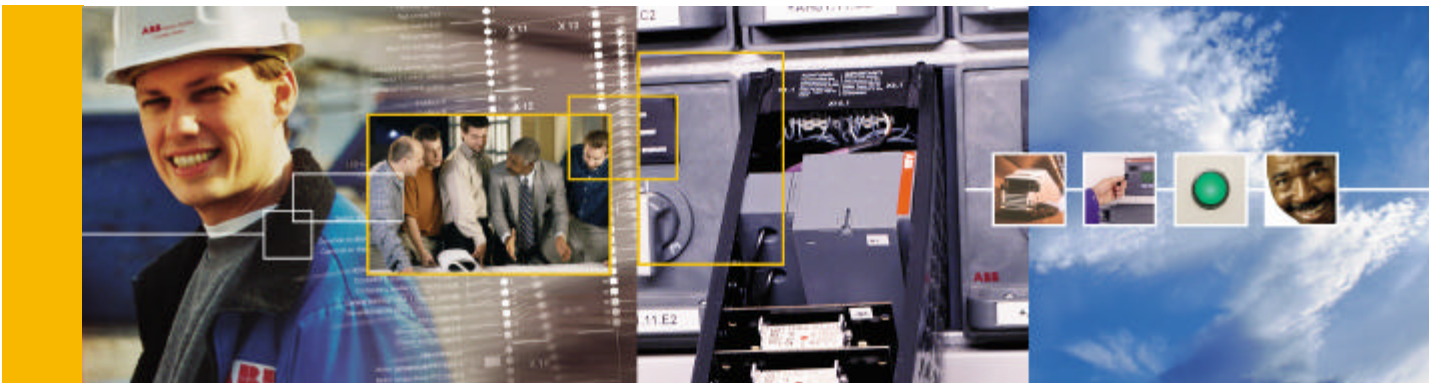


Protect IT – MNS Motor Management INSUM

MCU Parameter Description Version 2.1





INSUM[®]
MCU Parameter Description

Software Version 2.1

NOTICE

The information in this document is subject to change without notice and should not be construed as a commitment by ABB Schaltanlagentechnik GmbH. ABB Schaltanlagentechnik GmbH assumes no responsibility for any errors that may appear in this document.

In no event shall ABB Schaltanlagentechnik GmbH be liable for direct, indirect, special, incidental, or consequential damages of any nature or kind arising from the use of this document, nor shall ABB Schaltanlagentechnik GmbH be liable for incidental or consequential damages arising from use of any software or hardware described in this document.

This document and parts thereof must not be reproduced or copied without ABB Schaltanlagentechnik GmbH's written permission, and the contents thereof must not be imparted to a third party nor be used for any unauthorized purpose. Permission to translate the document shall be obtained from ABB Schaltanlagentechnik GmbH. The translated document shall be sent to ABB Schaltanlagentechnik GmbH together with the confirmation that the content of the document is the same.

The software described in this document is furnished under a license and may be used, copied, or disclosed only in accordance with the terms of such license.

© 2001 ABB Schaltanlagentechnik GmbH, Germany

TRADEMARKS

MNS and INSUM are registered trademarks of ABB Schaltanlagentechnik GmbH

Microsoft, Windows and Windows NT are registered trademarks of Microsoft Corporation.

Echelon, LON, LONWORKS, LonTalk, Neuron are trademarks of Echelon Corporation registered in U.S. and other countries.

Reference document 1SCA022641R4170A ABB Control Oy Finland

ABB INSUM

MCU Parameter Description

Software Version 2.1

1	Introduction	6
1.1	Objective	6
1.2	Related documentation	6
2	Document Overview	7
2.1	General	7
2.2	Parameter groups	7
3	Starter configuration	8
3.1	Starter Identifier	8
3.2	Starter Type (MCU1)	8
3.3	Starter Type (MCU2)	10
3.4	Number of Phases	12
3.5	External CT Installed	12
3.6	External CT1 Primary	13
3.7	External CT2 Primary	13
3.8	External CT Secondary	14
3.9	Latched Contactor	14
3.10	Torque Sensor	14
3.11	Feedback Supervision	15
3.12	Feedback Delay	15
3.13	Feedback Reset Mode	16
3.14	Em-Stop Reset Mode	16
3.15	MCB Reset Mode	16
3.16	External Trip Reset Mode	17
4	Motor data	18
4.1	Motor Identifier 1	18
4.2	Motor Identifier 2	18
4.3	Nominal current	19
4.4	Nominal Current N2	19
4.5	Startup I Ratio	20
4.6	Startup I Ratio N2	20
4.7	Motor Startup Time	21
4.8	Motor Startup Time N2	22
4.9	Autotrafo Start Time	22
4.10	S/D Changeover Basis	22
4.11	S/D Changeover Level	23
4.12	Softstart Ramp Time	23
4.13	Softstop Ramp Time	24
4.14	Motor Ambient Temperature	24
4.15	Failsafe Status	25
5	Thermal Overload Protection (TOL)	26
5.1	Function Enable, Disable	27
5.2	Thermal Model	28
5.3	Trip Class (t6)	28
5.4	Trip Class (t6) N2	31
5.5	Trip Class (te)	31
5.6	Trip Class (te) N2	32
5.7	Ia/In Ratio	33
5.8	Ia/In Ratio N2	33
5.9	Cool Down Time Factor	33
5.10	TOL Alarm Level	34
5.11	Trip Reset Mode	34
5.12	TOL Bypass Command	35
6	Stall Protection	36
6.1	Function Enable, Disable	36
6.2	Alarm Level	37
6.3	Trip Level	37
6.4	Trip Delay	37
6.5	Trip Reset Mode	38

ABB INSUM

MCU Parameter Description

Software Version 2.1

7	Rotation Monitor	39
7.1	Function Enable, Disable	39
7.2	Trip Delay	40
7.3	Trip Reset Mode	40
8	Phase Loss Protection	41
8.1	Function Enable, Disable	42
8.2	Alarm Level.....	42
8.3	Trip Level.....	42
8.4	Trip Delay	43
8.5	Trip Reset Mode	43
9	Unbalance Protection	44
9.1	Function Enable, Disable	44
9.2	Alarm Level.....	45
9.3	Trip Level.....	45
9.4	Trip Delay	45
9.5	Trip Reset Mode	46
10	Underload Protection	47
10.1	Function Enable, Disable	47
10.2	Alarm Level.....	48
10.3	Trip Level.....	48
10.4	Trip Delay	48
10.5	Trip Reset Mode	49
11	Cosphi Underload Protection.....	50
11.1	Function Enable, Disable	51
11.2	Alarm Level.....	51
11.3	Trip Level.....	51
11.4	Trip Delay	52
11.5	Trip Reset Mode	52
12	No Load Protection.....	53
12.1	Function Enable, Disable	53
12.2	Alarm Level.....	54
12.3	Trip Level.....	54
12.4	Trip Delay	54
12.5	Trip Reset Mode	55
13	Earth Fault Protection.....	56
13.1	Function Enable, Disable	57
13.2	Method.....	57
13.3	Residual CT Primary	58
13.4	Alarm Level.....	58
13.5	Trip Level.....	59
13.6	Trip Delay	59
13.7	Trip Reset Mode	59
14	Thermistor Protection.....	60
14.1	Temperature Protection Enable, Disable.....	61
14.2	Loop Supervision Enable, Disable.....	61
14.3	Cable Compensation	62
14.4	Alarm Level.....	63
14.5	Short Circuit Trip Level.....	63
14.6	Temperature Protection Trip Reset Mode	64
14.7	Loop Supervision Trip Reset Mode	64
15	Undervoltage Protection	65
15.1	Function Enable, Disable	66
15.2	External VT Installed.....	66
15.3	External VT Primary.....	67
15.4	External VT Secondary	67
15.5	Nominal Voltage	67
15.6	Alarm Level.....	68
15.7	Trip Level.....	68
15.8	Trip Delay	68
15.9	Reset Voltage Level.....	69

ABB INSUM

MCU Parameter Description

Software Version 2.1

15.10 Max. Autoreclose Time	69
15.11 Maximum Power Down Time	69
15.12 Staggered Start Time	70
15.13 Trip Reset Mode	70
16 Start Limitation Protection	71
16.1 Function Enable, Disable	72
16.2 Time Interval	72
16.3 Number of Starts	72
16.4 Trip Reset Mode	73
17 Start Interlock Protection	74
17.1 Function Enable, Disable	74
17.2 Interlock Time	74
17.3 Trip Reset Mode	75
18 Maintenance Functions	76
18.1 Preset Hours Run	76
18.2 Motor Hours Run Alarm	76
18.3 Preset CCa Cycles	77
18.4 CCa Cycles Alarm Level	77
18.5 Preset CCb Cycles	77
18.6 CCb Cycles Alarm Level	78
18.7 Preset CCc Cycles	78
18.8 CCc Cycles Alarm Level	78
19 Control Access	79
19.1 Function Enable /Disable	79
19.2 SU Lifelist Timeout	80
19.3 Station Priority	80
20 System	80
20.1 Failsafe Timeout	81
20.2 Status Heartbeat	81
20.3 NV Heartbeat Base	82
20.4 I Report Deadband	83
21 Device Data	84
21.1 Software ID	84
21.2 Parameter file version	84
21.3 Start inhibit level	84
21.4 Current unit (CU)	84
21.5 Voltage unit (VU)	84
21.6 TOL trip reset count	84
21.7 TOL bypass counter	84
21.8 Diagnostics	84
22 I/O Configuration	85
23 General purpose I/O	86
23.1 GpO1 ON Value	86
23.2 Gp O1 OFF Value	86
23.3 GpO2 ON Value	87
23.4 GpO2 OFF Value	87
23.5 Gpl1 ON Value	87
23.6 Gpl1 OFF Value	87
23.7 Gpl2 ON Value	88
23.8 Gpl2 OFF Value	88
Appendix A. MCU trip curves	89
Appendix B. PTC cable compensation tables	98
Appendix C. Terms and Abbreviations	104

INSUM[®]

MCU Parameter Description

Notes:

1 Introduction

1.1 Objective

The objective of this document is to provide a detailed parameter description of the INSUM field unit-Motor Control Unit (MCU).

