = Single phase, 3 = Three phases  
Default setting : 3 = Three phases  
Related parameters: Motor control/starter type  
Phase failure protection/function  
Unbalance protection / function  
Description :  
M10x can handle a single- or three-phase AC motor. Based on the number of phases of the motor, single or three can be selected. For single-phase motors, the motor current lead or the CT secondary lead (for > 63 A) is passed through L1 phase window of the M10x internal current transformer.



Single phase application is practicable with NR-DOL starter type. Neither the phase failure protection nor the unbalance protection is available for the application.

### System supply voltage (M102 Only)

Function : Motor information  
Range : 110(1)690V  
Default setting : 380V  
Related parameters : --  
Description :

This parameter is to be selected per system supply design value.

### System frequency

Function : Motor information  
Range : 50/60Hz  
Default setting : 50Hz  
Related parameters : --  
Description :

System frequency is a measured parameter when voltage is measured by M10x, for example a M102 with voltage inputs wired. It is a fixed value when voltage is not measured, e.g M101.

It is for reference only and does not affect operation of the M10x.

### Motor power rating

Function : Motor information  
Range : 0.01(0.01)1000kW  
Default setting : 1.5kW  
Related parameters : Motor information/Motor nominal current  
Motor information/Motor nominal current (N2)  
Description :

This is the reference data at rated voltage and frequency. The value is given on the motor rating plate and does not affect operation of the M10x.

### Motor nominal current (N1)

Function : Motor information  
Range : 0.08(0.01)63.0A or 0.5-1.0 Iprim or 0.1-1.0 Iprim  
Default setting : 4A  
Related parameters : Motor information/Motor power rating  
Motor control/External CT parameters  
Description :

This is the rated current  $I_n$  of the motor, at rated load, at rated voltage and frequency. The value is given on the motor rating plate. The rated current can be set within this range.

N1 setting is related to “External CT primary” and “External CT secondary” settings under “Motor control.”

Setting range without selecting external CT option is from 0.08-63A. If external CT is selected, the range is dependent on the primary and secondary of external CT, ie, If “External CT secondary” is set to 1, the range varies from 0.5 to 1.0 of CT nominal primary current. If “External CT secondary” is set to 5, the range varies from 0.1 to 1.0 of CT nominal primary current.

Example: In the case of an external current transformer primary of 100A, the range varies from 50 to 100A when external CT secondary is selected as 1. The range can also be from 10-100A if secondary of 5A is selected.

#### Motor nominal current (N2)

Function : Motor information  
Range : 0.08(0.01)63.0A or 0.5-1.0 I<sub>prim</sub> or 0.1-1.0 I<sub>prim</sub>  
Default setting : 4A  
Related parameters : Motor information/Motor power rating  
Motor control/Internal CT primary, external CT parameters  
Description :

This is the rated current I<sub>n</sub> of the motor, at rated load, at rated voltage and frequency. The value is given on the motor rating plate. The rated current can be set within this range.

N2 setting is related to “External CT primary” and “External CT secondary” settings under “Motor control.” This setting is available for two-speed motors where the second set of CT is required.

The setting range and reading is the same as for N1.



Applicable to both N1&N2 In cases of small current measurement (<0.5A) it is highly recommended to increase the primary wiring turns through internal CT in order to avoid nuisance current measurement. Refer to relevant parameter 'Internal CT primary winding'.

# Motor control

Motor control function consists of parameters which reflect the configuration of the motor feeder. For example, the ratings for external current transformers and contactor feedback supervision are included.

Parameters involved with the starter configuration function are:

- Starter ID
- Starter type
- Startup time
- Startup time (N2) (M102 Only)
- Changeover time (M102 Only)
- Ramp up time (M102 Only)
- Ramp down time (M102 Only)
- Earth fault primary
- Internal CT primary
- Communication failure delay
- Failsafe mode
- Feedback
- Feedback timeout
- Soft test switch
- External CT used
- External CT1 primary
- External CT2 primary (M102 Only)
- External CT secondary

## Starter ID (M10x-M Only)

Function	: Motor information
Range	: space ! # \$ % & ' ( ) + , - . 0... 9 ; = @ A...Z [ ] ^ _ ' a...z { } ~
Default setting	: A1
Related parameters	: --
Description	:

The user can name each motor starter to simplify addressing and handling. A maximum of 20 characters (ASCII) can be assigned.

### Starter type

Function	: Motor control
Range	: M101: NR-DOL, NR-DOL/RCU, REV-DOL, REV-DOL/RCU, Feeder, Contactor feeder, Contactor feeder/RCU M102: NR-DOL, NR-DOL/RCU, REV-DOL, REV-DOL/RCU, Actuator, NR-S/D, NR-2N, NR_2N Dahlander, Autotransformer, NR_softstarter, REV_softstarter, Feeder, Contactor feeder, Contactor feeder/RCU
Default setting	: NR-DOL
Related parameters	: Motor control/Failsafe mode Motor control/N2 parameters (NR-2N, NR_2N Dahlander) Motor control/S/D parameters (NR-S/D) Motor control/Autotransformer parameters Motor control/Ramp up/downtime
Description	:

M10x supports different kinds of motor connections. This parameter needs to be set according to the type of motor control desired.

More details of M10x starter types are described in the M10x user guide.

**NR-DOL:** Non reversing direct on line.

NR - Non reversing means the motor runs in only one direction.

When M10x accepts start command, internal relay CCA is closed and remains closed until stop command is accepted or protection function is active. Internal relay CCB and CCC has no functions in this application.

Internal relay CCB and CCC has no functions in this application.

**NR-DOL/RCU:** Non reversing direct on line RCU starter

RCU stands for, remote control unit. This is a starter type where contactors can be directly hardwired controlled by a control device located near the motor in parallel with M10x control. In other word, this starter allows motor control by remote control device even if M10x is not in operation.

When M10x accepts "Start CW" command, internal relay CCA is closed and remains for one second only. When "Stop" command is accepted or protection is active, CCC relay is closed to cut the contactor coil circuit and remains for one second only.

The wiring of the self-auxiliary contact across the start command latches the contactor.

#### **REV-DOL:** Reversing direct on line

REV- Reversing starter supports the motor running in both directions (clockwise CW, counter clockwise CCW).

When M10x accepts start 1 command, internal relay CCA is closed to start motor running in one direction and remains closed until stop command is accepted or protection function is active. Same operation is followed the opposite direction after accepting start 2 command. Possible changing direction sequence is as follows:

Start 1- Stop-Start2

Start 2- Stop-Start1

#### **REV-DOL/RCU:** Reversing direct on line RCU starter

In addition to NR-DOL/RCU, this starter supports the motor running in both directions.

**Actuator (M102 only):** Actuator starter is for controlling valves, dampers and actuators by using limit switches.

The limit switch stops the motor when activated, after the motor is running in one direction. The activated limit switch message is then read in M10x and only Start 2 command for reserve direction is allowed.

In case of an actuator starter with torque sensor, the torque switch associated with the sensor is used to stop the motor. The limit switch limits starting to the respective direction and indicates the respective stop position.

One of the digital inputs can be used as input for the torque sensor. If the torque activates before the limit switch, the motor is tripped with a message: DI trip.

**NR-S/D (M102 only ):** Reduced voltage starts in star and runs the motor in delta after transition conditions are met.

Star-delta starters are used mainly to restrict the starting current of a motor due to supply limitations. The motor is started with the winding connected in star and transferred to delta after the changeover time. Starting at a lower voltage also reduces shocks on the motor coupling, belts and gear mechanisms. Starting current and the torque are reduced to 1/3 of the DOL value. However, it must be determined whether the reduced motor torque is sufficient to accelerate the load over the whole speed range.



The changeover is based on “time,” the star-to-delta transition takes place after the parameterized changeover time.

The star-to-delta switchover is done with a maximum transition time to ensure quenching of the arc in star operation before it changes over to delta to prevent short-circuit.

During the contactor transitions, the M102 waits until the previous sequence is successfully completed. In case of any contactor failure, the feedback supervision trip will open all the contactors.

#### **NR-2N (M102 only):** Non-reversible two-speed motor separate winding

Two-speed drives are used for applications requiring dual motor outputs. NR-2N is the starter designed for two separate winding motors. Please refer to the user guide for more details on function description.

Current measurement for NR-2N utilizes two sets of external CTs, measuring current from main supply. External CTs can be selected separately for both motor windings.

#### **NR-2N Dahlander (M102 only):** Non-reversible two-speed motor Dahlander connection

Two-speed drives are used for applications requiring dual motor outputs. NR-2N Dahlander is the starter type designed for motors with Dahlander connection.

Please refer to the User Guide for more details on function description.

#### **Autotransformer (M102 only):** Non-reversible motor starter based on reduced voltage via auto-transformer

Autotransformer starter supports motor starting with reduced voltage, providing reduced motor startup current. As a result, the starting torque is reduced accordingly.

**NR\_softstarter (M102 only):** Non-reversible softstarter control

Softstarter applications are for controlling motor accessory softstarter devices. M10x 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. Please refer to the User Guide for more details on function description.

**Rev\_softstarter (M102 only):** Reversible softstarter control

Functionality of this starter type is according to NR-softstarter with support for reversing motor direction. Please refer to the User Guide for more details on function description.

**Feeder:** The feeder application is regarded as a specific starter type in M10x. For feeder mode, the dedicated motor protections are either auto-inhibited or prohibited via parameter setting. The circuit breaker trip signal is detected by M10x via specified inputs before an alarm sounded. All measurement and control functions are activated for this application.



Note: The internal relays CCA and CCB are electrically interlocked for all starter types.

**Contactor feeder:** Feeder control by contactor

When a start command is given, the internal relay CCA remains closed until a stop command is given. The internal relay CCB and CCC has no function here.

**Contactor feeder/RCU:** Feeder control by contactor on line (remote control of the contactor, bypassing the M10x).

The start CW command closes the internal relay CCA for 1sec respectively. The stop command will close relay CCC for 1 sec. The wiring of the self-auxiliary contact across the start command latches the contactor.

Removing the M10x from the starter will not prevent RCU operation depending however which the connection (external relay and/or switch) is used for start and stop). The stop pulse issued by the M10x will override the RCU-switch start position.

### Startup time

Function : Motor control  
Range : 1 (1) 250 s  
Default setting : 5s  
Related parameters : Motor control/Starter type (all)  
Motor control/Changeover time  
TOL protection/TOL alarm  
Stall protection/Function enable, disable  
Phase failure protection/Function enable, disable  
Unbalance protection/Function enable, disable  
Earth fault protection/Function enable, disable  
Underload protection/Function enable, disable  
Noload protection/Function enable, disable

Description :

Motor startup time parameter is used to define the maximum startup time for the motor. It is the time that is required for the motor to complete its starting sequence. The starting sequence is said to be complete when the startup current reaches 1.25 times the nominal current.

This parameter defines the length of time for the startup phase of the motor during which most of the protection functions and alarm messages are deliberately suppressed.

Protection type	Suppressed during motor startup	Selectable during motor startup
TOL protection		✓
Stall protection	✓	
Long start protection		✓
Phase failure protection	✓	
Unbalance protection	✓	
Underload protection	✓	
Noload protection	✓	
Earth fault protection		✓
PTC protection		✓
Undervoltage protection		✓
Start limitation		✓
Phase sequence		✓

#### Startup time (N2) (M102 Only)

Function : Motor control  
Range : 1 (1) 250 sec  
Default setting : 5sec  
Related parameters : Motor control/Motor startup time (N1)  
Motor control/Starter type (NR-2N, NR-2N Dahlander)  
Description :  
This parameter has the same definition as the previous parameter, "Motor startup time," except it is dedicated for speed N2.

#### Changeover Time (M102 Only)

Function : Motor control  
Range : 1 (1) 250 sec  
Default setting : 5sec  
Related parameters : Motor control/Starter type (NR-SD, NR-2N, NR-2N Dahlander, Autotransformer)  
Underload protection/Enabled, disabled  
Noload protection/Enabled, disabled  
Description :  
This parameter is applied to both NR-SD starter, Autotransformer starter, NR-2N starter and NR-2N Dahlander starter. In the case of autotransformer starter, the parameter defines the time that the motor is running with reduced voltage. The motor changes to line voltage connection when the defined time has elapsed. For SD starter, the start-to-delta transition is executed after the defined time. For NR-2N starter and NR-2N Dahlander starter, speed 2 will transfer to speed 1 after the defined time has elapsed.

#### Ramp up time (M102 Only)

Function : Motor control  
Range : 1 (1) 250 sec  
Default setting : 10sec  
Related parameters : Motor control/Starter type (NR-softstarter, REV-softstarter)  
Phase failure protection  
Unbalance protection  
Underload protection  
Noload protection

Description :

Softstarter is a separate unit to motors smoothly by limiting inrush current. The ramp up time is the parameter of the softstarter set to start up the motor. During this delay, the following protection functions are deactivated:

- Stall, Phase failure, Unbalance, Underload, Noload, Undervoltage.

M102 controls the motor by giving start/stop commands to the softstarter. The motor protection is done by the softstarter during startup.



The accuracy of the current measurement in M10x may be compromised if no prevention measures are taken to reduce the harmonics caused by the soft starters!

#### Ramp downtime (M102 Only)

Function : Motor control  
Range : 1 (1) 250 sec  
Default setting : 10sec  
Related parameters : Motor control/Starter type (NR-DOL, REV-DOL)  
Phase failure protection  
Unbalance protection  
Underload protection  
Noload protection

Description :

Softstarter unit has a parameter which is used to select the stop ramp time of the motor. M102 is adapted to this stop time by setting the ramp downtime not less than the selected stop ramp time of the motor.

#### Earth fault primary

Function : Motor control  
Range : 1A or 5A  
Default setting : 1A  
Related parameters : Earth fault protection/Function  
Earth fault protection/Alarm level  
Earth fault protection/Trip level

Description :

The parameter defines the maximum primary current of the RCT. If 1A RCT is selected, the setting range of earth fault protection is 100mA~3A; If 5A is selected, the range is 500mA ~15A.

### Internal CT primary winding

Function	: Motor control
Range	: 1-5T
Default setting	: 1T
Related parameters	: Motor information/Nominal current Motor information/Nominal current (N2)

Description :

The parameter defines the windings of internal CT primary.



When the nominal current is less than 0.5A ( $0.08 < I_n < 0.5$ ), it is highly recommended to increase the primary winding to 2~5 turns and set this parameter as '2' or '5' accordingly. Refer to relevant parameters 'motor nominal current N1' and 'motor nominal current N2'

### Communication failure delay

Function	: Motor control
Range	: 1(1)25sec or 255sec
Default setting	: 255sec
Related parameters	: Motor control/Failsafe mode
Description	:

This parameter is to defines the maximum permitted period after M10x detects a communication interruption. After the permitted time delay elapses, M10x considers loss of communication and activates failsafe function. Meanwhile the message of communication failure will be sent and shown on operator panel MDx.

If the the value is set at 255 sec, the communication failure function will not respond.

### Failsafe mode

Function	: Motor control
Range	: NOP/Start1(CW)/Start2(CCW)/Trip
Default setting	: NOP
Related parameters	: Communication/Communication failure delay
Description	:

If a loss of communications is detected, the failsafe function is activated. M10x will then operate under failsafe mode, ie:

- No operation
- Start motor direction 1
- Start motor direction 2
- Trip out motor

When the failsafe function is activated, M10x control access authority is assigned to the local and MDx operator panel until communication is restored, regardless of which control access group had authority prior to communication loss.