Each chapter consists of

- a brief explanation of the function,
- the parameter description along with the range and the default value (factory setting)
- the related parameters
- availability of this parameter for MCU1 and MCU2

Wherever necessary further explanations and examples are given for user's reference.

1.2 Related documentation

1TGC 901007 C0201 INSUM Technical Information
1TGC 901020 M0201 INSUM MCU Users Guide
1TGC 901033 M0201 INSUM MMI Operating Instruction
1TGC 901041 M0201 INSUM Modbus Gateway Manual
1TGC 901051 M0201 INSUM Profibus Gateway Manual
1TGC 901070 M0201 INSUM Control Access Guide
1TGC 901071 M0201 INSUM Failsafe Guide
1TGC 901072 M0201 INSUM Dual Redundancy Guide
1TGC 901073 M0201 INSUM Network Management Guide

Notes:

2 Document Overview

2.1 General

The parameterisation of MCU can be performed by using a configuration or parameterization tool (e.g. INSUM MMI or INSUM Operator Station). The motor related parameters and the protection function are to be set based on the motor manufacturer's data sheet. Other parameters of Motor Control Unit are to be carefully selected based on the process and the system requirements.

While changing any parameter, the related parameters that are affected should be noticed by the user and shall be edited if necessary.

Parameter description describes the possible range of values for parameters.

2.2 Parameter groups

The parameterisation in the MCU is mainly classified into following functions

- Starter Configuration
- Motor Data
- TOL Protection
- Stall Protection
- Rotation Monitor
- Phase Loss Protection
- Unbalance Protection
- Underload Protection
- Cosphi Underload Protection
- Noload Protection
- Earthfault Protection
- Thermistor Protection
- Undervoltage Protection
- Start Limitation
- Start Interlock
- Maintenance
- Control Access
- System
- Device Data
- I/O Configuration
- General Purpose I/O

These functions are further subdivided into parameters, which need to be set individually. The above functions and its related parameters are covered in each of the subsequent chapters.

INSUM[®]

MCU Parameter Description

Notes:

3 Starter configuration

Starter configuration function consists of parameters which reflects the configuration of motor feeder. For example the ratings for external current transformers and contactor feedback supervision are included. Parameters involved with the starter configuration function are as below:

Function	Starter configuration
Available parameters	Starter Identifier Starter Type Number Of Phases External CT Installed External CT1 Primary External CT2 Primary External CT Secondary Latched Contactor (NR-DOL, REV-DOL) Torque Sensor (Actuator) Feedback Supervision Feedback Delay Feedback Reset Mode Em-Stop Reset Mode MCB Trip Reset Mode External Trip Reset Mode

3.1 Starter Identifier

Function	Starter configuration
MMI text	Starter identifier
Related MCU	1 and 2
Range	SPACE ! " # \$ % & ' () * + , - . / 0... 9 : ; < = > ? @ A..Z [\ \] ^ _ ' a...z { } ~
Default setting	MCC LOCATION
Related parameter	---
Description	see hereunder

The user can give a name for each motor starter (MCU) to simplify addressing and handling. A maximum of 21 characters (ASCII) can be assigned.

3.2 Starter Type (MCU1)

Function	Starter configuration
MMI text	Starter type
Related MCU	1
Range	NR-DOL, REV-DOL, NR-DOL/RCU
Default setting	NR-DOL
Related parameters	Starter configuration / Feedback supervision Motor data / Failsafe status Motor grouping / Group start direction Maintenance / Preset CCx cycles Maintenance / CCx cycles alarm level
Description	see hereunder

MCU supports different kinds of motor connections. This parameter need to be set according to type of control desired for the motor and related starter module equipment.

NR-DOL: Non Reversing Direct On Line.
 NR - Non Reversing means that the motor only runs in one direction.

INSUM[®]

MCU Parameter Description

Notes:

REV-DOL: Reversing Direct On Line.

REV- Reversing means that the motor can run in both directions (clockwise CW, counter clockwise CCW).

NR-DOL-RCU: Non Reversing Direct On Line (remote control of the contactor, bypassing the MCU).

Note! The internal relays CCa and CCb are electrically interlocked.

Following are the starter types explained in detail:

NR-DOL:

NR-DOL is non-reversing direct on line starters.

In "Local" mode, the motor starts and stops when the respective I/O is activated (X13:12 for start and X13:14 for stop).

In "Remote" mode, the motor starts and stops when the respective command (telegram) is sent via the fieldbus.

When a "Start" command is given, the internal relay CCa remains closed until a stop command is given. The internal relay CCb has no function here.

With Latched contactor parameter "Yes", the "Start" command closes the internal relay CCa for 1 sec. Similarly, the internal relay CCc closes for 1sec with a stop command. The type of power contactor in the motor circuits can be either normal or mechanically latched. This starter type along with Latched contactor parameter "Yes" can be used for solenoid starters.

REV-DOL:

REV-DOL is reversing direct on line starters. The motor can be run both directions (clockwise and counter clockwise) and can be stopped.

In Local mode, the motor starts CW/CCW when the respective I/O is activated (X13:12 for CW and X13:13 for CCW). The motor stops when the Stop I/O is activated (X13:14).

In remote mode, the motor starts CW/CCW or stop when the respective command is given via the fieldbus. When "Start CW" command is given, the internal relay CCa remains closed until the stop command is given. The direction of the motor can be changed only after a stop. Similarly, when CCW start command is given, the internal relay CCb remains closed until a stop command. The relay CCc has no function.

With Latched contactor parameter "Yes", the "Start CW" and "Start CCW" command closes the internal relay CCa and CCb for 1sec respectively. The stop command will close relay CCc for 1 sec. The type of power contactor in the motor circuits can be either normal or mechanically latched.

NR-DOL/RCU:

The "Start CW" command closes the internal relay CCa 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 MCU from the starter will not prevent RCU operation depending however on the connection (external relay and/or switch is used for start and stop). The stop pulse issued by the MCU will override the RCU-switch start position.

INSUM[®]

MCU Parameter Description

Notes:

3.3 Starter Type (MCU2)

Function	Starter configuration
MMI text	Starter type
Related MCU	2
Range	NR-DOL, REV-DOL, NR-DOL/RCU, REV-DOL/RCU, NR-S/D, NR-2N, Actuator and Autotrafo
Default setting	NR-DOL
Related parameters	Maintenance / CCx Cycles Preset, Alarm level Motor data / Failsafe status Starter configuration / Torque sensor (Actuator) Starter configuration / Feedback supervision Motor grouping / Group start direction Starter configuration / N2 parameters (NR-2N) Starter configuration / External CT installed (NR-2N) Starter configuration / S/D parameters (NR-S/D) Starter configuration / Latched (NR-DOL, REV-DOL) Starter configuration / Softstart/stop ramp time (NR-DOL, REV-DOL) TOL protection / N2 parameters (NR-2N)
Description	see herunder

The MCU2 supports more starter types than different kinds of motor connections. This parameter shall be set according to the type of control desired for the motor. For more details refer to Starter type (MCU1).

- NR-DOL: Non Reversing, Direct On Line.
- REV-DOL: Reversing, Direct On Line.
- NR-DOL-RCU: Non Reversing, Direct On Line; remote control of the contactor, bypassing the MCU.
- REV-DOL/RCU: Reversing Direct On Line; remote control of the contactor, bypassing the MCU.
- NR-S/D: Reduced voltage starting in star and running of the motor in delta after meeting the transition conditions.
- REV-S/D: Reversing reduced voltage starting in star and running of the motor in delta after meeting the transition conditions.
- NR-2N: Non-reversible two speed motor.
- REV-2N: Reversible two speed motor.
- ACTUATOR: Reversing starters for applications like valves, dampers, actuators etc.
- Autotrafo: Non-reversible motor starter based on reduced voltage via auto-transformer.

Note! Reversing two speed (REV-2N) and reversing star-delta (REV-S/D) starters are not supported functions by the software version 2.1.

Further details about the starter types are described in the MCU 2.1 Users Guide.

REV-DOL/RCU:

The "Start CW" and "Start CCW" command closes the internal relay CCa and CCb 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 MCU from the starter will not prevent RCU operation depending however on the connection (external relay and/or switch is used for start and stop). The stop pulse issued by the MCU will override the RCU-switch start position.

Note! The internal relays CCa and CCb are electrically interlocked.

NR-S/D:

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 "Motor startup time". The starting at a lower voltage also reduces shocks on the motor coupling, belts and the gear mechanisms. The starting current and the torque is 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 star to delta changeover can be done based on either "Time" or "Current". When the changeover is based on "time", the star to delta transition takes place after the parameterised *Motor startup time*.

INSUM[®]

MCU Parameter Description

Notes:

When the changeover is based on “current”, the star to delta transition takes place if the current is below the parameterised value *S/D changeover level* for more than 1sec. The *Motor startup time* is used as the timeout value.

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

The contactor “Feedback Supervision” function must be enabled during star-delta starter type.

During the contactor transitions, the MCU 2 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:

Two speed drives are used for applications requiring dual motor outputs. In case of two speed drives there are separate commands for the two speeds. When started by command ‘speed1’ the contactor CCa is closed and when started by command ‘speed2’ the contactor CCb is closed. The contactor CCc is used for stopping the motor. Two speed starter can be implemented either as “Dahlander” or “separate winding” starter. When “Dahlander” starter is implemented two contactor control outputs are used, thus one of the two contactors for speed N2 can be left out by masking the alarm from contactor feedback.

Current measurement for two speed starter uses external current transformer with fixed transformation ratio.

Actuators:

Actuator starters are reversing direct on line starters where the limit switch inputs are used to stop the motor from running further after reaching the respective end positions. When one of the limit switch inputs is active, the motor can be started in another direction only.

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 will inhibit the starting to the respective direction and indicate the respective stop position.

The “CFc/TORQUE” pin X13:20 or X14:9 is used as input for the torque sensor. If the torque sensor activates before the limit switch, the motor is tripped with a message ‘Torque trip’.

See truth table 1 and 2 for messages corresponding to I/O inputs:

Table 1. “Actuator” starter type without “Torque sensor”.

I/O	Limit activated	
Limit1 input X13-18	1	0
Limit2 input X13-19	0	1
	Stop “Open”	Stop “Close”

Table 2. “Actuator” starter type with “Torque sensor”.

I/O	Torque and limit activated		Only torque activated
Limit1 input X13-18	1	0	0
Limit2 input X13-19	0	1	0
Torque input X13-20	1	1	1
	Stop “Open”	Stop “Close”	Trip “Torque trip”

Autotrafo:

Auto-transformer is used in order to reduce motor start current during start condition. While reduced voltage limit the starting current also usable torque is limited significantly. This must be considered carefully when designing starter based auto-transformer.

Autotrafo starter uses three contactor control outputs but can be implemented as variant using two outputs, as well.

INSUM[®]

MCU Parameter Description

Notes:

3.4 Number of Phases

Function	Starter configuration
MMI text	Number of phases
Related MCU	1 and 2
Range	1 phase / 3 phase
Default setting	3 phase
Related parameters	Starter configuration / Starter type Earth fault protection / Method Phase loss protection / Function enable, disable Unbalance protection / Function enable, disable
Description	see hereunder

MCU can handle a single or three phase AC motor. Based on the number of phases of the motor, 1 or 3 can be selected. For single-phase motors, the motor current lead or the CT secondary lead (for > 63 A) is passed through any of the phase window of the MCU internal current transformer. If Cosphi based measurement or protection is required, the current input L1 shall be used. As an alternative, the current can be led through all the current transformer openings.

The phase loss protection is deactivated in MCU for single-phase selection. Single phase application is practicable with NR-DOL starter type.

Table 3. Functions not available for single phase applications.

Function	MCU1	MCU2
Phase loss protection	Function is disabled	Function is disabled
Unbalance protection	-	Function is disabled
Earth fault protection (Calculated)	-	Function is disabled

3.5 External CT Installed

Function	Starter configuration
MMI text	Ext.CT's installed
Related MCU	1 and 2
Range	No / 1 / 2
Default setting	No
Related parameter	Starter configuration / External CT secondary Motor data / Nominal current Motor data / Nominal current N2 Starter configuration / External CT1 primary Starter configuration / External CT2 primary
Description	see hereunder

The internal current transformer of the MCU can handle currents up to 63 A without an external transformer. However, INSUM allows using one or two external current transformer to handle motor current above 63 A to 6300A. While using external current transformers for Motor current > 63 A, this parameter is set to "1" or "2" thus indicating the number of installed current transformers. Else, the *External CT Primary* and the *External CT Secondary* parameters can not be set.

If *External CT installed* parameter is set to "No" inspite of an additional current transformer, the MCU will assume a false current. Value "1" indicates for one installed CT and transformation ratio is automatically calculated from *External CT1 Primary* and *External CT Secondary* values. For applications with two speed motors there is support by choosing value "2". This defines two separate external current transformers used for different motor windings, i.e. low speed (N1) and high speed (N2) with two speed motors. The number of external CTs are defined with the following rules.

INSUM[®]

MCU Parameter Description

Notes:

Parameter *External CT installed* value for one speed motor configuration

- is "0" when current in application <63 A
- is "1" when current in application >63 A.

Parameter *External CT installed* value for two speed configuration (NR-2N)

- is "0" when current is <63 A for both winding
- is "1" when current is <63 A for low and >63 A for high current winding
- is "2" when current is >63 A for both low and high current winding.

When two external CTs are selected there is an additional parameter *External CT2 primary* for the second current measurement. This provides possibility for different configurations with two speed starters.

The external current transformer should be of protection class with a composite error of maximum 5% and a saturation factor of at least 10. The secondary burden of the external CT shall be suitably selected based on the length and cross section of the secondary cable, and the CT secondary current rating.

3.6 External CT1 Primary

Function	Starter configuration
MMI text	Ext.CT1 primary
Related MCU	1 and 2
Range	10 (1) 6300 A
Default setting	150 A
Related parameters	Starter configuration / External CT installed Starter configuration / External CT secondary Motor data / Nominal current
Description	see hereunder

While using an external current transformer for motor nominal current > 63 A, the nominal primary current of the external current transformer is defined by this parameter.

Note! External current transformers are considered out of use if *External CT Primary* and *External CT Secondary* parameters has the same value or either has a value zero. That is even when *External CT Installed* is put to "Yes".

3.7 External CT2 Primary

Function	Starter configuration
MMI text	Ext.CT2 primary
Related MCU	1 and 2
Range	10 (1) 6300 A
Default setting	150 A
Related parameters	Starter configuration / External CT installed Starter configuration / External CT secondary Starter configuration / External CT1 primary Motor data / Nominal current N2
Description	see hereunder

To support different two speed motor or star delta starter implementations MCU have additional parameter *External CT2 primary* for second external current transformer. Functionality of this parameter is according to *External CT1 primary* parameter.

With two speed motor applications and external transformers there are following considerations required between primary current settings.

- In case of one external current transformer, parameter *External CT1 primary* apply for high current measurement.
- In case of two external current transformers parameter *External CT1 primary* is for low and "External CT2 primary" is for high current measurement.

INSUM[®]

MCU Parameter Description

Notes:

The other implementation, i.e. NR-S/D, using this parameter can utilize external current transformers, if enabled, always in configuration with two CT unit.

3.8 External CT Secondary

Function	Starter configuration
MMI text	Ext.CT 1,2 secondary
Related MCU	1 and 2
Range	0.10 (0.01) 3.20 A or 2.0 (0.1) 63.0 A
Default setting	3 A
Related parameters	Starter configuration / External CT installed Starter configuration / External CT1 primary Starter configuration / External CT2 primary Motor data / Nominal current
Description	see hereunder

While using an external current transformer for motor nominal current >63 A, the nominal secondary current of the external current transformer is defined by this parameter.

For example: Motor rating 45 kW, $I_n = 86A$ with an external current transformer 100/1.
 Set *External CT installed* = 1,
 Set *External CT primary* = 100A
 Set *External CT secondary* = 1A
 The range available in the MMI = 50...100 A
 Set *Nominal current* = 86A

3.9 Latched Contactor

Function	Starter configuration
MMI text	Latched contactor
Related MCU	2
Range	Enabled / Disabled
Default setting	Disabled
Related parameter	Starter configuration/Starter type (NR-DOL, REV-DOL)
Description	see hereunder

Latched contactor is an extension to DOL starter type and is used when pulses drive the contactors. The start and stop is achieved by means of latching and unlatching of the contactor mechanically. The NR-DOL starters make use of relay CCA and CCC to give the start and the stop commands respectively. The REV-DOL starters make use of relay CCA, CCB and CCC for CW, CCW and Stop respectively. The length of the pulse is 1-sec duration. Solenoid starters can be handled as single phase DOL with normal or latched contactors.

3.10 Torque Sensor

Function	Starter configuration
MMI text	Torque sensor
Related MCU	2
Range	Yes / No
Default setting	No
Related parameter	Starter configuration / Starter type
Description	see hereunder

INSUM[®]

MCU Parameter Description

Notes:

This parameter is used along with the actuator starter type. 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 will inhibit the starting to the respective direction and indicate the respective stop position.

Pin "CFc/Torque" of the MCU2 is used for the torque sensor. If the torque sensor is activated before the limit switch, the MCU will execute a 'Torque trip' message.

About functionality refer to *Starter type-Actuator*.

3.11 Feedback Supervision

Function	Starter configuration
MMI text	Feedback supervision
Related MCU	1 and 2
Range	Enabled / Disabled / Trip only / Alarm only
Default setting	Enabled
Related parameter	Starter configuration / Feedback delay Starter configuration / Starter type I/O configurations
Description	see hereunder

This parameter helps to identify contactor faults such as welding of contacts or burn out of coil. If the parameter is set to 'Disabled', then the feedback signal from the contactors are ignored.

If the parameter is set to 'Enabled', the contactor signals are evaluated according to the starter type chosen. The feedback supervision cyclically checks the status of contactor auxiliary contact and if contactor transition is not fulfilled in time set by *Feedback delay*, an alarm or trip will be indicated. Only alarm and trip indication can be selected with this parameter. When alarm only is selected supervision will not give trip and respectively, if trip only is selected alarm indication is not issued but trip activates with indication, in a fault situation.

In case of a difference between the MCU control command and the contactor auxiliary status, an 'Feedback alarm CFx' alarm is sent to the fieldbus. If a difference between the MCU control command and the current measurement, an 'Feedback trip CFx' alarm is sent and the contactor tripping will occur. If the current is still detected, inspite open command from the MCU, the contactor watchdog is operated and "Motor still running" trip reported.

In case of MCU1 and MCU2 with starter type NR-DOL/RCU and MCU2 with starter type NR-S/D, NR-DOL/RCU, and REV-DOL/RCU, the feedback supervision must always be enabled.

Note! All RCU type starters uses feedback supervision even being disabled by parameter. Feedback signalling from contactor auxiliary contacts are then required.

3.12 Feedback Delay

Function	Starter configuration
MMI text	Feedback delay
Related MCU	1 and 2
Range	100 (25) 5000 ms
Default setting	500 ms
Related parameter	Starter configuration / Feedback supervision
Description	see hereunder

#This parameter defines the time for contactor to execute transition open to close or close to open. Feedback delay timer activates from the command to operate output relay and counts up to parametrised *Feedback delay* time. During that time contactor transition must be detected in respective feedback input (CFx), pin X14:7 - X14-9, otherwise an alarm or trip indication occurs to inform of the control failure.

INSUM[®]

MCU Parameter Description

Notes:

3.13 Feedback Reset Mode

Function	Starter configuration
MMI text	Feedback reset mode
Related MCU	1 and 2
Range	Auto / Remote / Local / Remote & Local
Default setting	Remote & Local
Related parameter	Starter configuration/Feedback supervision
Description	see hereunder

The 'Feedback trip CFx' can be reset from various locations.

Auto: The 'Feedback trip CFx' is reset automatically on restoration of normal condition.

Remote reset: Trip reset is only possible via the fieldbus (MMI, PCS via GW or OS).