### Feedback

Function : Motor control  
Range : Enabled/Disabled  
Default setting : Enabled  
Related parameters : Motor control/Starter type  
Motor control/Feedback timeout

Description :

M10x provides feedback supervision that monitors the status of motor and contactor after control command is given by M10x. Status is checked by using feedback signals (C\_Fa, C\_Fb, C\_Fc) wired from contactor auxiliary contacts or by current measurement.

Feedback function is fixed to enabled under most of the starter types where status of motor and contactor are checked through contactor auxiliary contacts. However, under starters NR-DOL and Contactor feeder, this function can also be set to disabled and status of contactor is checked through current measurement when feedback is set to disabled.

### Soft test switch

Function : Motor control  
Range : Disabled, enabled  
Default setting : Disabled  
Related parameters : Digital input/Function/Test switch  
Description :

“Soft test switch” parameter determines if M10x is under ‘test’ mode. Alternatively the “test” mode can be enabled through the digital input ‘test switch’ (hardwiring). When ‘test’ mode is enabled, it is allowed to stimulate all control functions but ignores current based protection functions if zero current is measured. If current ( $>5\% I_e$ ) is detected under ‘test’ mode, the protection functions are switched back on automatically.

### External CT used

Function : Motor control  
Range : Disabled, enabled  
Default setting : Disabled  
Related parameters : Motor control/Nominal current  
Motor control/Nominal current (N2)  
Motor control/External CT1 primary  
Motor control/External CT2 primary  
Motor control/External CT secondary

Description :

When motor rating exceeds 63A, external intermediate CT is used. In case of NR-2N, external CTs may be selected for both windings and the secondary output rating of both external CTs remains the same.

#### External CT1 primary

Function : Motor information  
Range : 1(1) 6300 A  
Default setting : 100A  
Related parameters : Motor control/Nominal current  
Motor control/External CT used

Description :

This parameter can only be set when external CT installed is enabled.

Secondary output of external CT shall match with internal CT primary. For example, if external CT primary is selected as 2.5-5A, only CTs with 5A secondary are used for external CTs.

#### External CT2 primary

Function : Motor information  
Range : 1(1) 6300 A  
Default setting : 100A  
Related parameters : Motor control/Nominal current(N2)  
Motor control/Starter type  
Motor control/External CT used  
Motor control/Internal CT primary  
Motor control/External CT secondary

Description :

This parameter is designed for the second sets of CTs under NR-2N starter.

#### Example

NR-DOL Motor rating 45kW, 86A, External CT 100/5, the settings are as follows:

Motor control/Nominal current	86A
Motor control/Nominal current(N2)	Not active
Motor control/External CT used	Enabled
Motor control/Internal CT primary	0.24~63A
Motor control/External CT1 primary	100A
Motor control/External CT2 primary	Not active
Motor control/External CT secondary	5A



#### External CT secondary

Function : Motor information

Range : 1, 5

Default setting : 1

Related parameters : Motor control/Nominal current  
Motor control/Nominal current(N2)  
Motor control/Starter type  
Motor control/External CT used  
Motor control/Internal CT primary  
Motor control/External CT secondary

Description :

This parameter is designed for the secondary of external CT.

## Modbus communication

The communication function provided by M10x-M is based on Modbus RTU. The fieldbus interface is RS485. There are two identical RS485 interfaces, for redundant design. Parameterization, remote control, data acquisition and transmission etc., are implemented via the communication function.

For more information on M10x-M communication, please refer to M10x User Guide and Modbus Protocol Implementation for M10x-M.

The parameters involved with the protection function are:

Device address

Parity check

Redundancy

Modbus baud rate

## Device address

Function : COMMS

Range : 1-127

Default setting : 1

Related parameters : -

Description :

Each M10x-M on the same serial communication network must have a unique address in the range of 1 to 127. Computer software driving the serial network must be configured to recognize each separate address.

## M10x parity check

Function : COMMS

Range : Odd/Even/None

Default setting : None

Related parameters : -

Description :

This parameter determines what type of parity checking is used when communicating with the M10x-M.

### Redundancy

Function : COMMS  
Range : Enabled/disabled  
Default setting : Disabled  
Related parameters : -  
Description :

There are two identical RS485 interfaces of Modbus RTU protocol in M10x-M for redundant design. When redundant communication is required, this parameter must be set as enabled to activate the standby communication port.

### Modbus baud rate

Function : COMMS  
Range : 1200/2400/4800/9600/19200/38400/57600 bps  
Default setting : 9600 bps  
Related parameters : -  
Description :

This parameter is to define the data transmission rate between M10x-M and an upper control system (such as DCS) or a workstation.

### PROFIBUS DP communication

Relevant parameters to set up PROFIBUS DP communication interface are as follows:

Device address  
Operating mode  
Block DP

#### Device address

Function : COMMS  
Range : 0-126  
Default setting : 126  
Related parameters : -  
Description :

Each M10x-P on the same serial communication network must have a unique address in the range of 0 to 126. Computer software driving the serial network must be configured to recognize each separate address.

#### Operating mode

Function : COMMS  
Range : DPV1  
Default setting : DPV1  
Related parameters : -  
Description :

For PROFIBUS DPV1, it allows cyclic and acyclic data exchange between master and slave station.

#### Block DP

Function : COMMS  
Range : Enabled/disabled  
Default setting : Enabled  
Related parameters : -  
Description :

The block DP function determines whether M10x will update the parameters when receiving the initialization command from the upward system. If it is disabled, the parameters in M10x will be overwritten by the data transmitted from master station during startup of the DP master. If the selection is enabled, the updating command from master DP during startup will be ignored. Parameter setting will be allowed through MCUSetup software only.

# Control authority

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

For detailed descriptions on control access in M10x, please refer to 1TNC 911112 D0205 M10x User Guide.

## PROFIBUS Option (Only in M10x-P)

Function	: Control Authority
Range	: PROFIBUS Auto Mode Active Enabled/ PROFIBUS Auto Mode Active Disabled
Default Setting	: PROFIBUS Auto Mode Active Disabled
Related Parameters	: Digital Inputs/Loc/R/Control Authority/Soft Local/ Remote Control Authority/MD Control
Description	:
When PROFIBUS auto mode active is enabled, M10x accepts the command from fieldbus to select the control access.	

## Soft Local/Remote

Function	: Control Authority
Range	: Local Hardwiring / Remote Fieldbus
Default Setting	: --
Related Parameters	: Digital inputs/Loc/R /Control authority/PROFIBUS option
Description	:
When Local hardwiring is enabled, M10x accepts its commands from the hardwired inputs.	
When Remote Fieldbus is enabled, M10x accepts its commands from the hardwired inputs.	

## MD Control

Function	: Control authority
Range	: MD (Operation panel)/MD enable in Local/ MD enabled in Remote/ MD enabled when Auto Mode set "0"/MD enabled when Auto Mode set "1"
Default Setting	: --
Related Parameters	: Digital inputs/Loc/R/MD control Control authority/PROFIBUS option

When MD (Operator panel) is enabled, M10x accepts the command from operator panel MD Control authority M10x Parameter Description.

# Motor grouping

In the case of conventional switchgear, the operator can start or stop a process by sequentially starting or stopping of the motors. The required delay between the motors is introduced either manually or with the help of a timer and serial interlocks. This increases the operators' time, cabling and the initial cost of the starter.

With the help of an intelligent system, the operator can start or stop the process with a single group command. The start and stop delay can be set for individual motors. The serial communication with logical connections between devices reduces the cabling, process interlocks and the hardware. In case of an abnormality in any motor of the group, a group tripping would follow.

In this context, a motor group means a collection of motors, which are operated by an individual group start or stop command. The successful start of the motor group is indicated.



Individual start/stop command from fieldbus can also be given to the devices located in the group as well as via the switches connected to the device I/O in the local mode.

Motor grouping function is only available for PROFIBUS-DPV1.

The parameters under motor grouping function are as below:

Function enable/disable  
Group start direction  
Group ID  
Group number  
Group start delay  
Group stop delay

## Function enable/disable

Function : Motor grouping  
Range : Enabled/disabled  
Default setting : Disabled  
Related parameters : Motor grouping/parameters  
Description :

Motor grouping function can be disabled with the help of this parameter. When disabled, motor group function does not have any functionality in the M10x and all other parameters of the function (group ID, group number, group start direction, group start/stop delay) are inactivated in the MCUSetup software.

#### Group start direction

Function : Motor grouping  
Range : Start1/Start2  
Default setting : Start1  
Related parameters : Motor grouping/parameters  
Motor control/Starter type

Description :

This parameter defines the direction of rotation of the motor when started by a group command. The rotating direction of the motor depends on the starter type parameter value.

#### Group ID (M10x-M only)

Function : Motor grouping  
Range : 16 characters  
Default setting : GROUP1  
Related parameters : Motor grouping/Group number  
Description :

Group name is the name of the group to which the motors (M10x) belong. This name is used only for identity and has no impact on motor operation.

#### Group number

Function : Motor grouping  
Range : 1 (1) 9  
Default setting : 1  
Related parameters : Motor grouping/Group identifier  
Description :

Each motor group is assigned with unique number.

#### Group start Delay

Function : Motor grouping  
Range : 0 (1) 300 sec  
Default setting : 0sec  
Related parameters : Motor grouping/Group start direction  
Motor control/Startup time  
Motor grouping/Group number

Description :

This is the delay for motor start after receipt of the group start command.

#### Group stop delay

Function : Motor grouping  
Range : 0 (1) 300 sec  
Default setting : 0sec  
Related parameters : -  
Description :

This is the delay for motor start after receipt of the group start command.

# Digital inputs

The M10x has either 13 sets of 24VDC programmable digital inputs or 9 sets of 110VAC/240VAC programmable digital inputs for motor control and supervision. Each input can be configured with various functions according to the predefined list. These functions (Limit1, Limit2, PLC control1, PLC control2, F\_CA, F\_CB, F\_CC, Loc/R, Main switch status, External trip) can only be assigned for one time at the same parameterization file. For each input, specific characteristic, such as Contact type, Delay etc., can be defined to different purposes.

The parameters under digital inputs are as below:

- Function
- Contact type
- Operation delay
- Operation

### Function

Function : Digital input  
Range : NOP, Start1, Start2, Stop (edge trigger), Stop (level trigger), Limit1, Limit2, Process interlock1, Process interlock2, Test switch, Emergency stop, PLC control1, PLC control2, Trip reset, Torque switch, F\_CA, F\_CB, F\_CC, Loc/R, Main switch status, External trip, MD control, TOL Bypass.  
Default setting :

The power supply of DI is 24VDC:

M10x	
Digital inputs	Default function
DI0	NOP
DI1	NOP
DI2	START1
DI3	START2
DI4	STOP
DI5	NOP
DI6	F_CA
DI7	NOP
DI8	NOP
DI9	NOP
DI10	NOP
DI11	NOP
DI12	NOP



The power supply of DI is 110V or 240VAC:

M10x	
Digital inputs	Default function
DI0	NOP
DI1	NOP
DI2	START1
DI3	START2
DI4	STOP
DI5	NOP
DI6	F_CA
DI7	NOP
DI8	NOP
DI9	NOP

Related parameters : Control authority/Control mode

Description :

Each digital input can be assigned to a specific function according to different purposes.

The description of individual digital input function is available in '1TNC911112 M10x User Guide', digital inputs section.

### Contact type

Function : Digital input  
Range : NO/NC  
Default setting : NO  
Related parameters : Digital input/Function  
Description :

This parameter is used to define the normal state of the input, normally open or normally closed.

Digital inputs have many functions for selection, and different functions have different characters as shown in the table below.

Trigger mode	Contact type	Function	Description
Edge triggering	NO, NC	Start1	If the input status is different the 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	
		External trip	
		Test switch	
		Stop*	
		TOL Bypass	
		NOP	Detects the input status only

\* Stop input can be edge trigger type or level trigger type



1. When motor starter type is Actuator, one of the digital inputs may be defined as torque switch input if needed. For wiring details, please refer to the User Guide.

2. When one of the digital inputs is defined as process interlock1, the input is regarded as unhealthy if the high/low is detected as the same type as the preset contact. For example, if the contact typed is set as NO type, a low input is regarded as unhealthy. With operation delay set to zero, motor start is prohibited when this unhealthy contact is detected.

3. When one of the digital inputs is defined as emergency stop, torque switch or external trip, the input is considered unhealthy if the high/low is different from the setting contact type. For example, if the contact type set is NO, a high input is considered unhealthy.

### Operation delay

Function : Digital input  
Range : 0-3600s  
Default setting : 0s  
Related parameters : Digital input/Function/start1, start2, stop, process interlock1, process interlock2

Description :

For Start1, Start2, this parameter sets the amount of time that CCA,CCB,CCC can remain open during a motor start. For Stop, this parameter sets the amount of time that CCA,CCB,CCC can remain closed during of a motor stop.

Process interlock1 sets the amount of time that the process interlock switch can remain open on the occurrence of a motor start. If the switch remains unhealthy for longer than this time, a trip/stop will occur. If this parameter is set to 0, the process interlock switch must be healthy in order for M10x to allow the motor to start.

Process interlock2, sets the amount of time that the process interlock switch can be unhealthy during normal operation. If the switch remains unhealthy for longer than this time, a trip/stop will occur.

### Operation

Function : Digital input  
Range : Stop/trip only/ alarm only/ trip and alarm  
Default setting : Stop  
Related parameters : Function/process interlock1, process interlock2, Emergency stop

Description :

This parameter determines whether DI feature is a trip (reset required in order to restart the motor) or a stop (no reset required) or an alarm (whenever the process interlock switch is unhealthy).

# Digital outputs

The M101 range of products is equipped with one set of programmable digital outputs while two sets are equipped in the M102 range of products. The parameters under programmable outputs are:

- Function
- Start/Stop delay
- Operation principle

### Function

Function : Digital outputs  
Range : Energize on start delay, De-energize on stop delay, DIx status\*, Trips, Specific Trip function (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), Alarms, Specific alarm function ( TOL, Earth fault alarm,overload 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), Watchdog, Communication Failure, RCU mode, Local\_remote output, Contactor welded, Ready to start.

Default setting : Fieldbus control  
Related parameters : Digital outputs/Start/Stop delay  
Description :

The description of individual function is available in document 1TNC911112 M10x User Guide, Digital Outputs section.

\* DIx status: in case of 24VDC M10x, DIx=DI9, DI10 &DI11; In case of M10x AC type, DIx=DI0,DI1 &DI2.

### Start/stop delay

Function : Digital outputs  
Range : 0 (0) 125sec  
Related parameters : Digital outputs/Function/Energize on motor start delay  
Digital outputs/Function/De-energize on motor stop delay

Description :

Only use for the function Energize on motor start delay and the function De-energize on motor stop delay.

### Trip delay

Function : Digital outputs  
Range : 0.1 (0.1) 12.5sec  
Related parameters : Digital outputs/Earth fault trip  
Description :

Only use for the function earth fault trip. If the parameter is set, digital output relay trip contactor after the setting delay time.

### Operation principle

Function : Programmable output  
Range : Open circuit, Close circuit  
Default setting : Open circuit (watchdog output)  
Close circuit (Trips, Specific trip, Alarms, Specific alarm, TOL, Communication Failure, Contactor welded)  
Related parameters : Programmable output/Function/(Trips, Specific trip, Alarms, Specific alarm, TOL, Communication Failure, Contactor welded)

Description :

This parameter is to set the operation principle of digital output.

If open circuit is selected, digital output relay will remain de-energized if the selected function does not occur; and digital relay will remain energized if selected function occurs.

If close circuit is selected, digital output relay will remain energized if the selected function does not occur; and digital relay will remain de-energized if selected function occurs.

# Thermal overload protection (TOL)

M10x protects the motor by calculating the thermal image of the motor during both run and stop. This image is used to allow optimal performance of the motor with calculated time to trip.

The thermal image is calculated based on the highest of the three measured phase currents and depends on the parameterized data such as trip class ( $t_6$ ), motor ambient temperature ( $T_{AMB}$ ), cool down time factor ( $M_{t6}$ ).

Motor ambient temperature is taken into account for thermal image calculation by means of a device internal parameter TFLC, where TFLC is the highest of the measured three phase currents related to motor ambient temperature.

When the thermal capacity level reaches the setting of trip level (eg, 100%), the thermal overload trip will occur. The TOL trip can be reset after the thermal image goes below the motor reset level. The motor can be restarted only after TOL trip is reset.

When the motor is being stopped, the thermal image calculation continues by using the background heat level and cooling down time factor until thermal capacity level decreases to zero. The thermal capacity decreases at a constant rate until it reaches the background heat level, after which it depends on the parameter's trip class and cool down time factor, thus simulating cooling down of the stator winding and the iron body of the motor.

During power failure, the thermal capacity level of the motor is stored in the memory and the cooling down calculation starts from this level after resumption of power.

TOL Protection conforms to IEC 947-4-1, ie, with a motor current  $1.05 \times \text{TFLC}$  running for 2 hrs will not cause TOL-trip and subsequent rise in current to  $1.2 \times \text{TFLC}$  will cause trip within 2 hrs.

In case of an unbalance situation, the fictitious negative sequence current in remaining phases is taken into TOL calculation to trip early.

Parameters involved in TOL protection are:

- Function disabled, enabled
- Thermal model
- Trip class t6 (standard model)
- Trip class te Time (EEx e model)
- Ia/In ratio (EEx e model)
- TOL alarm level
- Trip reset mode
- TOL bypass command (standard model)
- Cool coefficient
- Ambient temperature

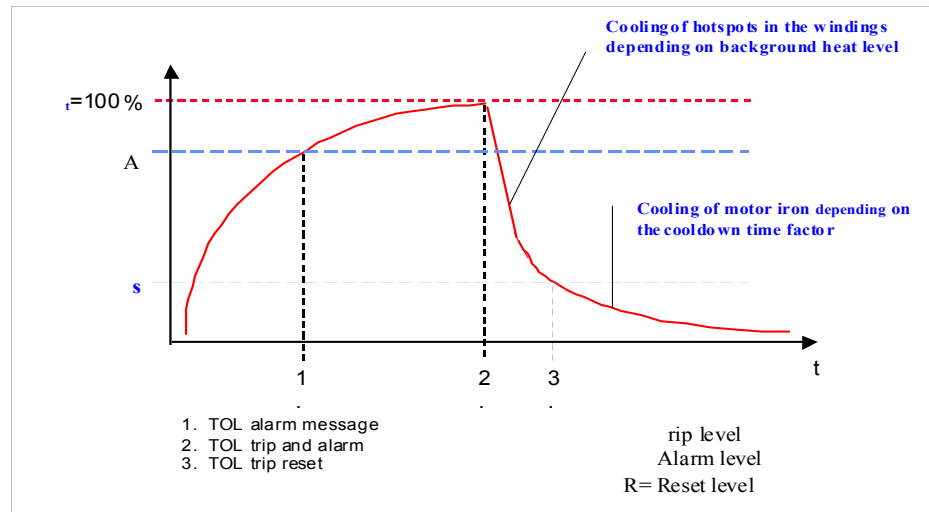


Fig. 1. Illustration of motor thermal simulation behavior

#### Function enable/disable

Function : TOL protection  
 Range : Enabled/Disabled/Disabled during motor startup  
 Default setting : Enabled  
 Related parameters : TOL protection/Parameters  
                             Motor control/Motor startup time  
                             Motor control/Motor startup time N2

Description :

TOL protection function is recommended to be switched on all through motor starting, running stop period.

If set as enabled, function is carried through motor starting, running and stopped stage.

If set as disabled, function is switched off through all motor operating stages. All relevant parameters of the TOL function (trip reset mode, thermal model, TOL bypass, trip level, trip delay, T6, Te, cool coefficient, Ia/In and temperature) do not have any functionality in the motor control unit.

If set as disabled during motor startup, this function is disabled only through motor starting stage.

#### Disabled during motor startup

Function : TOL protection is inactivated during motor startup time  
 Range : Enabled/disabled  
 Default setting : Disabled  
 Related parameters : TOL protection  
 Description :  
 TOL protection function can be enabled or disabled during motor startup time via this parameter.

#### Thermal mode

Function : TOL protection  
 Range : Standard/EEEx e  
 Default setting : Standard  
 Related parameters : TOL protection/Parameters  
                                   PTC protection/Trip level/Reset level  
                                   TOL protection/Motor ambient temperature  
 Description :  
 The thermal model can be selected as either standard or EEx e. The standard model makes use of trip class, startup I ratio and motor startup time in TOL calculation. Parameter trip class definition defines the trip time for 6x motor nominal current (In) and it must be less than defined cold state maximum value for the motor.

The protection of explosion-proof three-phase induction motors with type of protection 'increased safety' EEx e is done with two special parameters, the stall/nominal current ratio (Ia/In ratio) and te time. The tripping time of the TOL protection from the cold state motor must be less than the te time rated for the motor.

For EEx e thermal model a set of parameters have fixed values or are not available in order to simplify parametering instructions and parametering process while providing a secured protection functionality. This should be carefully considered by the user since the given parameter values do not affect functionality in this case.

The following parameters are not available when EEx e mode is selected:

TOL Protection/Motor ambient temperature : Fixed 40°C  
 TOL Protection/TOL bypass command : Disabled



### Trip class (T6)

Function	: TOL protection
Range	: 3 (1) 40 sec
Default setting	: 6sec
Related parameters	: TOL protection/Thermal model (standard) Motor information/Nominal current (In) Motor information/Motor ambient temperature

Description :

Parameter trip class (t6) is the basic setting of the thermal protection function. This allows the user to set the thermal model characteristic according to motor startup requirements and characteristics. The trip class parameter allows the user to define the time that protection permits current of  $6 \times I_n$  from cold condition for motor protection.

Motor startup is the most common reason for short overload situations. Normally, two starts from cold condition and one start from a hot condition are permitted. The Trip class (t6) value can be set for one cold start, which allows easy setting of protection.



The trip class (t6) time for protection is defined based on the motor maximum start time, provided by the manufacturer.

Initial information required for trip class (t6) definition:

- Motor startup current ratio (rated motor data,  $I_s/I_n$ ), see parameter Startup I ratio
- Maximum start time permitted for cold motor
- Maximum start time permitted for warm motor
- Motor ambient temperature, see parameter Motor ambient temperature.

Example 1. A thermal protection is set for a motor M2BA315SMC, 110 kW.

- |   |        |
|---|--------|
| ▪ Motor startup current ratio ( $I_s/I_n$ ) | 7,5    |
| ▪ Maximum start time for cold motor         | 30 sec |
| ▪ Maximum start time for warm motor         | 15 sec |
| ▪ Motor ambient temperature                 | 40°C   |

With the initial information, the protection characteristic can be defined by the following procedure: First, the motor start current is calculated according to the ambient temperature. Practically, with 40°C about ambient temperature, the following calculation for start current can be passed. For more information about ambient temperature coefficient, see table of maximum permitted current in the chapter Ambient temperature.

Temperature coefficient is derived with the following routine: Since the motor ambient temperature in the example is 40°C, the TFLC is  $1.00 \times I_n$ .

Motor startup current ratio is 7.5, thus motor rated start current (Is) is:

$$I_s = I_n / I_n \times I_n$$

The effect of ambient temperature is derived when Is and TFLC are known:

$$I_s / TFLC = 7.5 \times I_n / 1.00 \times I_n = 7.5$$

The calculated start current ratio (7.5) and motor maximum start time (30 sec) are placed on the cold condition time/current characteristic diagram. Start current ratio is located on the horizontal axis, while the maximum permitted time for cold motor start is set on the vertical axis. The cross point of these constraints shows the maximum setting for trip class (t6).

The received setting is the absolute maximum value without further considerations and a lower value can be selected. A longer start is not protected by thermal protection and additional protection against stalled rotor is necessary. In case of thermal protection trip at start, with the setting of maximum Trip class (t6) value, checking the motor size for extreme start requirement is recommended.

The 40 sec setting is limited by the range of parameter. Value for trip class (t6) is derived from the cold condition time/current diagram, (see Fig. 2). This setting allows start time up to approx. 26 sec for cold motor, before a thermal protection trip occurs. The start time for a warm motor with this parameter setting can be read from the hot condition time/current diagram accordingly. The check routine is shown in Fig. 3.

The warm condition start must be within motor ratings. In this case, the start time for a warm motor is approximated from the latter diagram and must be shorter than 12 sec, as read from the diagram. In practice, starts lasting longer than 12 sec will lead to trip from the thermal protection.

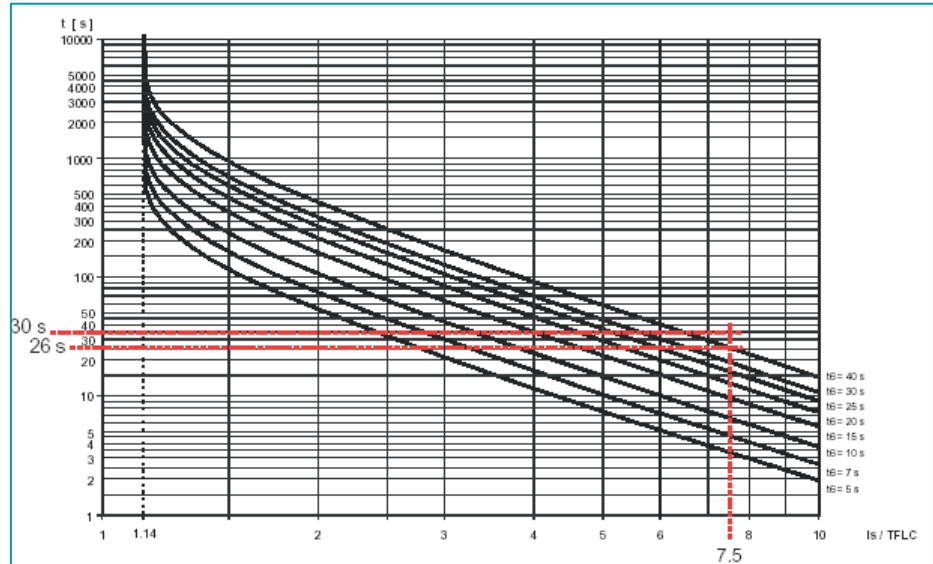


Fig. 2. Trip class ( $t_6$ ) definition from cold condition time/current diagram.  
Diagram presented in 40°C motor ambient temperature

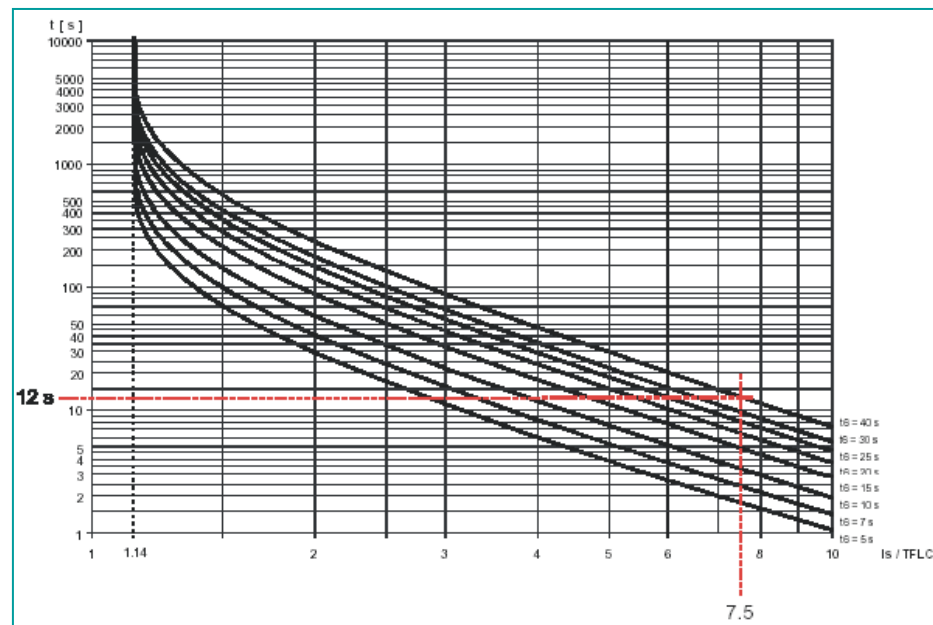


Fig. 3. Start time vs. trip class ( $t_6$ ) definition from hot condition time/current diagram.  
Diagram presented in 40°C motor ambient temperature

A more optimized setting of the thermal protection is needed in case one start for warm motor is required. In this case, the trip class (t6) parameter is derived from the warm condition time/current diagram according to actual duration of motor start and motor startup current.

The derived trip class (t6) value is verified from the cold condition time/current diagram to ensure that thermal protection trip time is less than maximum allowed start time for a cold motor, ie, the protection is well defined.

Separate protection is needed for unsuccessful start, ie, stalled rotor, if the thermal protection characteristic allows longer start before trip than is allowed for the motor. In this case, stall protection is utilized for a cold motor start supervision. By defining the operation of Startup time and stall protection trip delay, the trip must be set before motor maximum start time is exceeded, in case of unsuccessful start.

#### Trip class (Te)

Function	: TOL protection
Range	: 5 (5) 40 sec
Default setting	: 5sec
Related parameters	: TOL protection/Thermal model (EEx e) TOL protection/Ia/In ratio Motor information/Motor ambient temperature

Description :

The safe locked rotor te time of a particular induction motor is the time necessary for the winding temperature to rise from its final operational value to a fixed maximum value determined by the corresponding temperature class of the motor during locked rotor. It is of particular significance when the overload protection is specified for motors destined for use in hazardous locations. The te time is for EEx e motors to withstand Ia/In current.

The parameter value for trip class te time is as rated for EEx e motor in the data book which represents the maximum value. Parameterized value for trip class te time can be equal or less than motor rated te time. For a faster trip, value less than rated is selected.

With Ia/In ratio, this parameter makes it possible for M10x unit to calculate the trip time of the motor according to the load. M10x calculates the trip time for EEx e motor automatically, but the trip time for a certain current for further investigation can be defined as presented in this chapter.

Trip time can be defined with the help of the following cold condition time/current diagram. The diagram represents TOL standard model cold condition.