Local reset: Trip reset is only possible via the device I/O. By operating "RESET" switch connected to pin X13:15 resets the trip in the local mode. The local mode is activated with pin X13:16.

3.14 Em-Stop Reset Mode

Function	Starter configuration
MMI text	Em-Stop reset mode
Related MCU	1 and 2
Range	Auto / Remote / Local / Remote & Local
Default setting	Remote & Local
Related parameter	---
Description	see hereunder

The emergency stop command to the MCU, pin X13:17, will trip the motor with a message 'Em-Stop Activated'. With this reset mode parameter the required reset is selected.

Auto: The "Em-Stop Activated" trip is reset automatically on restoration of normal condition.

Remote: The "Em-Stop Activated" trip can be reset via the fieldbus (MMI, PCS via GW or OS) on restoration of normal condition.

Local: The 'Em-Stop Activated' trip reset is only possible via the device I/O. By operating "RESET" switch connected to pin X13: 15 resets the trip in the local mode. The local mode is activated with pin X13: 16.

Note! MCU Em-Stop inputs are only for annunciation. The primary protection function has to be realised according to national standards.

3.15 MCB Reset Mode

Function	Starter configuration
MMI text	Ext.trip reset mode
Related MCU	1 and 2
Range	Auto / Remote / Local / Remote & Local
Default setting	Auto
Related parameter	Starter configuration / External trip
Description	see hereunder

When the MCB input (Pin no. X14:06) is activated, a "MCB trip" message is sent to the fieldbus and the contactor is tripped. This parameter defines the reset mode for MCB trip.

Auto: The "MCB trip" is reset automatically on closing the MCB.

INSUM[®]

MCU Parameter Description

Notes:

Remote: The "MCB trip" can be reset via the fieldbus (MMI, PCS via GW or OS) on closing the MCB.

Local: The "MCB trip" reset is only possible via the device I/O. By operating "RESET" switch connected to pin X13:15 resets the trip in the local mode. The local mode is activated with pin X13:16.

3.16 External Trip Reset Mode

Function	Starter configuration
MMI text	Ext.trip reset mode
Related MCU	1 and 2
Range	Auto / Remote / Local / Remote & Local
Default setting	Auto
Related parameter	Starter configuration / External trip
Description	see hereunder

When the external trip input (Pin no. X14:03) is activated, a "External trip" message is sent to the fieldbus and the contactor is tripped. The external trip reset mode parameter defines the way the trip is reset.

Auto: The "External trip" is reset automatically when input restores to normal condition.

Remote: The "External trip" can be reset via the fieldbus (MMI, PCS via GW or OS) after restoring to the normal condition.

Local: The "External trip" reset is only possible via the device I/O. By operating "RESET" switch connected to pin X13:15 resets the trip in the local mode. The local mode is activated with pin X13:16.

INSUM[®]

MCU Parameter Description

Notes:

4 Motor data

Motor data consist of parameters related closely to motor protection settings. For example: Motor *Nominal current*, *Trip class* and *Ambient temperature* parameters of this function are used for calculating thermal capacity to protect the motor through TOL protection function.

Parameters involved with the motor data function are as below:

Function	Starter configuration
Available parameters	Motor Identifier 1
	Motor Identifier 2
	Nominal Current
	Nominal Current N2 (NR-2N)
	Startup I Ratio
	Startup I Ratio N2
	Motor Startup Time
	Motor Startup Time N2 (NR-2N)
	Autotrafo Start Time (Autotransformer)
	S/D Changeover Basis (NR-S/D)
	S/D Changeover Level (NR-S/D)
	Softstart Ramp Time (NR-DOL, REV-DOL)
	Softstop Ramp Time (NR-DOL, REV-DOL)
	Motor Ambient Temperature
	Failsafe Status

4.1 Motor Identifier 1

Function	Motor data
MMI text	Motor identifier 1
Related MCU	1 and 2
Range	SPACE ! " # \$ % & ' () * + , - . / 0 ... 9 : ; < = > ? @ A ... Z [\] ^ _ ' a ... z { } ~
Default setting	MOTOR TAG NUMBER
Related parameter	---
Description	see hereunder

The user can assign 21 characters (ASCII) to describe the location or function of the motor.

4.2 Motor Identifier 2

Function	Motor data
MMI text	Motor identifier 2
Related MCU	1 and 2
Range	SPACE ! " # \$ % & ' () * + , - . / 0 ... 9 : ; < = > ? @ A ... Z [\] ^ _ ' a ... z { } ~
Default setting	MOTOR DESCRIPTION
Related parameter	---
Description	see hereunder

The user can give 21 characters (ASCII) to further identify the motor.

INSUM[®]

MCU Parameter Description

Notes:

INSUM allows four ways of identifying a motor; one starter identifier, two motor identifiers and by LON address of the device. The user can address the motor in relation to the process, switchgear, KKS number etc. with the help of these identifiers.

Example: Conveyor belt - starter identifier
 KKS no.... - Motor identifier1
 MCC-19BFA - Motor identifier2
 0/1/32... - LON address (domain/subnet/node)

Additionally, the visualisation at the MMI, OS, and PCS can be done using any of these four alternatives.

4.3 Nominal current

Function	Motor data
MMI text	Nominal current / Nominal current N2
Related MCU	1 and 2
Range	0.10 (0.01) 3.20 A, 2.0 (0.1) 63.0 A, and 0.1 (0.1) 1.0 Iprim
Default setting	3.2 A
Related parameters	Starter configuration / External CT parameters
Description	see hereunder

This is the rated current (In) of the motor, at rated load, at rated voltage and frequency. The value is given on the motor rating plate. The MCU automatically detect which of the internal CTs is connected, and the range is displayed accordingly. The rated current can be set within this range.

In the case of starter with external current transformers, the range is dependent on the nominal primary current of the current transformer. The range varies from 0.1 to 1.0 of CT nominal primary current.

Example: In the case of an external current transformer of 100/*A, the range varies from 10 to 100 A. The nominal motor current can be set within this range.

4.4 Nominal Current N2

Function	Motor data
MMI text	Nominal current N2
Related MCU	2
Range	0.10 (0.01) 3.20 A, 2.0 (0.1) 63.0 A, and 0.1 (0.1) 1.0 Iprim
Default setting	3.2 A
Related parameters	Starter configuration / Starter type (NR-2N) Starter configuration / External CT parameters
Description	see hereunder

This parameter is used along with the two speed starter types. It is the rated current In of the motor for speed N2 (In2), at rated load, at rated voltage and frequency. The value is given on the motor rating plate. The current N2 shall be within the current range.

INSUM[®]

MCU Parameter Description

Notes:

4.5 Startup I Ratio

Function	Motor data
MMI text	Startup I ratio / Startup I ratio N1
Related MCU	1 and 2
Range	1.0 (0.1) 10.0
Default setting	2.0
Related parameter	Starter configuration / Starter type Motor data / Nominal current Motor data / Motor startup time TOL protection / Trip class TOL protection / TOL alarm
Description	see hereunder

This parameter is a setting of the ratio between the startup current and the nominal current (I_s/I_n).

When a motor starts, it draws a high current of the order of 6 to 8 times the nominal current (I_n). The motor startup current varies from one motor to another and may differ from manufacturer to manufacturer. This data along with *Motor startup time* (ts) is essential for the relay, as this represents the design and construction of the motor largely, thereby deciding the thermal capacity required by the motor during startup.

The *Startup I ratio*, *Motor startup time* and *Trip class* decide the startup inhibit level; below which a successful start of the motor can be made.

The startup inhibit level is a read only parameter in the Device Data section.

4.6 Startup I Ratio N2

Function	Motor data
MMI text	Startup I ratio N2
Related MCU	2
Range	1.0 (0.1) 10.0
Default setting	2.0
Related parameter	Starter configuration / Starter type (NR-2N) Motor data / Startup I ratio TOL protection / TOL alarm
Description	see hereunder

This parameter allows setting of the startup current ratio (I_{s2}/I_{n2}) between the two-speed motor startup current (I_{s2}) and motor nominal current (I_{n2}).

Also refer to *Startup I ratio*.

INSUM[®]

MCU Parameter Description

Notes:

4.7 Motor Startup Time

Function	Motor data
MMI text	Motor startup time / Motor startup time N1 / S/D changeover time
Related MCU	1 and 2
Range	1 (1) 600 s
Default setting	5.0 s
Related parameter	Starter configuration / Starter type (all) Motor data / Startup I ratio Motor data / Nominal current Motor data / S/D changeover basis TOL protection / TOL alarm Unbalance protection / Function enable, disable Phase loss protection / Function enable, disable Rotation monitor / Function enable, disable Earth fault protection / Function enable, disable Stall protection / Function enable, disable Cosphi underload protection / Function enable, disable
Description	see hereunder

Motor startup time (t_s) 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 along with the *Startup I ratio* and *Trip class* decides the startup inhibit level.

This parameter defines the length of time for the startup phase of the motor during which a set of functions or protections are disabled. The disabled functions are listed in the table.

Table 4. Functions which are disabled during *Motor startup time*.

Function	MCU1	MCU2
"O/L alarm" message	Alarm is not issued	Alarm is not issued
Stall protection	Protection is disabled	Protection is disabled
Unbalance protection	-	Protection is disabled
Cosphi underload protection	-	Protection is disabled
Earth fault protection	-	Protection is disabled (measured and calculated)

The parameter is used as switching time for starter type NR-S/D.

Notes:

4.8 Motor Startup Time N2

Function	Motor data
MMI text	Motor startup time N2
Related MCU	2
Range	1 (1) 600 s
Default setting	5.0 s
Related parameter	Motor data / Motor startup time Starter configuration / Starter type (NR-2N) TOL protection / TOL alarm
Description	see hereunder

This parameter is like *Motor startup time* (t_s) but dedicated for speed N2 (t_{s2}). During this time protection functions defined for *Motor startup time* are disabled.

4.9 Autotrafo Start Time

Function	Motor data
MMI text	Autotrafo start time
Related MCU	2
Range	0 (1) 5 sec
Default setting	5.0 s
Related parameter	Starter configuration / Starter type (Autotransformer) Underload protection / Function enable, disable
Description	see hereunder

This parameter is used along with autotransformer starter type. It defines the time that motor is running with reduced voltage. When this time is elapsed motor is connected to direct line voltage.