Initial information, as parameterized, is required:

$I_a/I_n$  ratio for EEx e motor

$t_e$  time for EEx e motor

When  $I_a/I_n$  ratio is placed on the current ( $I_s/T_{FLC}$ ) axis and  $t_e$  time is placed on the time ( $t$ ) axis, the coordinate on which the lines drawn through these points cross each other is located on the  $t_6$  curve. According to defined  $t_6$  curve, trip time vs. motor current are available from cold condition time/current diagram. The same  $t_6$  curve can be also used for defining the trip time from a hot condition time/current diagram, as well.

For example:  $I_a/I_n$  ratio for EEx e motor is 7 and parameter  $t_e$  time value is 7 sec. By using the following cold condition time/current diagram,  $t_6$  curve can be found. When  $t_6$  curve is defined, other trip times vs motor current are available.

Motor ambient temperature is not observed because it does not have an affect in TOL EEx e module usage, thus  $I_a/I_n$  can directly be used (see parameter Ambient temperature).

The readout is  $t_6$  curve which is either existing in the diagram or is an estimation below the defined point. In this case Trip class ( $t_6$ ) = 9 sec is estimated from the diagram below. Trip time for current  $3 \times I_n$  is estimated approximately 40 sec.

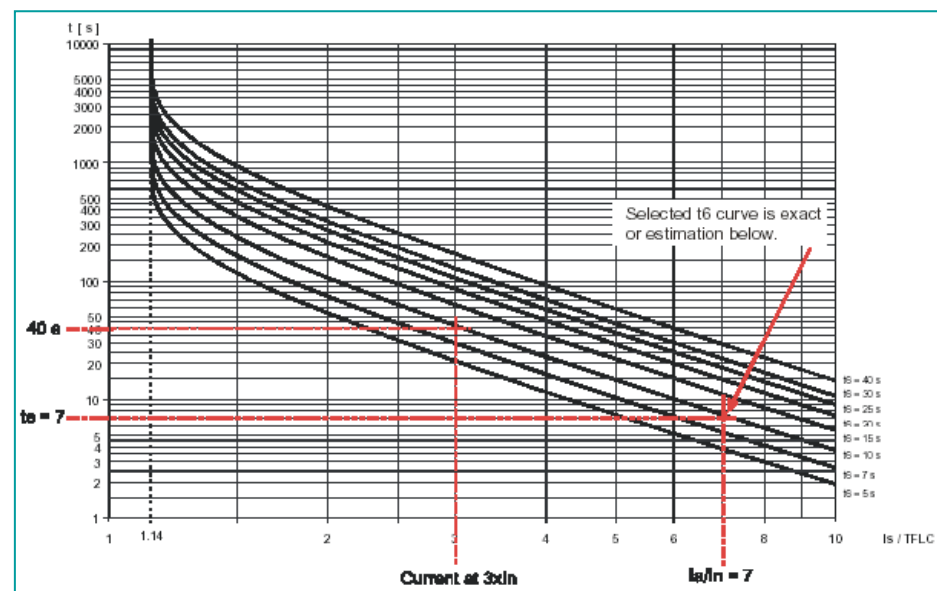


Fig. 4. Trip class definition for TOL/EEx e model from cold condition with time/current diagram.

Diagram presented in 40°C motor ambient temperature.

### Ia/In

Function : TOL protection  
Range : 1.2 (0.1) 8  
Default setting : 5  
Related parameters : TOL protection/Thermal model (EEx e)  
TOL protection/Trip class te time

Description :

This is the ratio of stall current to the nominal current for EEx e application. The motor will withstand this current for the duration trip class te time.

This information is rated for EEx e motor and available in motor data sheet.

### TOL alarm Level

Function : TOL protection  
Range : 60 (1) 100%  
Default setting : 90%  
Related parameters : --  
Description :

When the motor thermal level reaches thermal capacity level set by this parameter, the M10x sends a warning TOL alarm. The TOL alarm is automatically reset when the thermal capacity reaches the parameterized TOL alarm level again.

An overload alarm is reported when the motor current exceeds  $1.14 \times I_n$ .

### TOL trip Level

Function : TOL protection  
Range : 60 (1) 100%  
Default setting : 100%  
Related parameters : --  
Description :

When the motor thermal level reaches thermal capacity level set by this parameter, M10x issues a trip command to stop motor with a message: TOL trip.

### TOL reset level

Function : TOL protection  
Range : 10 (1) 60%  
Default setting : 50%  
Related parameters : --  
Description :

Following a TOL trip, the thermal capacity of the motor is decreasing. Until the motor thermal level reaches thermal capacity level set by this parameter, TOL trip cannot be reset. The motor cannot be restarted before resetting.

### Trip reset mode

Function	: TOL protection
Range	: Auto/Remote/Local/Remote and local
Default setting	: Remote and local
Related parameters	: Programmable inputs/Function
Description	:

TOL trip can be reset in multiple ways depending on the control philosophy. It is possible to reset the fault as desired by parameterization.

**Auto reset:** Reset the relay automatically. Reset is not possible before the calculated thermal capacity reaches the reset level.

**Remote reset:** Reset through fieldbus. Reset is not possible before the calculated thermal capacity reaches the reset level.

**Local reset:** Reset the relay through local hardwiring or MD panel. Reset is not possible before the calculated thermal capacity reaches the reset level.

### TOL bypass enable/disable

Function	: TOL protection
Range	: Enabled/Disabled
Default setting	: Disabled
Related parameters	: TOL protection / Thermal model (standard)/ DI Function-TOL Bypass
Description	:

This parameter is part of TOL bypass function which raise the TOL tripping level up to 200% temporarily when it is activated. 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. An 'de-activate TOL bypass' command deactivate the function.

More description of TOL bypass function is available in the document 1TNC911112 M10x User Guide, TOL bypass function.

### Cooling coefficient (Mt6)

Function : TOL protection

Range : 1 (1) 10

Related parameters : --

Description :

For an accurate thermal image of the motor, M10x needs to know the characteristics of the motor to be controlled. Different motors in different environments need different time periods to warm up and to cooling down. The cooling down period for a stopped motor is usually about four times longer than the warm up period and it certainly differs within the motor, eg, in certain hot spots of the windings from the iron core. But this value can be different depending on dirt or other material covering the motor, motor body size, weight installation place, etc.



The normal value for the parameter is between 4...8 describing the slower cooling for a stopped motor [curve 1 and 2] than cooling of a running motor [curve 3]. In practice, this has been discovered as the normal rule for motors covering various applications.

However, if the motor manufacturer gives recommendation for another value, it may be set to the protection.

For example: External cooling system is installed for improving the cooling down of a stopped motor. According to the motor manufacturer, cooling time constants for a running and stopped motor are equal. Thus, the parameter can be set below recommended value 4 [curve 1].

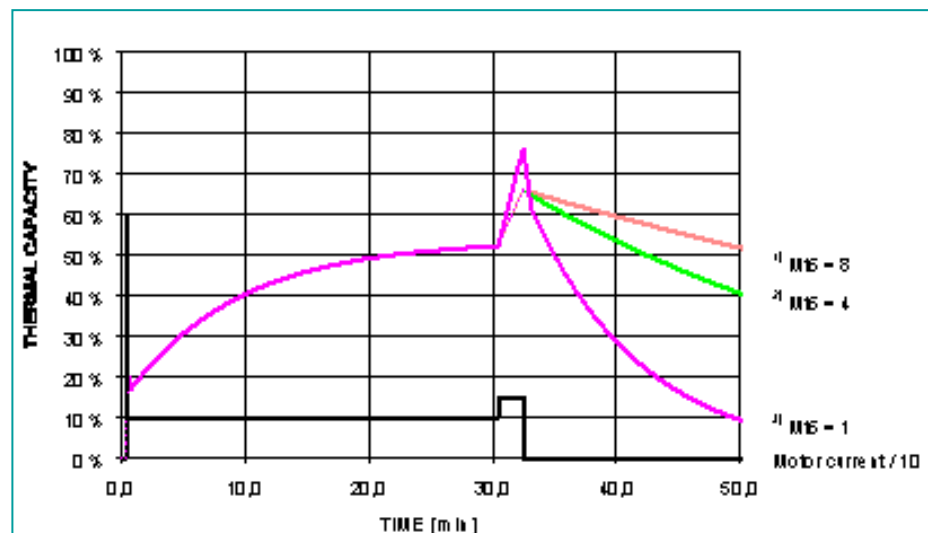


Fig. 5. Cooling coefficient (Mt6) parameter influence on stopped motor cooling (principle diagram)



### Ambient temperature

Function : Motor information  
Range : 0 (5) + 80°C  
Default setting : 40°C  
Related parameters : TOL protection/Thermal model  
Motor information/Nominal current  
TOL protection/Trip class  
TOL protection/Trip class te time  
TOL protection/TOL, and O/L alarm

Description :

Motors of basic design are intended for operation in a maximum ambient temperature of 40°C. If a motor is to be operated in higher ambient temperature, it should normally be derated and should not be loaded to the same thermal capacity. Normally this reduction of output power is done automatically by M10x, but it is also possible to do it manually, as will be shown later in this chapter.

To calculate the thermal image of the motor being protected, the M10x needs to know the temperature of the environment in which the motor is running. Especially in industries where the motors are located near the heat source, the maximum thermal capacity level of the motor is reduced based on the increased surrounding temperature.

Motors designed for EEx e applications are always rated and certified for a certain maximum ambient temperature, most commonly 40°C. If EEx e motor is designed for other temperatures, the manufacturer will supply the motor rated data.

Because of the nature of EEx e motor, the output power ratings are not reduced automatically according to ambient temperature by M10x. Instead of using ambient temperature parameter, M10x uses fixed value 40°C, thus the multiplier is one (1) when TOL EEx e model is selected.

The M10x reduces the maximum permitted current by the multiplier as indicated in the table below (TOL standard model):

Ambient temperature°C	40	45	50	55	60	65	70	75	80	Ambient temperature°C
Permitted current = In x	1.00	0.96	0.92	0.87	0.82	0.74	0.65	0.58	0.50	Permitted output, % of rated output

Example: The thermal capacity level of the motor reduces from 100% at 40°C to 85% at 50°C. Therefore, the motor can be loaded maximum to 92% of its rated load at 50°C.

Manual reduction may be needed if other reduction multipliers than presented in the table above are required. Output power reduction is done by setting the value 40°C to parameter motor ambient temperature and calculating the temperature reduction directly to nominal current. When the multiplier is calculated this way it must be applied to trip class time as well (Is/TFLO).

Example: Motor data sheet specifies that at 60°C motor can be loaded maximum of 75% of the nominal. Thus motor ambient temperature is set to 40°C and when setting the nominal current the rated motor current is derated:

**nominal current=0.75xIn**

When nominal current is derated, trip class parameter is defined with the same factor. It should also be considered that other parameters, ie, protection function trip and alarm levels, referring to nominal current are affected relatively.

# Stall protection

Stall protection is used to protect the driven mechanical system from jams and excessive overloads. Under such conditions, the motors have to be switched off in good time and reported to avoid undue mechanical and thermal stress on the motor and the installation.

This protection function is active only after the motor has successfully started or after parameterized motor startup time has elapsed, and will cause relay activation in case of a motor stall while it is running.

The parameter can be set to a higher value for applications experiencing overload as part of normal operation.



Large low-voltage motors and those devices (eg, mixers, crushers, saw cutters, etc.) having short admissible stalling time less than the startup time are not protected by this function.

Stall protection function consists of the following parameters:

- Function enable, disable
- Trip level
- Trip delay
- Trip reset mode

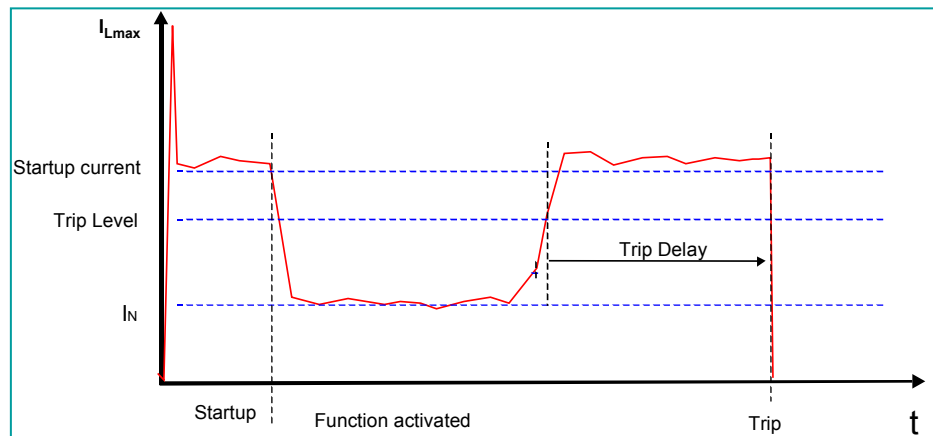


Fig. 6. Stall protection function

#### Function enable/disable

Function : Stall protection  
Range : Enabled/Disabled  
Default setting : Disabled  
Related parameters : Stall protection /parameters  
Motor control/Motor startup time  
Motor control/Motor startup time N2

Description :

Stall protection function can be disabled with the help of this parameter. When selecting disabled, all parameters under stall protection are deactivated.

Stall protection activates after motor startup when either of the following criteria are met:

- a) Motor running current has recovered around  $1,25 \times I_n$  after starting
- b) Startup time (setting value) has elapsed

#### Trip level

Function : Stall protection  
Range : 120 (10) 800%  
Default setting : 400%  
Related parameters : Stall protection/Function enable/disable  
Stall protection/Trip delay

Description :

When the highest of the measured phase currents remains above the set value for a trip delay time, the M10x will perform a trip with a message: Stall trip. If normal conditions are restored before the trip delay elapses, the M10x will go back to normal operation.

The trip level referenced to  $I_n$  is set based on the motor technical data sheet supplied by the manufacturer and the requirements/restrictions of the application.

### Trip delay

Function : Stall protection  
Range : 0.0 (0.1) 25.0 sec  
Default setting : 0.5sec  
Related parameters : Stall protection/Function enable, disable  
Stall protection/Trip level

Description :

When the condition for a stall trip is present, the M10x will start count down for the time specified in trip delay parameter. The trip is followed with a message: Stall Trip. The trip delay is set based on the requirements/restrictions of the application.

### Trip reset mode

Function : Stall protection  
Range : Remote/Local/Remote and local  
Default setting : Remote and local  
Related parameters : Stall protection/Function enable, disable  
Programmable inputs/Function

Description :

Stall trip can be reset in multiple ways depending on the control philosophy. It is possible to reset the trip as desired by parameterization.

**Remote reset:** Reset through fieldbus.

**Local reset:** Reset through operator panel MD or local hardwiring

### Phase failure protection

Phase failure in motor phase currents is a common phenomenon in industrial environments. It 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. It is an extreme situation where a complete loss of phase occurs. This can be caused by a utility supply problem or by a blown fuse in one phase. Unbalanced phase currents are a major cause of motor thermal damage due to the nature of the current. The negative sequence current induced in the rotor is double the power supply frequency and produces a counter torque to the desired motor output. For small unbalances, the overall output torque will remain same as the motor develops a large positive sequence torque to overcome the negative sequence torque. This opposing torque and the high negative sequence current lead to an increased temperature rise in the rotor and stator.

Reasons for the phase failure are neither temporary nor self-covering. Although TOL protection performs an accelerated trip during phase failure and unbalance over 20%, there are no good reasons to wait for the trip to occur through TOL protection. By the use of phase failure protection a motor can be tripped without waiting for thermal calculation. Indeed, phase failure protection should be parameterized to trip in less time than TOL.

Parameters involved in phase failure protection are:

- Function enabled/disable
- Alarm level
- Trip level
- Trip delay
- Trip reset mode

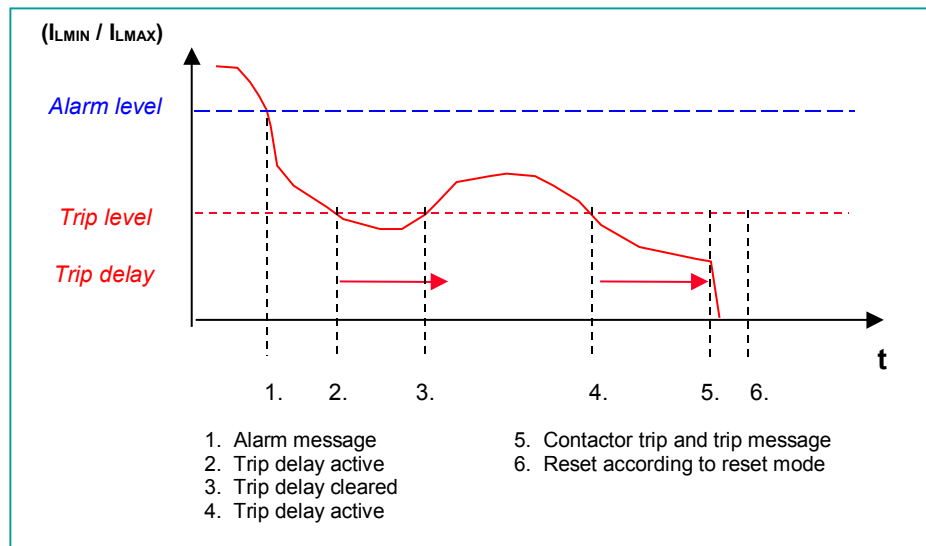


Fig. 7. Phase failure protection

### Function enable/disable

Function	: Phase failure protection
Range	: Enabled/Disabled/Alarm only
Related parameters	: Phase failure protection/parameters Motor control/Startup time Motor control/Startup time N2 Motor control/Ramp time Motor control/Motor type
Description	:

Phase failure protection function can be disabled with the help of this parameter. When disabled, protection function does not have any functionality in the M10x. Alarm only is an option of function disable/enable. When Alarm only is active, an alarm occurs only if the measured value is more than the set alarm level.

This function is disabled automatically in the case of single-phase motor and during the motor startup period.

### Alarm level

Function	: Phase failure protection
Range	: 10 (1) 90%
Default setting	: 80%
Related parameters	: Phase failure protection/Function enable/disable
Description	:

To avoid motor failure by phase failure, the M10x calculates the ratio between the lowest phase current to the highest phase current ( $I_{L_{MIN}} / I_{L_{MAX}}$ ) from the measured currents of all three phases. If the condition set by this parameter is true, there will be a phase failure alarm warning message. The phase failure alarm clears automatically on restoration of normal condition.

### Trip level

Function	: Phase failure protection
Range	: 5 (1) 90%
Default setting	: 70%
Related parameters	: Phase failure protection/Function enable/disable Phase failure protection/Trip delay
Description	:

When the ratio  $I_{L_{MIN}} / I_{L_{MAX}}$  corresponds to the value set on trip level, the M10x will trip after the elapse of trip delay time with a message: Phase failure trip. If normal conditions are restored before the trip, the M10x will go back to normal operation.

### Trip delay

Function	: Phase failure protection
Range	: 0 (1) 60 sec
Default setting	: 10sec
Related parameters	: Phase failure protection/Function enable/disable Phase failure protection/Trip delay
Description	:

After trip level condition is reached, the M10x will delay the trip for the time defined by pre-parameterized trip delay. A message: Phase failure trip is generated. With this delay, a short phase current loss can be filtered. The M10x can be reset according to the trip reset mode parameter.

### Trip reset mode

Function	: Phase failure protection
Range	: Remote, Local, Remote and local
Default setting	: Remote and local
Related parameters	: Phase failure protection/Function enable/disable
Description	:

Phase failure trip can be reset in multiple ways depending on the control philosophy. It is possible to reset the trip as desired by suitable parameterization.

**Remote reset:** Reset through fieldbus.

**Local reset:** Reset through operator panel MD or local hardwiring.

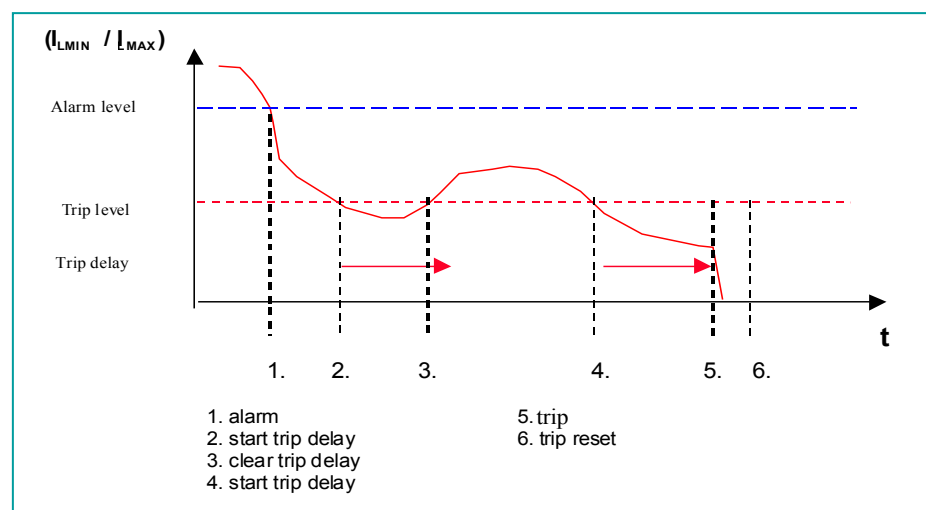


# Unbalance protection

Unbalance protection function protects the motor against a small degree of unbalance in the motor phases. The function monitors the ratio between  $I_{L_{MIN}}/I_{L_{MAX}}$ . The calculation of the motor thermal capacity takes into account the unbalance for early tripping to prevent motor damage due to negative sequence currents. For more information, refer to phase failure protection.

Parameters involved in unbalance protection are as below:

- Function enable/disable
- Alarm level
- Trip level
- Trip delay
- Trip reset mode



**Fig. 8. Unbalance protection**

## Function enable/disable

Function	: Unbalance protection
Range	: Enabled/Disabled/Alarm only
Default setting	: Disabled
Related parameters	Unbalance protection/Parameters Motor information/Number of phases (3 phase applications) Motor control/Motor startup time Motor control/Motor startup time N2

Description :

The unbalance protection function can be disabled with the help of this parameter. When disabled, the protection function does not have any functionality in the M10x. Alarm only is an option of Function disable/enable. When Alarm only is active, an alarm occurs only if the measured value is more than the set alarm level.

This function is disabled automatically in the case of single-phase motor and during the motor startup period.

### Alarm level

Function	: Unbalance protection
Range	: 50 (1) 90%
Default setting	: 90%
Related parameters	: Unbalance/Function enable/disable/Alarm only
Description	:

To avoid a motor failure by phase unbalance, the M10x calculates a ratio between the lowest phase current to the highest phase current ( $I_{L\text{MIN}}/I_{L\text{MAX}}$ ) from the measured currents of all three phases. If the condition set by this parameter is true, there will be an Unbalance alarm warning message.

The unbalance alarm clears automatically after normal status is attained.

### Trip level

Function	: Unbalance protection
Range	: 50 (1) 90%
Default setting	: 85%
Related parameters	: Unbalance/Function enable/disable/Alarm only Unbalance/Trip delay
Description	:

When the ratio ' $I_{L\text{MIN}}/I_{L\text{MAX}}$ ' corresponds to the value set for this parameter, M10x will start a countdown set by trip delay parameter after which a trip occurs with an unbalance trip message. If normal conditions are restored before the trip, the M10x will go back to normal operation.

### Trip delay

Function	: Unbalance protection
Range	: 0 (1) 60 sec
Default setting	: 10sec
Related parameters	: Unbalance/Function enable/disable/Alarm only Unbalance/Trip level
Description	:

After the trip level is reached, the M10x will delay the trip for the time set by this parameter. After the set trip delay, the M10x will trip the motor and give an unbalance trip message. With this delay, short phase unbalances can be filtered. The M10x can later be reset according to the trip reset mode parameter.

### Trip reset mode

Function	: Unbalance protection
Range	: Remote/Local/Remote and local
Default setting	: Remote and local
Related parameters	: Unbalance/Function enable/disable/Alarm only
Description	:

A phase unbalance trip can be reset in multiple ways. Depending on the control philosophy, it is possible to reset the trip as desired by suitable parameterization.

**Remote reset:** Reset through fieldbus.

**Local reset:** Reset through operator panel MD or local hardwiring.

# Underload protection

Underload protection function monitors the process against loss or decrease in motor load. This protection function is current-based protection. It is especially useful for indication of loss of suction for pumps, broken belt for conveyors, loss of airflow for fans, broken tools for machines, etc. Such states do not harm the motor but early diagnosis helps to minimize the extent of damage to the mechanical installation and subsequent loss of production.

The motors on underload draw mainly the magnetizing current and a small load current to overcome frictional losses. Therefore, the other reason to isolate the motors on underload is to reduce the reactive load on the power system network.



Underload protection function is based on the highest measured phase current.

Underload protection is active only after the motor has successfully started, ie, when current is detected.

Parameters involved in underload protection are:

- Function enable/disable
- Alarm level
- Trip level
- Trip delay
- Trip reset mode

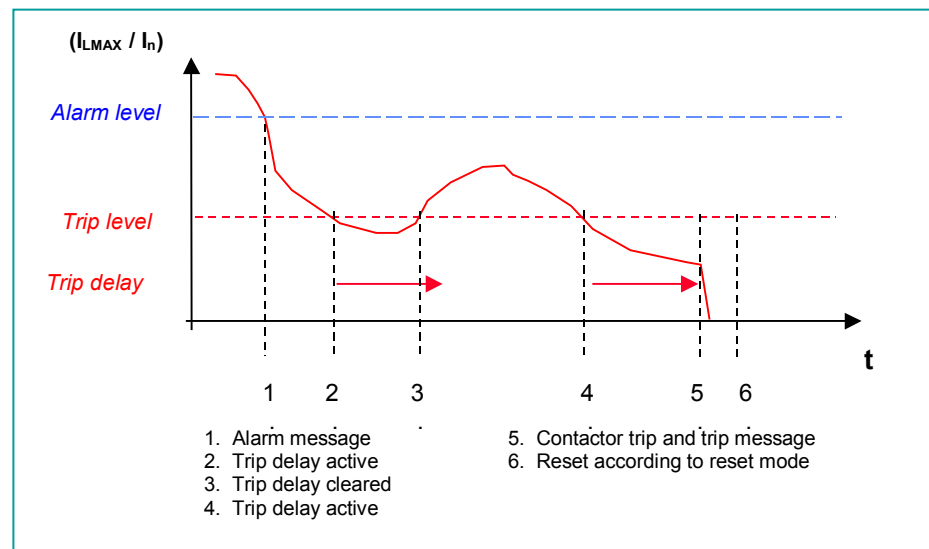


Fig. 9. Underload protection

### Function enable/disable

Function : Unload protection  
Range : Enabled/Disabled/Alarm only  
Default setting : Disabled  
Related parameters : Motor control/Ramp-up time  
Motor control/Ramp-down time  
Motor control/Startup time (Autotrafo)

Description :

Underload protection function can be disabled with the help of this parameter. When disabled, protection function does not have any functionality in the M10x. Alarm only is an option of function disable/enable. When alarm only is active, an alarm occurs only if the measured value is more than the set alarm level.

In the startup time of softstarter/autotransformer, underload protection is suppressed.

### Alarm level

Function : Unload protection  
Range : 20 (1) 90%  
Default setting : 30%  
Related parameters : Underload protection/Function  
Description :

If the highest phase current ( $I_{LMAX}$ ) of the measured three phase currents is detected below the alarm level, then an underload alarm warning message is created to inform the operator of the underload condition.

Underload alarm clears automatically on restoration of normal condition.

### Trip level

Function : Unload protection  
Range : 5 (1) 90%  
Default setting : 20%  
Related parameters : Underload protection/Function  
Underload protection/Trip delay  
Description :

When current  $I_{LMAX}$  reaches the trip level, the M10x trips the motor after elapse of trip delay time. An underload trip message is generated after the trip. If normal conditions are restored before the trip, the M10x will go back to normal operation.

### Trip delay

Function : Unload protection  
Range : 0 (1) 1800 sec  
Default setting : 10sec  
Related parameters : Underload protection/Function  
Underload protection/Trip level

Description :

The trip is delayed by the time set by this parameter. If underload condition is not back to normal before the elapse of trip delay time, a trip is generated with a message. With this delay, short underload situations can be filtered.

### Trip reset mode

Function : Unload protection  
Range : Remote/Local/Remote and local  
Default setting : Remote and local  
Related parameters : Underload protection/Function  
Underload protection/Trip level

Description :

Underload trip can be reset in multiple ways depending on the control philosophy. It is possible to reset the trip as desired by suitable parameterization.

**Remote reset:** Reset through fieldbus.

**Local reset:** Reset through operator panel MD or local hardwiring.

# Noload protection

The noload protection function protects the process against sudden loss of load. This condition does not harm the motor, but requires a switchoff to safeguard the process.

The no load current is of the order of 0.2 to 0.6  $I_n$  depending on the size and speed of the motor. The no load current of slow-speed motors is high and that of large motors is low.

The noload protection function is based on the highest phase current measured by the current measurement unit. The noload protection function detects missing current with respect to the contactor and the main switch ON feedback, and executes actions as parameterized.



Noload protection is active only after the motor has successfully started, ie, when current is detected.

Parameters involved in noload protection are:

- Function enabled/disable
- Alarm level
- Trip level
- Trip delay
- Trip reset mode

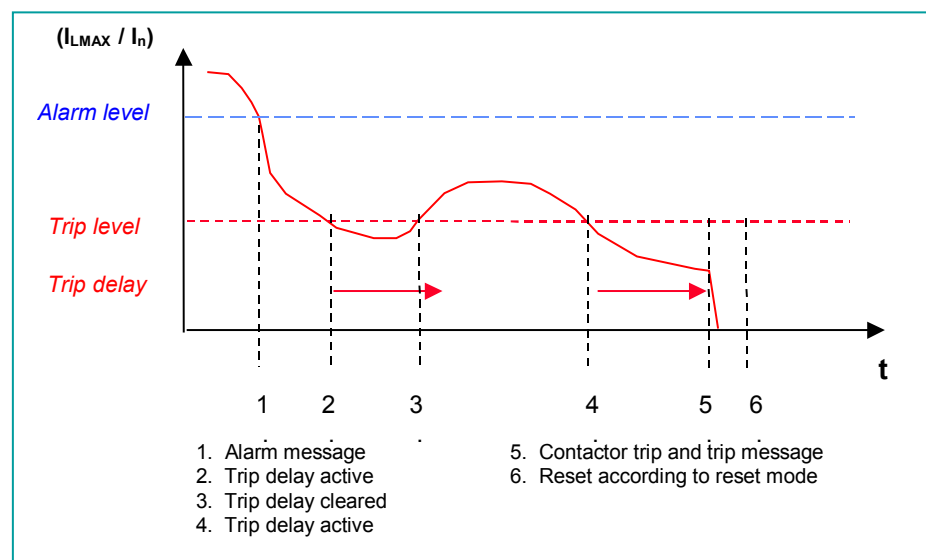


Fig. 10. Noload protection

#### Function enable/disable

Function : Noload protection  
Range : Enabled/Disabled/Alarm only  
Default setting : Disabled  
Related parameters : Noload/Parameters  
Description :

Noload protection function can be disabled with the help of this parameter. When disabled, protection function does not have any functionality in the M10x. Alarm only is an option of function disable/enable. When alarm only is active, an alarm occurs only if the measured value is more than the set alarm level.