Table 5. Functions not available during *Autotrafo start time*.

Function	MCU2
Underload protection	Function is disabled

4.10 S/D Changeover Basis

Function	Motor data
MMI text	S/D changeover basis
Related MCU	2
Range	Time / Current
Default setting	Current
Related parameter	Starter configuration / Starter type (NR-S/D) Motor data / S/D changeoverlevel Motor data / Motor startup time
Description	see hereunder

The star to delta changeover can be done based on either "current" or "time". When the selected *S/D changeover basis* is "time", the star to delta transition takes place after a pre-parameterised motor startup time. When the selected *S/D changeover basis* is "current", the star to delta transition takes place after the start-up current reaches a pre-defined value. Current must go down from higher (inrush) to lower current.

INSUM[®]

MCU Parameter Description

Notes:

4.11 S/D Changeover Level

Function	Motor data
MMI text	S/D changeover level
Related MCU	2
Range	10 (10) 100%
Default setting	80 %
Related parameter	Motor data / S/D changeover basis Starter configuration / Starter type (NR-S/D) Motor data / Motor startup time
Description	see hereunder

When the measured current is used as criteria for S/D switching condition, it is compared against the parameterised changeover current value. The switchover from star to delta is executed when the current remains below the parameterised value for a time longer than a fixed 1s delay. The current value is parameterised in proportion to the motor nominal current. The *Motor startup time* is used as the timeout value after which the contactor opens with a message "Stall trip" indicating S/D changeover failure.

4.12 Softstart Ramp Time

Function	Motor data
MMI text	Softstart ramp time
Related MCU	2
Range	0 (1) 1200 s
Default setting	0 s
Related parameter	Starter configuration / Starter type (NR-DOL, REV-DOL) Motor data / Softstop ramp time Phase loss protection / Function enable, disable Unbalance protection / Function enable, disable Earth fault protection / Function enable, disable Underload protection / Function enable, disable Cosphi underload protection / Function enable, disable
Description	see hereunder

This parameter must be used when MCU is controlling motor via a softstarter unit. Softstarter unit is a separate unit limiting the voltage during motor start thus limiting also inrush current. Softstarter unit has a set of parameters for the start and stop of the motor. MCU is adapted to start ramp time by setting the *Softstart ramp time* \geq selected start ramp time of the motor. Upon this parameter the listed protection functions are deactivated:

Table 6. Functions not available during *Softstart ramp time*.

Function	MCU1	MCU2
Phase loss protection	Function is disabled	Function is disabled
Underload protection	Function is disabled	Function is disabled
Cosphi underload protection	-	Function is disabled

MCU2 will give start/stop commands to the softstarter. The motor protection is done by the softstarter.

Note!

MCU unit alone will not act as a softstarter unit when *Softstart ramp time* or *Softstop ramp time* parameters has been set. A softstarter is always needed for this functionality.

The accuracy of the current measurement is affected by the harmonics caused by the soft starters. This may harm especially the earth fault detection based on vector sum method (calculation).

INSUM[®]

MCU Parameter Description

Notes:

4.13 Softstop Ramp Time

Function	Motor data
MMI text	Softstop ramp time
Related MCU	2
Range	0 (1) 1200 s
Default setting	0 s
Related parameter	Starter configuration / Starter type (NR-DOL, REV-DOL) Motor data / Softstart ramp time
Description	see hereunder

Softstarter unit has a parameter which is used to select the stop ramp time of the motor. MCU is adapted to this stop time by setting the *Softstop ramp time* \geq selected stop ramp time of the motor.

Within the time defined by this parameter the listed functions are deactivated:

- “Motor still running” trip

4.14 Motor Ambient Temperature

Function	Motor data
MMI text	Motor ambient temp.
Related MCU	1 and 2
Range	+30 (5) 80 °C
Default setting	+40 °C
Related parameter	TOL protection / Thermal model Motor data / Nominal current TOL protection / Trip class TOL protection / Trip class te time TOL protection / TOL, and O/L Alarm
Description	see hereunder

Motors of basic design are intended for operation in a maximum ambient temperature (T_{AMB}) 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 MCU but it is also possible to do it manually which is instructed later in this chapter.

To calculate the thermal image of the motor being protected, the MCU 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 temperature 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 MCU. Instead of using ambient temperature parameter MCU uses fixed value 40°C, thus multiplier is one (1) when TOL EEx e model is selected.

Table 7. The MCU reduces the maximum permitted current by the multiplier as indicated in the table below (TOL standard model).

Ambient temp. °C	40	45	50	55	60	65	70	75	80	Ambient temp. °C
Permitted current = $I_n \times$	1,00	0,96	0,92	0,87	0,82	0,74	0,65	0,58	0,50	Permitted output, % of rated output

INSUM[®]

MCU Parameter Description

Notes:

For 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 multiplier 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 multiplier is calculated this way it must be applied to trip class time as well (Is/TFLC).

For example: Motor data sheet specifies that in 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,

$$\text{Nominal current} = 0.75 \times I_n$$

When nominal current is derated *Trip class* parameter is defined with the same factor. It should also be considered that other parameter's, i.e. protection function trip and alarm levels, referring to *Nominal current* parameter are effected relatively.

4.15 Failsafe Status

Function	Motor data
MMI text	Failsafe status
Related MCU	1 and 2
Range	Start / Start CW / Start CCW / Stop / NOP (No operation)
Default setting	NOP
Related parameter	Starter configuration / Starter type System / Failsafe timeout ICU devices (MMI, OS, GW) / Failsafe heartbeat, Failsafe timeout
Description	see hereunder

INSUM offers a failsafe function where the user has the possibility to decide motor status after a failure either in MCU internal communication or PCS communication to INSUM.

If the communication to a PCS is disturbed the ICU devices will initiate the failsafe command and all MCU will executed the pr-parameterized command.

If the MCU detects a failure in communication, the command is executed after a pre-parameterised failsafe timeout.

Depending on the heartbeat parameterisation, a relatively short break in the communication is accepted with no activation of failsafe function.

Refer to 'INSUM Failsafe Guide' for more information.

INSUM[®]

MCU Parameter Description

Notes:

5 Thermal Overload Protection (TOL)

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

The thermal image is calculated based on the highest of the three measured phase currents and depends on the parameterised data such as *Trip class* (t_6), *Motor ambient temperature* (T_{AMB}), *Motor startup I ratio* (I_s/I_n), *Motor startup time* (t_s) and *Cool down time factor* (Mt_6).

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 100%, the thermal overload trip will occur. The TOL trip can be reset after the thermal image goes below the motor startup inhibit level. The motor can be restarted only after TOL trip is reset.

The startup inhibit level depends on the *Trip class* (t_6), motor *Startup I ratio* (I_s), and the *Motor startup time* (t_s).

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 till it reaches the background heat level, after which it depends on the parameters *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 947-4-11.e with a motor current $1.05 \times TFLC$ running for 2 hrs will not cause TOL-trip and subsequent rise in current to $1.2 \times TFLC$ will cause trip within 2 hrs.

The time to trip calculation begin when the current is above $1.14 \times I_n$. The time to reset is calculated after TOL trip and is equal to zero when the thermal image reaches the startup inhibit level.

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

Parameters involved in TOL protection are as below:

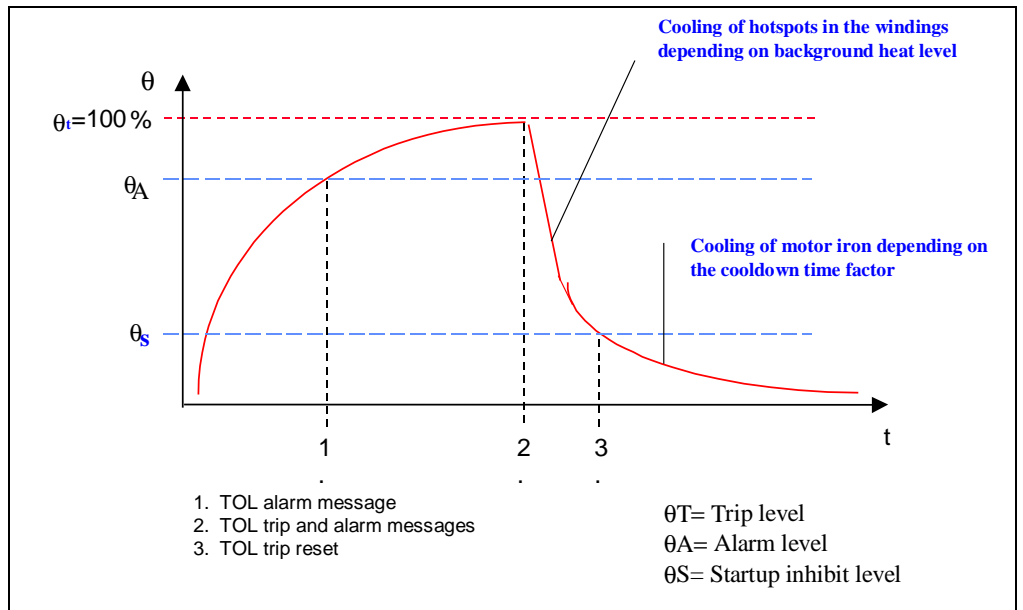
Function	Starter configuration	
Available parameters	Function Enable / Disable	
	Thermal Model	
	Trip Class (t_6)	(Standard)
	Trip Class (t_6) Time N2	(Standard)
	Trip Class (t_e)	(EEx e)
	Trip Class (t_e) Time N2	(EEx e)
	I_a/I_n Ratio	(EEx e)
	I_a/I_n Ratio N2	(EEx e)
	Cool Down Time Factor	
	TOL Alarm Level	
	Trip Reset Mode	
	TOL Bypass Command	(Standard)

INSUM[®]

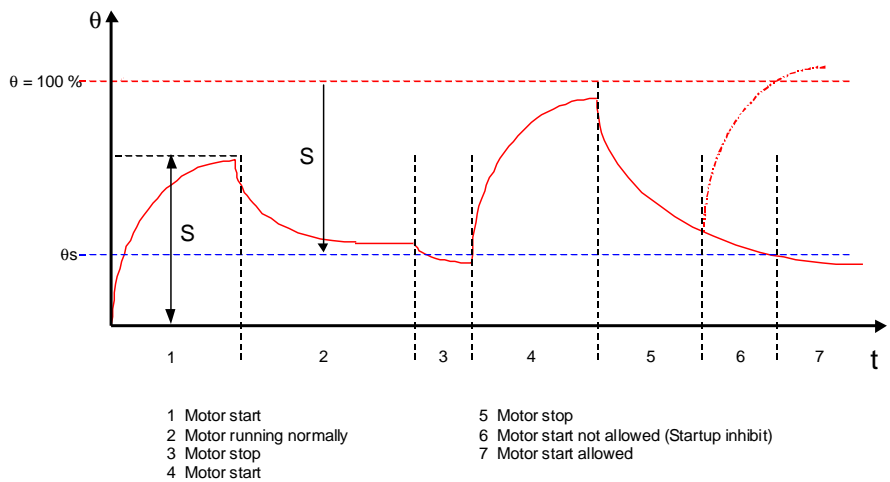
MCU Parameter Description

Notes:

Picture 1. Illustration of motor thermal simulation behaviour.