This function is disabled automatically during the motor startup period.

#### Alarm level

Function : Noload protection  
Range : 5 (1) 50%  
Default setting : 20%  
Related parameters : Noload protection/Function  
Description :

If the highest phase current ( $I_{LMAX}$ ) of the measured three phase currents is detected below the alarm level, a noload alarm warning message is created to inform the operator of the no load condition.

Noload alarm clears automatically on restoration of normal condition.

#### Trip level

Function : Noload protection  
Range : 5 (1) 50%  
Default setting : 15%  
Related parameters : Noload protection/Function  
Noload protection/Trip delay  
Description :

If the highest phase current ( $I_{LMAX}$ ) of the measured three phase currents falls below the trip level for longer than the time period set by the trip delay, the M10x trips the motor with a noload trip message.



### Trip delay

Function : Noload protection  
Range : 0 (1) 1800 sec  
Default setting : 5sec  
Related parameters : Noload protection/Function  
Noload protection/Trip level

Description :

When the current ILMAX reach the noload trip level, the M10x trips the motor after elapse of trip delay time. A noload trip message is generated after the trip. If normal conditions are restored before the trip, the M10x will go back to normal operation. With this delay, short noload situations can be filtered.

### Trip reset mode

Function : Noload protection  
Range : Remote/Local/Remote and local  
Default setting : Remote and local  
Related parameters : Noload protection/Function

Description :

The noload trip can be reset in multiple ways depending on the control philosophy. It is possible to reset the trip as desired by suitable parameterization.

**Remote reset:** Noload trip reset is possible via the fieldbus.

**Local reset:** Noload trip reset is only possible via digital input which is assigned for reset (or via operator panel MD).

# Earth fault protection

The earth fault protection function protects the motor and the network against ground current flow. During earth fault, the motors can reach a dangerous potential above the ground level thus posing a safety hazard to personnel. The earth faults are mainly caused due to aging of the insulation, deterioration of insulation due to sustained or cyclic overloading, moisture or conductive dust. Most insulation faults result in leakage to the frame of the motor. Earth fault protection in M10x device provides the protection for fatal isolation damages.

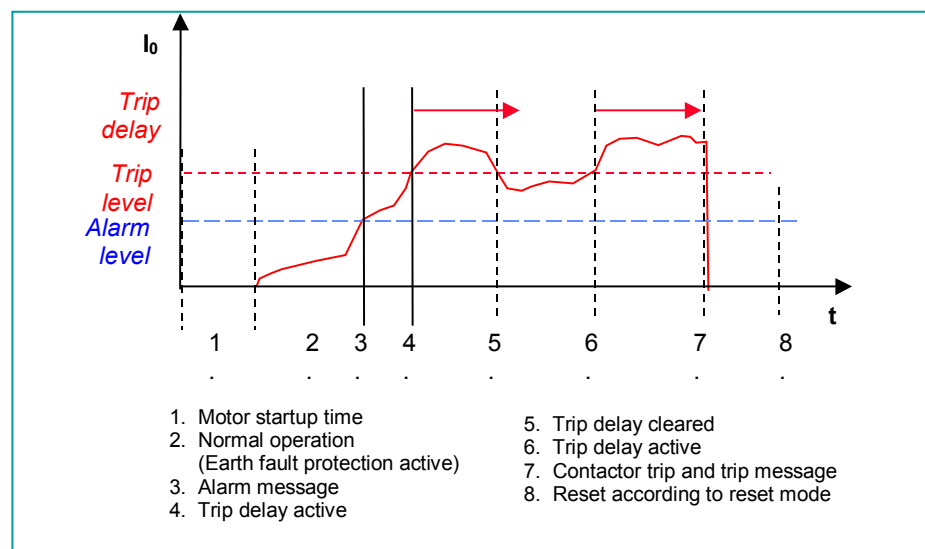
The function is by default suppressed by parameters Motor startup time and Softstart ramp time to avoid nuisance tripping due to harmonics caused by saturation of the current transformers. In some cases, it may need to be switched on during startup in specific project requirements.



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

Parameters involved in the earth fault protection are as below:

- Function enable/disable  
(Earth fault protection is activated during motor startup time).
- Alarm level
- Trip level
- Trip delay
- Trip reset mode



**Fig. 11. Earth fault protection**

### Function enable/disable

Function : Earth fault protection  
Range : Enabled/Disabled/Alarm only  
Default setting : Disabled  
Related parameters : Earth fault protection/Parameters  
Motor control/Motor startup time  
Motor information/Number of phases (3 phase applications)

Description :

Earth fault protection function can be disabled with the help of this parameter. When disabled, the protection function does not have any functionality in the M10x. Alarm only is an option of function disable/enable. When alarm only is active, an alarm occurs only if the measured value is more than the set alarm level.

### Enable earth fault protection during motor startup

Function : Earth fault protection is activated during motor startup time  
Range : Enabled/Disabled  
Default setting : Disabled  
Related parameters : Earth fault protection  
Description :

Earth fault protection function can be enabled or disabled during motor startup time via this parameter.

### Alarm level

Function : Earth fault protection  
Range : 100(100)3000mA(Earth fault primary: 1A) or  
500(100)15000mA(Earth fault primary: 5A)  
Default setting : 500mA  
Related parameters : Earth fault/Function  
Description :

When the earth fault current exceeds the pre-set level, an earth fault alarm is generated. The earth fault alarm is automatically reset when the current falls below the alarm level.

This function can be bypassed during the startup of a motor by parameterization of a trip delay.

### Trip level

Function	: Earth fault protection
Range	: 100(100)3000mA(Earth fault primary: 1A) or 500(100)15000mA(Earth fault primary: 5A)
Default setting	: 800mA
Related parameters	: Earth fault protection/Function Earth fault protection/Trip delay

Description :

When the earth fault current remains above the trip level for a preset trip delay time, the M10x will generate a trip command with an earth fault trip message. If normal conditions are restored before the trip delay time elapses, the M10x will go back to normal operation.

### Trip delay

Function	: Earth fault protection
Range	: 0.1(0.1) 60sec
Default setting	: 0.1sec
Related parameters	: Earth fault protection/Function Earth fault protection/Trip level

Description :

When the earth fault current rises above the trip level, the M10x will execute a trip command after elapse of the time specified in the trip delay parameter. The trip is followed with an earth fault trip message. The countdown is reset if the earth fault current goes below the trip level before the pre-set trip delay. The trip is reset depending on the parameterization of the trip reset mode.

### Trip reset mode

Function	: Earth fault protection
Range	: Remote/Local/Remote and local
Default setting	: Remote and local
Related parameters	: Earth fault protection/Function
Description	:

An earth fault trip can be reset in multiple ways depending on the control philosophy. It is possible to reset the trip as desired by parameterization.

**Remote reset:** Reset through fieldbus.

**Local reset:** Reset through operator panel MD or local hardwiring.

# PTC protection (M102 only)

PTC thermistors are semiconductor elements with a very high positive temperature coefficient. PTC temperature detectors are used extensively in the protection of motors against excessive temperature rise. They are embedded directly between the phase windings on the overhang of the stator winding normally during manufacture.

In contrast to the trip class (t6) and TOL protection that responds to the load current, the PTC protection responds to the change in thermistor resistance due to temperature rise in the windings. The PTC protection is also sensitive to fall in temperature in order to make it possible to reset the trip.

The thermistors are selected to have a rated operating temperature (TNF) to correspond with the insulation class, type and construction of the motor. Its resistance increases sharply in the range of its rated operating temperature (TNF). Use a type A temperature sensor with a characteristic curve according to IEC 60947-8.

The M102 senses this abrupt change in the resistance to execute a trip command. A trip will follow when trip level is detected by the measurement and reset is allowed when resistance is under reset level.

Parameters involved in PTC protection are:

- Function enable/disable
- PTC alarm level
- PTC trip level
- PTC trip delay
- PTC reset level
- PTC short circuit alarm level
- Trip reset mode

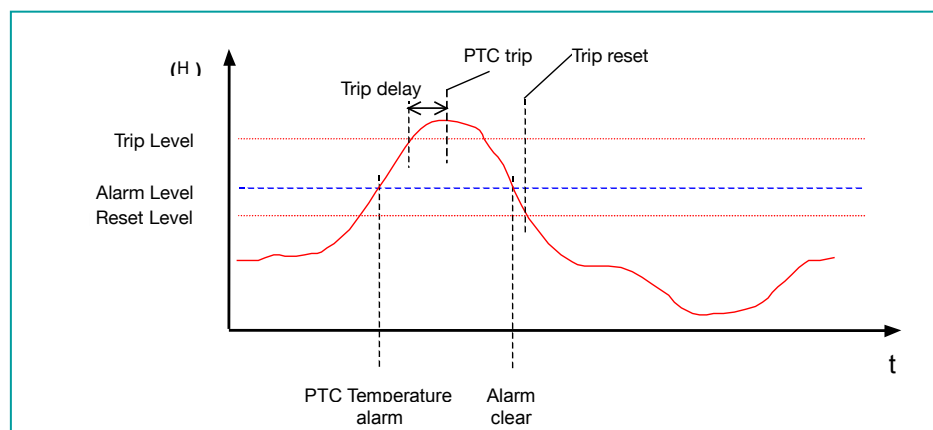


Fig. 12. PTC protection

#### Function enable/disable

Function : PTC protection  
Range : Enabled/Disabled/Alarm only  
Default setting : Disabled  
Related parameters : PTC protection/Parameters  
Description :

The PTC protection function can be disabled with the help of this parameter. When disabled, the protection function does not have any functionality in the M102. Alarm only is an option of function disable/enable. When alarm only is active, an alarm occurs only if the measured value is more than the set alarm level.

#### PTC alarm level

Function : PTC protection  
Range : 100 (1) 10,000 ohms  
Default setting : 1,600 ohms  
Related parameters : PTC protection/Function enable, disable  
Description :

This parameter defines the alarm level for the PTC protection function. The limit causes a PTC temperature alarm message to be issued when the measured temperature is higher than the alarm level. The temperature is measured via the PTC thermistors.

Usually, three PTC thermistors in series are built into the overhang of the stator winding at the coolant air exhaust end of the motor. The thermistors are selected to have a rated operating temperature (TNF) to correspond with the insulation class, type and construction of the motor. If the resistance corresponding to the high temperature at one or more of the thermistors exceeds this value, an PTC temperature alarm will be generated.

The PTC temperature alarm clears automatically on reaching the normal condition, ie, resistance restores below alarm level.

#### PTC trip level

Function : PTC protection  
Range : 100 (1) 10,000 ohms  
Default setting : 3,600  
Related parameters : PTC protection/Function  
Description :

When PTC resistance remains above the trip level for a preset trip delay time, the M102 will generate a trip command with a PTC trip message. If normal conditions are restored before the trip delay time elapses, the M102 will go back to normal operation.

#### PTC trip delay

Function : PTC protection  
Range : 1 (1) 1800 sec  
Default setting : 1sec  
Related parameters : PTC protection/Function  
PTC Protection/PTC trip level

Description :

When the PTC resistance rises above the trip level, the M102 will execute a trip command after elapse of the time specified in the trip delay parameter. The trip is followed with PTC trip message. The countdown is reset if PTC resistance goes below the trip level before the pre-set trip delay. The trip is reset depending on the parameterization of the trip reset mode.

#### PTC reset level

Function : PTC protection  
Range : 100 (1) 10,000 ohms  
Default setting : 1,600 ohms  
Related parameters : PTC protection/Function  
Description :

Following a PTC trip, the resistance of PTC is decreasing. Until the resistance reaches the level set by this parameter, PTC trip cannot be reset. The motor cannot be restarted before reset.

#### PTC short circuit alarm level

Function : PTC protection  
Range : 0 (1) 250 ohms  
Default setting : 10 ohms  
Related parameters : PTC protection/Function  
Description :

This parameter defines the alarm level for the PTC short circuit protection function. The limit causes a message PTC short circuit alarm to be issued when the measured temperature is lower than the alarm level.

#### PTC trip reset mode

Function	: PTC protection
Range	: Auto / Remote / Local / Remote & Local
Default setting	: Remote & Local
Related parameters	: PTC protection/Function
Description	:

A PTC trip can be reset in multiple ways depending on the control philosophy. It is possible to reset the trip as desired by parameterization.

**Auto reset:** The PTC temperature trip resets automatically after the sensor loop resistance goes below the threshold set for the trip-reset level.

**Remote reset:** Reset through fieldbus.

**Local reset:** Reset through operator panel MD or local hardwiring.



# Undervoltage protection (M102 only)

The undervoltage protection function protects the motor against overload during voltage dips. During a mains undervoltage, the electrical energy required to drive the rotor remains the same for some period, owing to its inertia.

According to the energy conservation law:

Mechanical energy = Electrical energy

$$V_L \cdot I_L \cdot \cos \Phi \dots \text{Equation 1}$$

Where  $V_L$  is the motor line voltage,  $I_L$  is the motor line current and  $\cos \Phi$  is the power factor.

From Equation 1, the motor draws more current during voltage dips to deliver the same mechanical energy.

The motors switched off during voltage dip or power failure can be restarted on power resumption sequentially to prevent simultaneous switch-on of the motors and thus prevent another mains failure on the network. The tripping of motors due to undervoltage of short duration can be bypassed. The feature also helps to restart the process on power resumption by sequentially starting the motors (staggered start).

The undervoltage protection also prevents startup of the motor if the voltage is not high enough and indicates phase loss before switching on the motor.

Parameters involved in undervoltage protection are:

- Function enable/disable
- Alarm level
- Trip level
- Trip delay
- Reset level
- Trip reset mode

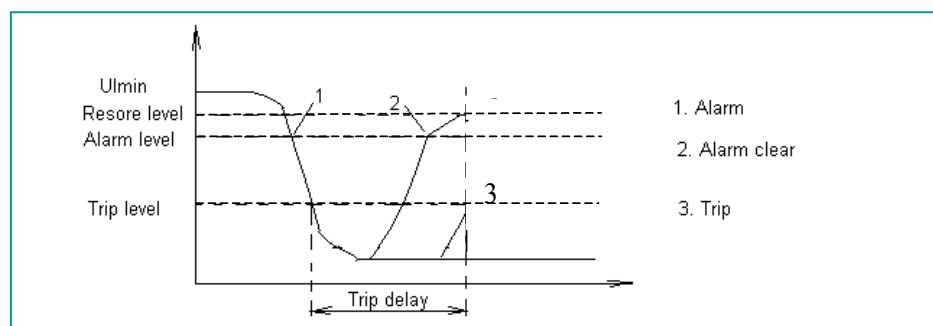


Fig. 13. Undervoltage protection

### Function enable/disable

Function : Undervoltage protection  
Range : Enabled/Disabled/Alarm only  
Default setting : Disabled  
Related parameters : Undervoltage protection/Parameters  
Autorestart/Function

Description :

The undervoltage protection function can be disabled with the help of this parameter. When disabled, the protection function does not have any functionality in the M102. Because the function of autorestart is associated with the undervoltage protection, if the undervoltage protection is disabled, the function of autorestart can not be enabled. Alarm only is an option of function disable/enable. When alarm only is active, an alarm occurs only if the measured value is more than the set alarm level.

This function is disabled automatically during the motor startup period.

### Alarm level

Function : PTC protection  
Range : 50 (1) 100%  
Default setting : 80%  
Related parameters : Undervoltage protection/Function  
Description :

This parameter defines the voltage level for an undervoltage alarm. The undervoltage protection is based on the lowest of the measured phase-phase voltages. An undervoltage alarm is generated when the lowest of the measured voltages is below the parameterized alarm level.

### Trip level

Function : Undervoltage protection  
Range : 30 (1) 100%  
Default setting : 65%  
Related parameters : Undervoltage protection/Function  
Undervoltage protection/Trip delay  
Autorestart/parameters

Description :

This parameter defines the trip level for the undervoltage protection function. When the lowest of the measured phase-phase voltages goes below the trip level, the M102 will start counting a trip delay or go into the autorestart process.

### Trip delay

Function	: Undervoltage protection
Range	: 0.2 (0.1) 5 sec
Default setting	: 1sec
Related parameters	: Autorestart/Maximum powerdown time
Description	:

This parameter defines the time from the undervoltage trip level to the execution of the trip command. When the lowest of the measured phase-phase voltages goes below the trip level for a time specified in the trip delay, the M102 will open the contactor.

### Reset level

Function	: Undervoltage protection
Range	: 50 (1) 100%
Default setting	: 90%
Related parameters	: Undervoltage/Trip delay Autorestart/Maximum autoreclose time Autorestart/Maximum powerdown time Autorestart/Staggered start time
Description	:

The reset voltage level is a voltage limit for restarting the motor after an undervoltage trip. The motor will start immediately or after a delay depending on the time during which the reset voltage level is reached (refer to Fig. 13).

### Trip reset mode

Function	: Undervoltage protection
Range	: Remote/Local/Remote and local
Default setting	: Remote and local
Related parameters	: Undervoltage protection/Function
Description	:

A undervoltage trip can be reset in multiple ways depending on the control philosophy. It is possible to reset the trip as desired by parameterization.

**Auto reset:** Undervoltage trip resets automatically after the voltage goes above the reset voltage level

**Remote reset:** Reset through fieldbus.

**Local reset:** Reset through operator panel MD or local hardwiring.

# Autorestart function (M102 only)

The phase A – phase C (Uac) voltage is supervised continuously. It is possible to automatically restart the motor after momentary power loss. Two alternative models of autorestart function are provided in M102: standard and enhanced.

In standard mode, the reaction of the auto restart function depends on the length of the voltage dip.

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

## Case 1: Voltage dip < autoreclose time

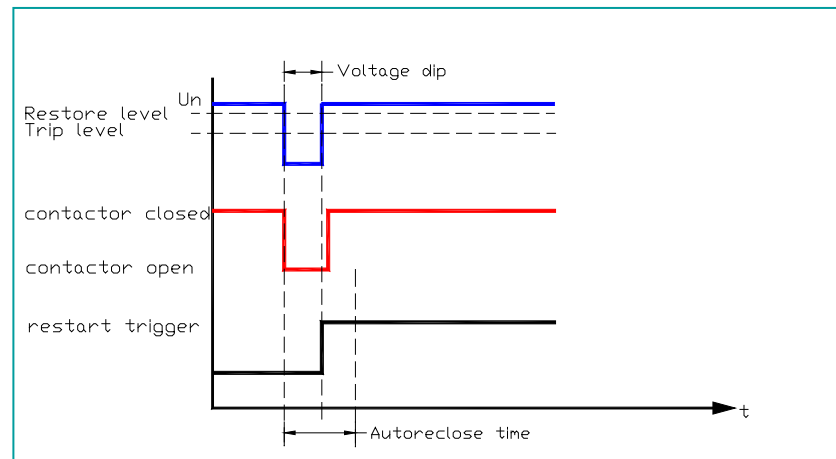


Fig. 14. Voltage dip < autoreclose time

If voltage is restored within the autoreclose time, the motor will be restarted immediately.

## Case 2: autoreclose time < voltage dip < Max. power down time

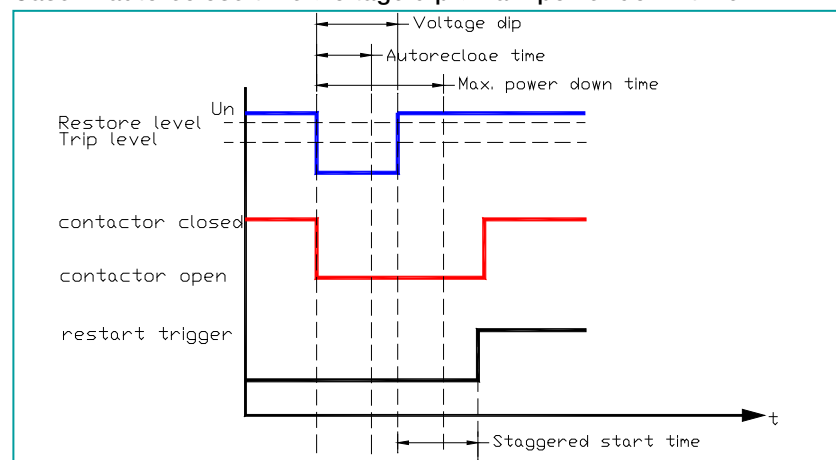
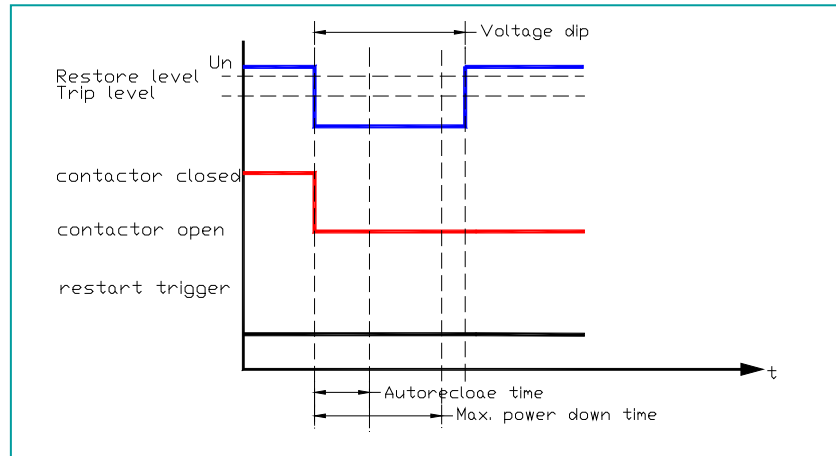


Fig. 15. autoreclose time < voltage dip < Max. power down time

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

### Case 3: Voltage dip > Maximum power down time



**Fig. 16. Voltage dip > Maximum power down time**

If the supply remains below the restore level after maximum power down time, no automatic restart is triggered, even if voltage restores later.

If voltage dip impact is more of a concern, enhanced autorestart function can be introduced.

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 certain time.

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

#### Case1: Voltage dip < autoreclose time

Identical to Standard mode Case1

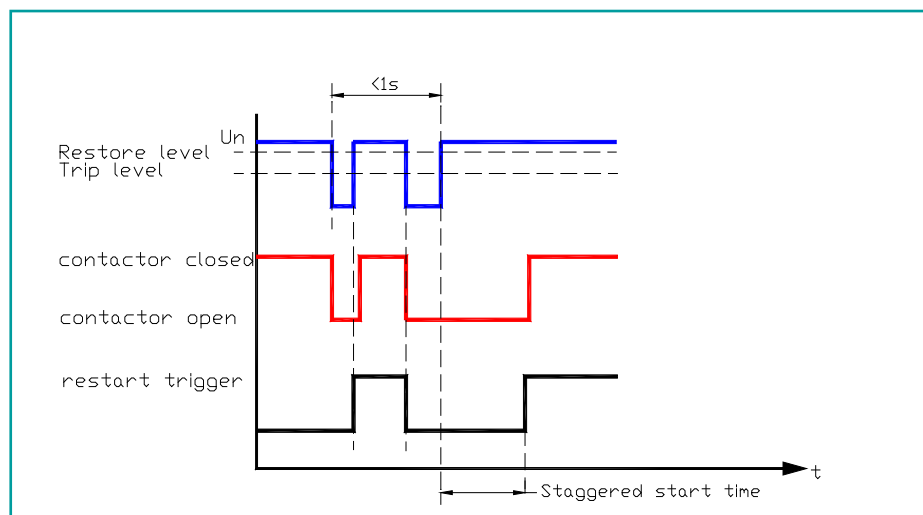
#### Case2: autoreclose time < voltage dip < Maximum power downtime

Identical to Standard mode Case2

#### Case3: Voltage dip > Maximum power downtime

Identical to Standard mode Case3

#### Case4: 2xdip < 200ms within 1s



**Fig. 17.  $2 \times \text{dip} < 200\text{ms}$  within 1s**

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

Parameters involved in autorestart function are:

- Function enable/disable
- Function mode
- Maximum autoreclose time
- Maximum powerdown time
- Staggered start delay

#### Function enable/disable

Function : Autorestart  
 Range : Enabled/Disabled/Alarm only  
 Default setting : Disabled  
 Related parameters : Autorestart/Parameters  
 Undervoltage/Parameters

Description :

The Autorestart function can be disabled with the help of this parameter. When disabled, the autorestart does not have any functionality in the M102. Because the function of autorestart is associated with the undervoltage protection, if the the function is to be enabled, the undervoltage protection will be enable automatically.

### Maximum autoreclose time

Function : Autorestart  
Range : 0 (100) 5000 msec  
Default setting : 200msec  
Related parameters : Autorestart/Function  
Undervoltage/Trip reset mode  
Undervoltage/Reset level  
Undervoltage/Maximum power down time

Description :

Maximum autoreclose time is the time during which the motor immediately restarts on restoration of voltage above the reset voltage level.

### Maximum power downtime

Function : Autorestart  
Range : 0 (0.1) 1200 sec  
Default setting : 5sec  
Related parameters : Autorestart/Function  
Undervoltage/Trip reset mode  
Undervoltage/Trip voltage delay  
Undervoltage/Maximum power downtime  
Undervoltage/Staggered start time

Description :

The maximum powerdown time starts after the trip delay time has elapsed. It is the maximum waiting time of the M102 for the power resumption. The motor will restart after staggered start delay on voltage restoration above the reset voltage level between end of maximum autoreclose time and maximum power down time. The M102 issues an undervoltage trip message if the voltage recovers above the reset voltage level after the maximum powerdown time. The trip can be reset based on the parameterization of the trip reset mode.

### Staggered start delay

Function : Autorestart  
Range : 0.6 (0.1) 1200 sec  
Default setting : 5sec  
Related parameters : Autorestart/Function  
Undervoltage/Trip reset mode  
Undervoltage/Trip delay  
Undervoltage/Reset voltage level  
Autorestart/Maximum autoreclose time  
Autorestart/Maximum powerdown time

Description :

This parameter defines the time from the voltage rise above the reset voltage level to the time when the start command is executed. It is applicable to the motors if the voltage restores above the reset voltage level between the delay. This parameter can be used to start the motors sequentially after resumption of power to prevent voltage dip caused by simultaneous starting of several motors.

# Start limitation protection

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.

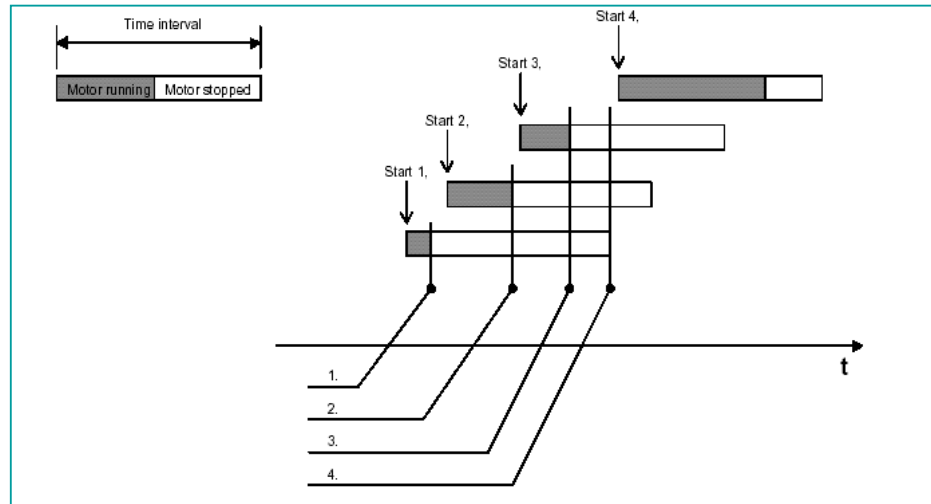
The parameterization of the protection function can be the number of starts per time interval or the time between two consecutive starts. In the first case, the user must wait after the trip for the reset to take place before making a start. The time to reset after start limitation trip is provided to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

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

Functionality is presented in the following example. Fig. 18 shows the start limitation protection with three starts allowed.

- i) 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.
- ii) Two timers are still active, thus stop command generates a start limitation alarm message and one more start is allowed, "Start 3".
- iii) The third 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, here starting from "Start 1". When start limitation trip is active the time to reset is provided to the fieldbus.
- iv) Trip can be reset when the first timer from "Start 1" is finished. Motor start is possible when all pending trips are reset. Supervision continues with a new timer from Start 4.





**Fig. 18. Start limitation alarm**

The parameters involved with the protection function are:

- Function enable/disable
- Time interval
- Number of starts

#### Function enable/disable

Function : Start limitation protection  
 Range : Enabled/Disabled  
 Default setting : Disabled  
 Related parameters : Start limitation/Parameters  
 Description :

The start limitation protection function can be disabled with the help of this parameter. When disabled, the protection function does not have any functionality in the M10x.

#### Time interval

Function : Start limitation protection  
 Range : 1 (1) 600 min  
 Default setting : 1min  
 Related parameters : Start limitation/Number of starts  
 Description :

During this time interval the number of starts is limited by setting the parameter number of starts.

#### Number of starts

Function : Start limitation protection  
 Range : 1 (1) 100  
 Default setting : 2  
 Related parameters : Start limitation/Time interval  
 Description :

This parameter defines the number of allowed starts during a predefined time window set by the parameter time interval. If this value is set to one, the parameterized time interval will define the time between two consecutive starts.