Picture 2. Motor thermal simulation behaviour during repeated starts.



5.1 Function Enable, Disable

Function	TOL protection
MMI text	Function
Related MCU	1 and 2
Range	Enabled / Disabled / Trip only / Alarm only
Default setting	Enabled
Related parameter	TOL protection parameters
Description	see hereunder

TOL protection function can be disabled with this parameter. When disabled, all other parameters of the function (i.e. *Trip class*, *TOL alarm level*, *Trip reset mode* and *Cool down time factor*) do not have any functionality in the starter configuration unit (hidden in MMI and greyed out in OS).

INSUM[®]

MCU Parameter Description

Notes:

5.2 Thermal Model

Function	TOL protection
MMI text	Thermal model
Related MCU	2
Range	Standard / EEx e
Default setting	Standard
Related parameter	TOL protection / Parameters Thermistor protection / Trip level, reset level Motor data / Motor ambient temperature
Description	see hereunder

The thermal model can be selected as either standard or EEx e. The standard model makes use of parameters *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* (I_n) 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 *Ia/In ratio* (stall/nominal current 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 value do not have effect to functionality in this case.

When EEx e thermal model is selected the listed functions do have special functionality:

Table 8. Functions which are disabled when EEx e thermal model is selected.

Function	Parameter	Remarks
Starter configuration	Motor ambient temperature	Fixed 40°C value
Thermal protection	TOL bypass command	Command not allowed
Thermistor protection	Temperature protection enable, disable	'Alarm only' not allowed
Thermistor protection	Loop supervision enable, disable	'Alarm only' not allowed

5.3 Trip Class (t6)

Function	TOL protection
MMI text	t6 time / t6 time N1
Related MCU	1 and 2
Range	5 (1) 40 s
Default setting	10 s
Related parameter	TOL protection / Thermal model (standard) Motor data / Nominal current Motor data / Startup I ratio Motor data / Motor ambient temperature
Description	see hereunder

Parameter *Trip class* (t6) is the basic setting of the thermal protection function. For user it provides the possibility to set the thermal model characteristic according to motor startup requirements and characteristic. With *Trip class* (t6) parameter user defines the time that protection allows current of $6 \times I_n$ from cold condition for protected motor.

INSUM[®]

MCU Parameter Description

Notes:

Normally the *Trip class (t6)* value can be set according to one cold start, which allows easy setting of protection. However, when a requirement of one start for hot motor exists the setting is derived for the motor according to hot condition thermal protection time/current characteristic.

The *Trip class (t6)* time for protection is defined based on the motor maximum start time which is informed 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 s
- Maximum start time for warm motor 15 s
- 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 of ambient temperature, the following calculation for start current can be passed. For more information of ambient temperature coefficient see table of maximum permitted current in chapter "*Motor 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 x I_n .

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

$$I_s = \frac{I_s}{I_n} \times I_n$$

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

$$\frac{I_s}{\text{TFLC}} = \frac{7.5 \times I_n}{1.00 \times I_n} = 7.5 .$$

The calculated start current ratio (7.5) and motor maximum start time (30 second) 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)*.

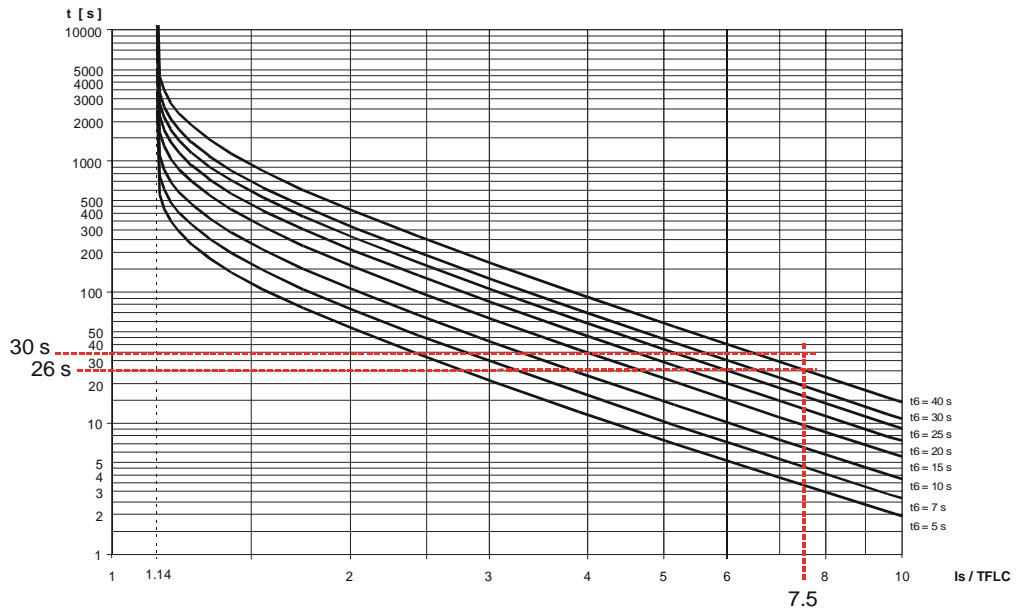
The received setting is the absolute maximum value without further considerations and a lower value can be selected. A longer start is not protected by thermal protection and additional protection against stalled rotor is necessary. In case of thermal protection trip at start, with the setting of maximum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

Now, the setting of 40 second is limited by the range of parameter. Value for *Trip class (t6)* is derived from the cold condition time/current diagram, see the picture. This setting allows start time up to approx. 26 second 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 the latter picture.

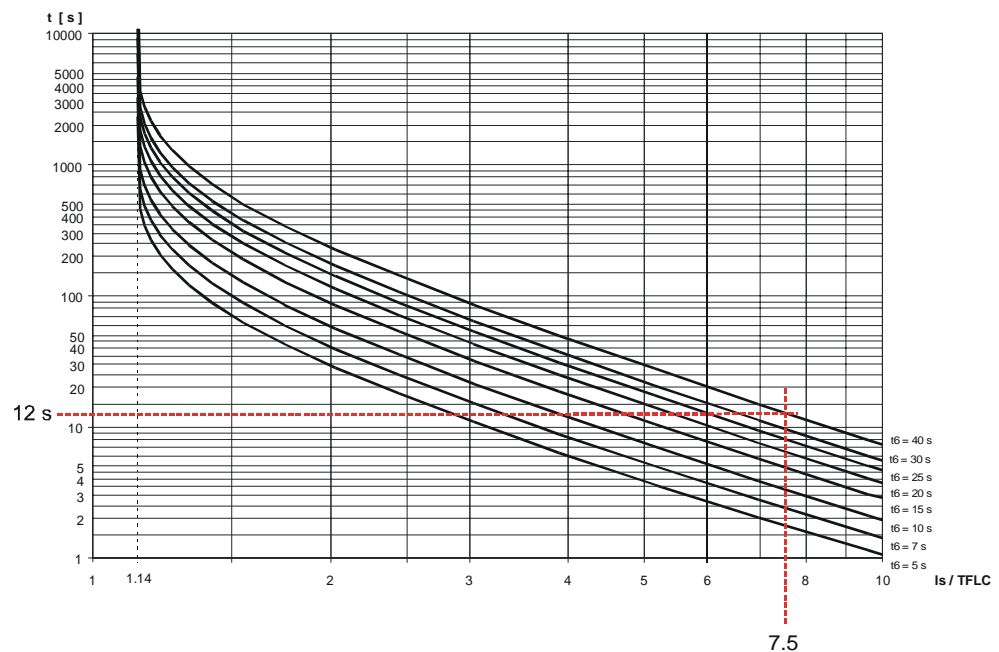
The warm condition start must be within motor ratings. In this case, the start time for a warm motor is approximated from the latter picture and must be shorter than 12 second, as read from the picture. In practice, start lasting longer than 12 second, will lead to trip from the thermal protection.

Notes:

Picture 3. Trip class (t_6) definition from cold condition time/current diagram. Diagram presented in 40°C Motor ambient temperature.



Picture 4. Start time vs. Trip class (t_6) definition from hot condition time/current diagram. Diagram presented in 40°C Motor ambient temperature.



More optimized setting of thermal protection is needed in case of one start for warm motor is required. In this case the Trip class (t_6) 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 (t_6) 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, i.e. the protection is well defined.

There is a need to arrange a separate protection for unsuccessful start, i.e. stalled rotor, if the thermal protection characteristic allows longer start before trip than is allowed for the motor. Then stall protection is utilised for a cold motor start supervision. By defining the operation of Motor startup time and stall protection Trip delay the trip must be set before motor maximum start time is exceeded, in case of unsuccessful start.

INSUM[®]

MCU Parameter Description

Notes:

5.4 Trip Class (t6) N2

Function	TOL protection N2
MMI text	t6 time N2
Related MCU	2
Range	5 (1) 40 s
Default setting	10 s
Related parameter	Starter configuration / Starter type (NR-2N) TOL protection / Trip class
Description	see hereunder

This parameter gives the user a possibility to set the maximum time that a motor can handle 6 times the nominal current (t6-time) for two speed motor second winding N2.