# Long start protection

The long start protection function protects motors against lock or stall 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.

This protection function is active only during the parameterized motor startup time. If motor startup time has elapsed it will cause relay activation in case of a motor stall, but not long start protection.

Long start protection function is based on the highest measured phase current.

The parameters involved with the protection function are:

- Function enable/disable
- Locked rotor level
- Locked rotor delay
- Trip reset mode

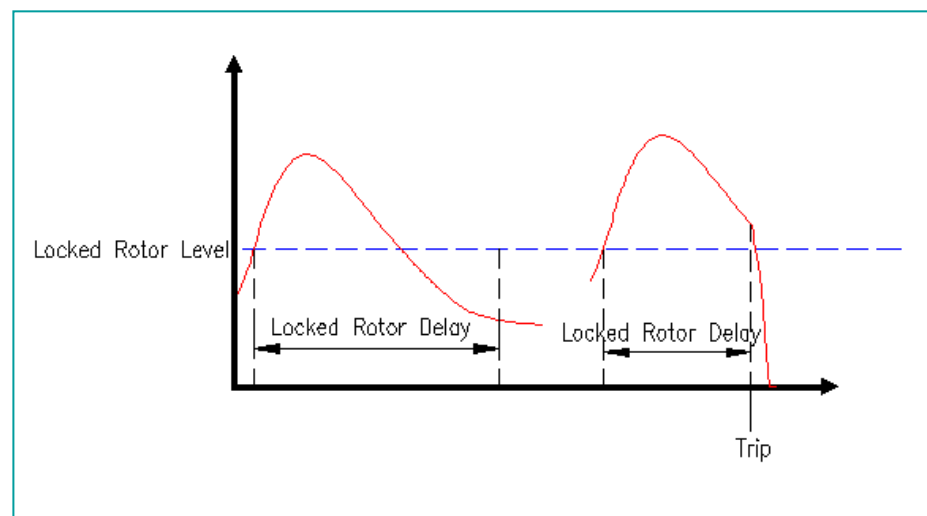


Fig. 19. Long start protection

#### Function enable/disable

Function : Long start protection  
Range : Enabled/Disabled/Alarm only  
Default setting : Disabled  
Related parameters : Long start protection/Parameters  
Motor information/Motor startup time  
Motor information/Motor startup time N2

Description :

The long start protection function can be disabled with the help of this parameter. When disabled, the protection function does not have any functionality in the M10x.

#### Locked rotor level

Function : Long start protection  
Range : 120 (10) 800 %  
Default setting : 120  
Related parameters : Long start protection/Function enable/disable  
Long start protection/Locked rotor delay

Description :

After a start signal, when the measured phase currents remain above the set value for a locked rotor delay time during the startup time, M10x will perform a trip with a long start trip message. If normal conditions are restored before the trip delay elapses, or parameterized motor startup time has elapsed, the M10x will go back to normal operation.

The trip level referenced to  $I_n$  is set based on the motor technical data sheet supplied by the manufacturer and the requirements/restrictions of the application.

#### Locked rotor delay

Function : Long start protection  
Range : 0 (1) 250 sec  
Default setting : 10sec  
Related parameters : Long start protection/Function enable/disable  
Long start protection/Locked rotor level

Description :

When measured current above the set value of locked rotor level during the startup time, the M10x will start countdown for the time specified in locked rotor delay parameter. The trip is followed with a long start trip message. The trip delay is set based on the requirements/restrictions of the application.

# Phase sequence Protection

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.

## Function Enable/Disable

Function : Phase sequence protection  
Range : Enabled/Disabled  
Default setting : Disabled  
Related parameters : Phase sequence protection/Parameters

Description :

A phase sequence trip can be reset in multiple ways depending on the control philosophy. It is possible to reset the trip as desired by parameterization.

## Trip Reset Mode

Function : Phase sequence protection  
Range : Remote/Local/Remote & Local  
Default setting : Remote & Local  
Related parameters : Phase sequence protection/Function

Description :

A phase sequence trip can be reset in multiple ways depending on the control philosophy. It is possible to reset the trip as desired by parameterization.

**Remote Reset:** Reset through fieldbus.

**Local Reset:** Reset through operator panel MD or local hardwiring

# Maintenance

Preventive maintenance is the best way to have long service life for any equipment. Maintenance function can be configured suitably as a reminder for preventive maintenance. The user reaps high benefits in terms of reduced process downtime and loss of production.

Maintenance function indicates the operation of the motor in terms of hours run and the usage of starter in the form of operating cycles. Number of hours run helps to assess the bearing life and its lubrication or replacement, whereas the number of operating cycles help in deciding replacement of worn-out power contacts or the contactor itself.

Maintenance alarm can be activated after lapse of the set counter. The counters can be set after maintenance according to two different principles depending, of course, on normal routine of the user.

Parameters of the maintenance function are:

- Running time alarm level
- Start number alarm level

## Running time alarm level

Function : Maintenance  
Range : 0 (1) 65,535 h  
Default setting : 65535(Disabled)  
Related parameters : --  
Description :

The user can set a period after which preventive maintenance is desired. When the running timer exceeds the preset running time alarm level, a running time alarm message is generated for the corresponding M10x. This helps to lubricate and maintain the bearings of the motor within the correct service interval.

When the parameter is set to 65535, the running time alarm is disabled.

## Start number alarm level

Function : Maintenance  
Range : 0 (1) 65,535  
Default setting : 65535(Disabled)  
Related parameters : --  
Description :

This parameter reflects the control cycles of contactors. Users can set this parameter in line with the electrical life of a contactor. When start counter has run through the set value of cycles in preset start number alarm level, the corresponding M10x generates a start number alarm message. This helps in carrying out preventive maintenance of power contacts.

When the parameter is set to 65535, the start number alarm is disabled.

# Diagnosis information (M10x-P only)

M10x, as a slave station, gives diagnosis information to master stations on the basis of the following three groups of information:

## **Group 1: Alarm information for selection:**

TOL, Overload, Phase failure, Phase unbalance, Underload, Noload, Earth fault, PTC, Undervoltage, Autoreclose, Contactor feedback, Welded contactor, PTC short circuit, PTC open circuit, Start limitation, Ready to trip reset, Running time, Start number, Serial communication, DI0, DI1, DI2, DI3, DI4, DI5, DI6, DI7, DI8, DI9, DI10, DI11, DI12

## **Group 2: Trip information for selection:**

TOL, Stalled failure, Phase failure, Phase unbalance, Underload, Noload, Earth fault, PTC, Undervoltage, Contactor feedback, Serial communication, Start limitation, Feeder, Long start, Emergency stop, External trip, DI0, DI1, DI2, DI3, DI4, DI5, DI6, DI7, DI8, DI9, DI10, DI11, DI12

## **Group 3: Other information for selection:**

Signal (input from terminal X1): DI0, DI1, DI2, DI3, DI4, DI5, DI6, DI7, DI8, DI9, DI10, DI11, DI12

Trigger resource: Field(RCU), MD, Fieldbus, DI0, DI1, DI2, DI3, DI4, DI5, DI6, DI7, DI8, DI9, DI10, DI11, DI12

Other Information: Block DP, Discrepancy in parameter settings, Hardware fault, Parameter status, Watchdog alarm, Current of last TOL trip

By tipping the ticket in front of each message, users can define which message needs to be sent.



DI9~DI12 are available only for the DC24V power of DIs.

# User definable map (M10x-M only)

The M10x-M contains a user definable area in the memory map. This area allows re-mapping of the addresses of any actual values or setpoints registers. The user definable area has two sections:

1. A register index area (memory map addresses 1100H-1114FH) that contains 80 actual values or parameter register addresses.
2. A register area (memory map addresses 0050H-009FH) that contains the data at the addresses in the register index.

Register data that is separated in the rest of the memory map may be re-mapped to adjacent register addresses in the user definable registers area. This is accomplished by writing to register addresses in the user definable register index area. This allows for improved throughput of data and can eliminate the need for multiple read command sequences. The user definable register index is stored as a parameter and therefore it is “remembered” even when the power is removed.

For example, if the values of phase L1 current (register address 0028H) and motor status (register address 0019H) are required to be read from a M10x-M, their addresses may be re-mapped as follows:

Write 0028H to address 1100H (User definable register index 0000) using function code 06H or 10H.

Write 0019H to address 1101H (User definable register Index 0001) using function code 06H or 10H.

It is now possible to read these two data registers with one read, at addresses 0050H, 0051H. Address 0050H will contain Phase L1 current and address 0051H will contain Motor state.

# User definable data (M10x-P only)

The M10x contains a user definable data area in the memory map. Three data structures are available for user to define in different applications. Up to 12 bytes data can be sent out to PROFIBUS master station with three options of 4 bytes, 8 bytes, 12bytes.

The functions for selection are as below:

## Type1: 4 bytes in and 2 bytes out

No bytes are mappable. But, in the Configurable area byte1 bit4-7 can be defined for DIs (DI0~DI12) by user.

## Type2: 8 bytes in and 2 bytes out

3 bytes in are mappable by master station.

Data assignable for byte4&5 ( two bytes value only) includes:  $I_{L1}/I_n$ ,  $I_{L2}/I_n$ ,  $I_{L3}/I_n$ ,  $U_{L1L2}$ ,  $U_{L2L3}$ ,  $U_{L3L1}$ , Power factor, Earth fault current, Power, Thermistor value, Running time, Start number, Frequency, Time to TOL trip, Time to TOL reset, Actual startup time.

Data assignable for byte6: Thermal capacity, Current unbalance

And 12 bits can be defined to DIs(DI0, DI1, DI2, DI3, DI4, DI5, DI6, DI7, DI8, DI9, DI10, DI11, DI12) by user:

- 4 bits come from Configurable area byte1 bit4-7.
- 8 bits come from User definable area byte 7 bit0-7



$U_{L1L2}$ ,  $U_{L2L3}$ ,  $U_{L3L1}$ , Power factor, Power, Thermistor value and Frequency are only available for M102 byte4 & byte5.

## Type3: 12 bytes in and 2 bytes out

7 bytes in are mappable by master station.

Data assignable for byte4&5 ( two bytes value only) includes:  $I_{L1}/I_n$ ,  $I_{L2}/I_n$ ,  $I_{L3}/I_n$ ,  $U_{L1L2}$ ,  $U_{L2L3}$ ,  $U_{L3L1}$ , Power factor, Earth fault current, Power, Thermistor value, Running time, Start number, Frequency, Time to TOL trip, Time to TOL reset, Actual startup time.

Data assignable for byte6&7 ( two bytes value only) includes:  $I_{L1}/I_n$ ,  $I_{L2}/I_n$ ,  $I_{L3}/I_n$ ,  $U_{L1L2}$ ,  $U_{L2L3}$ ,  $U_{L3L1}$ , Power factor, Earth fault current, Power, Thermistor value, Running time, Start number, Frequency, Time to TOL trip, Time to TOL reset, Actual startup time.



Data assignable for byte8&9 ( two bytes value only) includes:  $I_{L1}/I_n$ ,  $I_{L2}/I_n$ ,  $I_{L3}/I_n$ ,  $U_{L1L2}$ ,  $U_{L2L3}$ ,  $U_{L3L1}$ , Power factor, Earth fault current, Power, Thermistor value, Running time, Start number, Frequency, Time to TOL trip, Time to TOL reset, Actual startup time.

Data assignable for byte10: Thermal capacity, Current unbalance

And 12 bits can be defined to DIs(DI0, DI1, DI2, DI3, DI4, DI5, DI6, DI7, DI8, DI9, DI10, DI11, DI12) by user.

- 4 bits come from Configurable area byte1 bit4-7.
- 8 bits come from User definable area byte 11 bit0-7



$U_{L1L2}$ ,  $U_{L2L3}$ ,  $U_{L3L1}$ , Power factor, Power, Thermistor value and Frequency are only available for M102 byte4~byte9.

- i) Only the PROFIBUS master station can decide which of the cyclical data type (Type1, Type2 and Type3) will be mapped to the M10x.
- ii) MCUSetup software can be used to set the certain function for each configurable type or bit.
- iii) DI9~DI12 are only available for the DC24V power of DIs.

For more details, please refer to M10x-P PROFIBUS DP Implementation for M10x.

# MD LED

The MD(operation panel) has 4 LED indicators. Each LED can be configured with various color and function. As shown in Fig. 20 and 21, from top to the bottom, the LED is called LED1, LED2, LED3 and LED4.

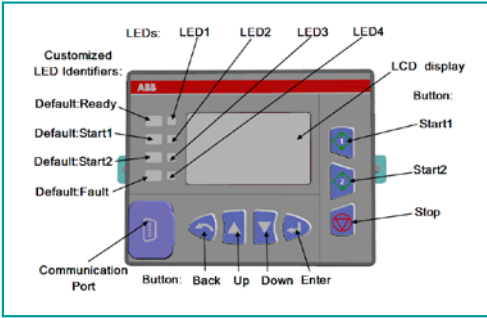


Fig.20. View of MD21

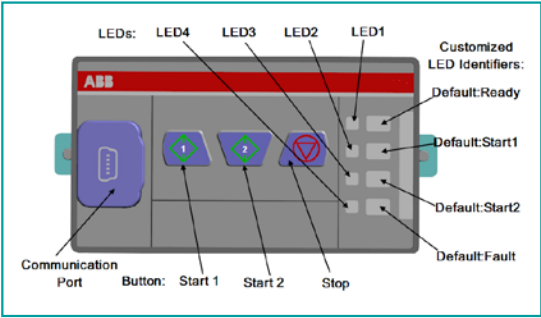


Fig.21. View of MD31

The parameters under MD LED for LED1~4 are :

- Color
- Function

## Color

Function : MD LED  
Range : Green(LED1), Green/Red(LED2 LED3), Red/Yellow(LED4)  
Default setting : Green(LED1), Red(LED2), Red(LED3), Yellow(LED4)  
Related parameters : MD LED/Function  
Description :

The parameter defines the color of each LED which is used to indicate the selected function.

## Function

Function : MD LED  
Range : Ready, Start1, Start2, Running, Stop, Ready to start, Fault,  
Default setting : DI0, DI1,DI2, DI3, DI4, DI5, DI6, DI7, DI8, DI9<sup>1</sup>, DI10<sup>1</sup>, DI11<sup>1</sup>, DI12<sup>1</sup>  
Related parameters : Ready (LED1), Start1(LED2), Stop(LED3), Fault(LED4)  
MD LED/Function  
Description :

The parameter defines the function of each LED. If motor is in the selected situation, the LED will be on. The definition of each function is listed below.

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 stopping or feeder is open
Ready to start	Motor ready to start, i.e. there is no active internal or external trip, motor is not under emergency stop state (if defined) & Main Switch is ON (if defined)
Fault	Motor is at fault
Dlx <sup>1</sup>	The status of Dlx



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



# MD21 Display option

MD21 supports up to 13 running parameter windows/pages. Users are free to configure which parameters are to be shown on MD21 panel and mask out unwanted information.

The following information is available for LCD display:

Actual current

Percentage current

Line voltage\*

Power related (include active power, reactive power, power factor)\*

Thermal capacity

Frequency\*

Energy\*

Earth fault current

PTC resistor value\*

Time to TOL performance (include time to TOL trip and time to TOL reset)

DI status

Startup time

Current phase unbalance



Parameters marked with “\*” are available in M102 only!

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