Thermal behaviour in two speed motors is simulated by calculating thermal level from the actual winding and its parameters. Thermal flow between winding is considered to be 100%.

For more details refer to parameter *Trip class (t6)*.

5.5 Trip Class (te)

Function	TOL protection
MMI text	te time
Related MCU	2
Range	5.0 (0.1) 30.0 sec
Default setting	5.0 s
Related parameter	TOL protection / Thermal model (EEx e) TOL protection / Ia/In ratio Motor data / Motor ambient temperature
Description	see hereunder

The safe locked rotor time (te) 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. Parameterised 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 MCU unit to calculate the trip time of the motor according to the load. MCU 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 following cold condition time/current diagram. Diagram is according to TOL standard model cold condition.

Initial information, as parameterised, is required.

- *Ia/In ratio* for EEx e motor
- *te time* for EEx e motor

When *Ia/In ratio* is placed on the current (Is/TFLLC) axis and te 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 t6 curve. According to defined t6 curve trip time vs. motor current are available from cold condition time/current diagram. The same t6 curve can be used for defining the trip time from a hot condition time/current diagram, as well.

For example: *Ia/In ratio* for an EEx e motor is 7 and parameter *te time* value is 7 seconds. By using the following cold condition time/current diagram t6 curve can be found. When t6 curve is defined other trip times vs motor current are available.

INSUM[®]

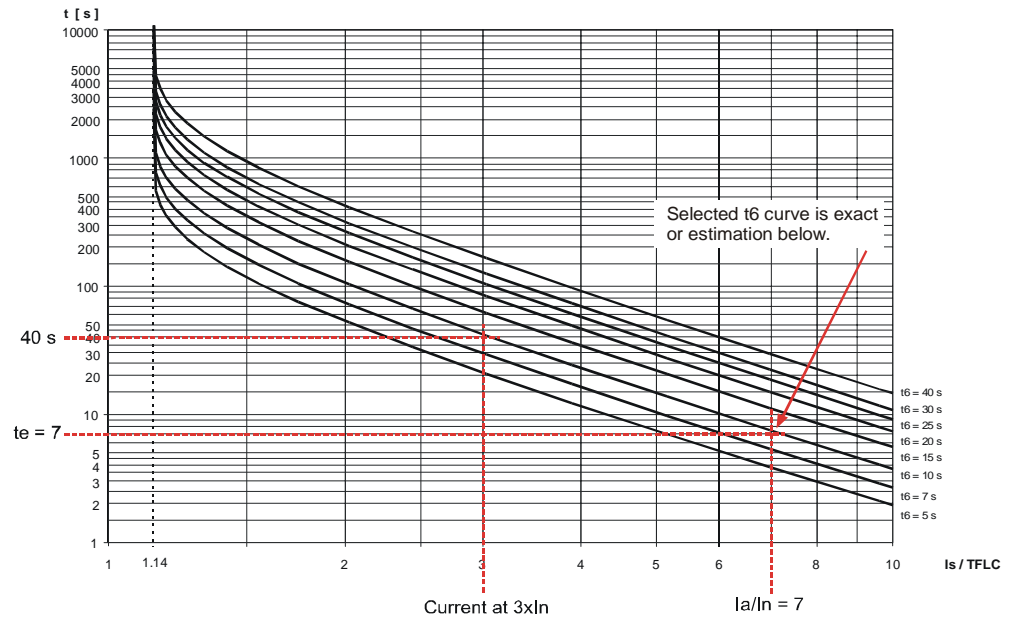
MCU Parameter Description

Notes:

Motor ambient temperature is not observed because it does not have effect in TOL EEx e model usage, thus I_a/I_n ratio can directly be used (see parameter *Motor 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 seconds is estimated from the example picture below and is drawn to the diagram. Trip time for current $3 \times I_n$ is estimated approx. 40 seconds.

Picture 5. Trip class definition for TOL/EEx e model from cold condition with time/current diagram. Diagram presented in 40°C *Motor ambient temperature*.



5.6 Trip Class (t_e) N2

Function	TOL protection N2
MMI text	t_e time N2
Related MCU	2
Range	5.0 (0.1) 30.0 sec
Default setting	5.0 s
Related parameter	Starter configuration / Starter type (NR-2N) TOL protection / Thermal model TOL protection / Trip class t_e time
Description	see hereunder

The parameter *Trip class (t_e) N2* defines the time second winding N2 for EEx e motor withstand I_a/I_n current. This information is rated for EEx e motor and available in motor data sheet.

For more details refer to parameter *Trip class (t_e)*.

INSUM[®]

MCU Parameter Description

Notes:

5.7 Ia/In Ratio

Function	TOL protection
MMI text	Ia/In ratio / Ia/In ratio N1
Related MCU	1 and 2
Range	1.0 (0.1) 10.0
Default setting	5.0
Related parameter	TOL protection / Thermal model (EEx e) TOL protection / Trip class te time
Description	see hereunder

It is the ratio of stall current to the nominal current (Ia/In) for EEx e application. The motor shall withstand this current for the duration *Trip class te time*. This information is rated for EEx e motor and available in motor data sheet.

5.8 Ia/In Ratio N2

Function	TOL protection N2
MMI text	Ia / In ratio N2
Related MCU	2
Range	1.0 (0.1) 10.0
Default setting	5.0
Related parameter	Starter configuration / Starter type (NR-2N) TOL protection / Thermal model TOL protection / Trip class (te) N2
Description	see hereunder

This parameter defines the ratio between the stall current to the nominal current (Ia/In) of the second winding N2 for EEx e motor. This information is rated for EEx e motor and available in motor data sheet.

For more details refer to *Trip class (te)* parameter.

5.9 Cool Down Time Factor

Function	TOL protection
MMI text	Cooldown factor
Related MCU	1 and 2
Range	1 (1) 100
Default setting	4
Related parameter	---
Description	see hereunder

For an accurate thermal image of the motor, MCU 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 cool down. Motor warming up is simulated via calculated function while cooling down is simulated by using *Cool down time factor* (Mt6). 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, e.g. 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 practise, this has been discovered as the normal rule for motors covering various applications.

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

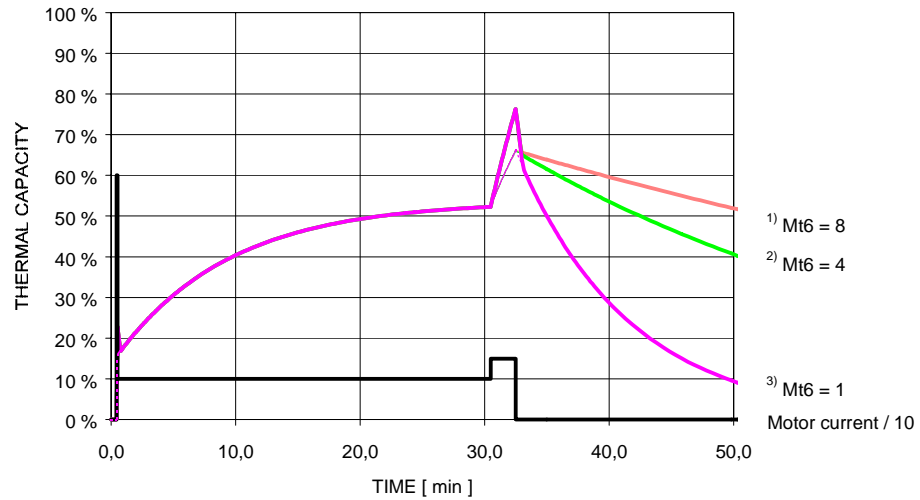
INSUM[®]

MCU Parameter Description

Notes:

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

Picture 6. Cooling down time (Mt6) parameter influence on stopped motor cooling (principle picture).



5.10 TOL Alarm Level

Function	TOL protection
MMI text	Alarm level
Related MCU	1 and 2
Range	50 (1) 100%
Default setting	90 %
Related parameter	---
Description	see hereunder

When the motor thermal level reaches thermal capacity level set by this parameter, the MCU sends a warning "TOL Alarm" to the fieldbus. When the thermal level reaches 100%, the motor will trip and a message "TOL Trip" is sent to the fieldbus. The TOL alarm is automatically reset when the thermal capacity reaches the parameterised *TOL alarm level* again.

An "O/L alarm" and the time to trip is reported to the fieldbus when the motor current exceeds $1.14 \times I_n$. The time to reset becomes zero when the startup inhibit level is reached

5.11 Trip Reset Mode

Function	TOL protection
MMI text	Trip reset mode
Related MCU	1 and 2
Range	Auto / Remote / Local / Remote & Local / Autorestart
Default setting	Remote & Local
Related parameter	TOL protection / Enable, Disable
Description	see hereunder

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

INSUM[®]

MCU Parameter Description

Notes:

Auto reset: Trip resets automatically after the calculated thermal capacity attains the startup inhibit level (time to reset reaches 0).

Remote reset: Trip reset is only possible after the calculated thermal capacity attains the startup inhibit level via the fieldbus (MMI, PCS via GW or OS). The pin X13: 16 can be in position REMOTE or LOCAL).

Local reset: Trip reset is only possible after the calculated thermal capacity attains the startup inhibit level via the device I/O. By operating "RESET" switch connected to pin X13: 15 resets the trip in the local mode. The local mode is activated with pin X13: 16.

5.12 TOL Bypass Command

Function	TOL protection
MMI text	TOL bypass
Related MCU	2
Range	Enabled / Disabled
Default setting	Disabled
Related parameter	TOL protection / Thermal model (standard)
Description	see hereunder

The operation of the TOL protection function can be prevented by a special 'TOL bypass' command given via the fieldbus when the thermal level rises over the *TOL alarm level*. With the TOL bypass feature the thermal level can be raised up to 200 % after which a trip will be executed. The possibility for execution of this command is enabled by this parameter.

If there is no trip, the TOL bypass command sent before is automatically deactivated when the thermal capacity decreases below the *TOL alarm level*.

An emergency restart is possible with the thermal capacity being above the startup inhibit level by issuing a start command immediately after TOL-bypass command. TOL-bypass command cannot be enabled when the EEx e parameter is active. The time tag of the latest TOL-bypass command and the number of the commands will be stored and provided as statistical values (read only parameters in Device Data section).

INSUM[®]

MCU Parameter Description

Notes:

6 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 parameterised *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 application experiencing overload as part of normal operation.

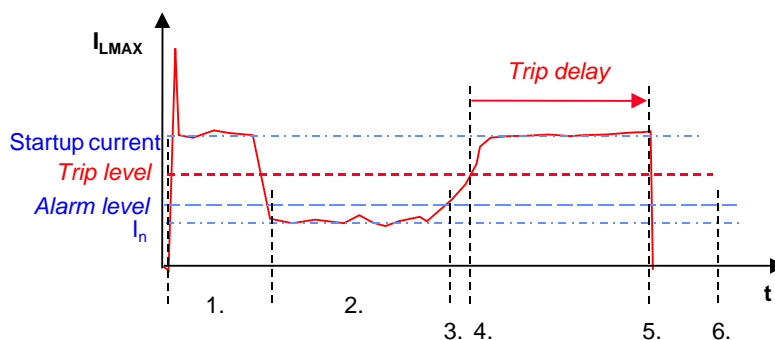
Note! Large low-voltage motors and those[#] having short admissible stalling time less than the startup time are not protected by this function.

- Mixers, crushers, saw cutters etc.

Stall protection function consists of following parameters:

Function	Starter configuration
Available parameters	Function Enable, Disable Alarm Level Trip Level Trip Delay Trip Reset Mode

Picture 7. Stall protection function.



1. Motor startup time
2. Normal operation (Stalled protection active)
3. Alarm message
4. Trip delay active
5. Contactor trip and trip message
6. Reset according to reset mode

6.1 Function Enable, Disable

Function	Stall protection
MMI text	Function
Related MCU	1 and 2
Range	Enabled / Disabled / Trip only / Alarm only
Default setting	Enabled
Related parameter	Stall protection / Parameters Motor data / Motor startup time Motor data / Motor startup time N2
Description	see hereunder

INSUM[®]

MCU Parameter Description

Notes:

Stall protection function can be disabled with the help of this parameter. When disabled, all other parameters of the stall function (*Alarm level*, *Trip level*, *Trip delay* and *Trip reset mode*) do not have any functionality in the starter configuration unit (hidden in MMI, greyed out in OS).

Stall protection activates after motor startup when either of following condition is fulfilled:
 – motor have succesful start, i.e. current has decreased under 1,25 x I_n after current inrush
 – time specified by *Motor startup time* parameter has elapsed

6.2 Alarm Level

Function	Stall protection
MMI text	Alarm level
Related MCU	1 and 2
Range	100 (1) 800%
Default setting	300 %
Related parameter	Stall protection / Function enable, disable
Description	see hereunder

Stall function creates “Stall Alarm”, when the motor current reaches the set value to inform the operator about the situation. A gradually approaching over stress such as bearing damage can be reported well in advance.

“Stall alarm” clears automatically if the current goes down below the alarm threshold.

6.3 Trip Level

Function	Stall protection
MMI text	Trip level
Related MCU	1 and 2
Range	100 (1) 800%
Default setting	400 %
Related parameter	Stall protection / Function enable, disable Stall protection / Trip delay
Description	see hereunder

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

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

6.4 Trip Delay

Function	Stall protection
MMI text	Trip delay
Related MCU	1 and 2
Range	0.0 (0.1) 60.0 s
Default setting	5.0 s
Related parameter	Stall protection / Function enable, disable Stall protection / Trip level
Description	see hereunder

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

INSUM[®]

MCU Parameter Description

Notes:

6.5 Trip Reset Mode

Function	Stall protection
MMI text	Trip delay
Related MCU	1 and 2
Range	Auto / Remote / Local / Remote & Local
Default setting	Remote & Local
Related parameter	Stall protection / Function enable, disable
Description	see hereunder

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

Auto reset: The trip resets automatically after the trip.

Remote reset: Trip reset is only possible via the fieldbus (MMI, PCS via GW or OS).

Local reset: Trip reset is only possible via the device I/O. By operating "RESET" switch connected to pin X13: 15 resets the trip in the local mode. The local mode is activated with pin X13: 16.

INSUM[®]

MCU Parameter Description

Notes:

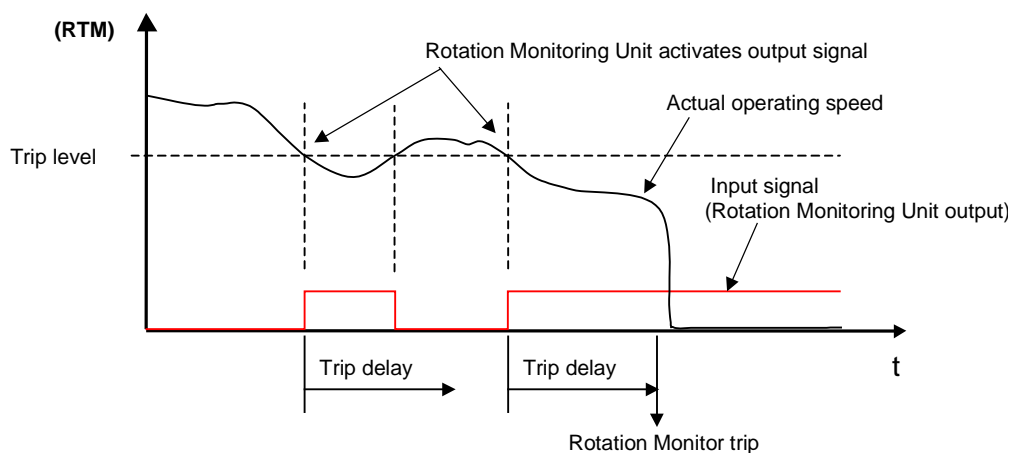
7 Rotation Monitor

Rotation monitor function (RTM) is used to protect the motor against locked rotor. It is especially useful for the protection of driven process where the rotation sensor can be used and already a slight decrease of rotation speed is very critical. Rotation monitor input is a binary input which activates when an external Rotation Monitoring Unit connected to this input activates.

Parameters involved in rotation monitoring protection are as below:

Function	Starter configuration
Available parameters	Function Enable, Disable Trip delay Trip Reset Mode

Picture 8. Rotation monitor function.



7.1 Function Enable, Disable

Function	Rotation monitor
MMI text	Function
Related MCU	2
Range	Enabled / Disabled / Trip only / Alarm only
Default setting	Disabled
Related parameter	Rotation monitor / Parameters Motor data / Motor startup time Motor data / Motor startup time N2
Description	see hereunder

The rotation monitor function can be disabled with the help of this parameter. When disabled, protection function does not have any functionality in the MCU and all other parameters of the function (*Trip delay and Trip reset mode*) are hidden in MMI and greyed out in the OS.

INSUM[®]

MCU Parameter Description

Notes:

7.2 Trip Delay

Function	Rotation monitor
MMI text	Trip delay
Related MCU	2
Range	1 (1) 60 sec
Default setting	10 sec
Related parameter	Rotation monitor / Function enable, disable
Description	see hereunder

This parameter defines the delay for the rotation monitor trip function.

When the rotation monitor input remains activated for a period longer than the *Trip delay*, the MCU will execute a contactor trip with a message 'Rotation trip'. With this delay a short fault situation can be filtered.

The trip state is reset according to the parameterisation of *Trip reset mode*.

7.3 Trip Reset Mode

Function	Rotation monitor
MMI text	Trip reset mode
Related MCU	2
Range	Auto / Remote / Local / Remote & Local
Default setting	Remote & Local
Related parameter	Rotation monitor / Function enable, disable
Description	see hereunder

Rotation trip can be reset in multiple ways. Depending on the control philosophy, it is possible to reset the trip as desired by suitable parameterisation.

Auto reset: "Rotation Trip" resets automatically after trip.

Remote reset: "Rotation trip" reset is only possible via the fieldbus (MMI, PCS via GW or OS).

Local reset: "Rotation trip" reset is only possible via the device I/O. By operating "RESET" switch connected to pin X13: 15 resets the trip in the local mode. The local mode is activated with pin X13: 16.

Notes:

8 Phase Loss Protection

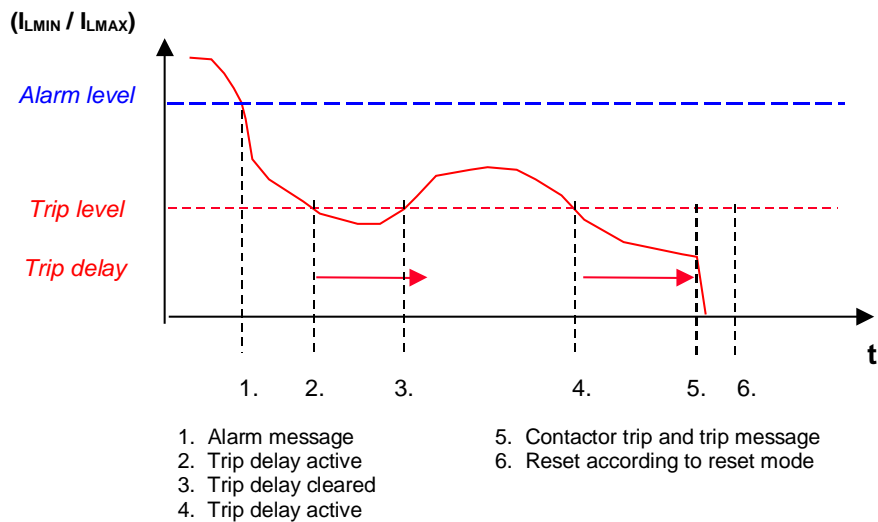
Phase loss in motor phase currents is a common phenomenon in industrial environment. It generally occurs because of pitted contacts in the contactor or SCPD, imbalance in the mains supply, loose connections, blown fuse, and faults within the motor. Phase loss is an extreme situation where a complete 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 of 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 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 loss are neither temporary nor self-covering, however phase loss protection may indicate a missing phase, according to actual settings, along with undervoltage protection. Although TOL protection performs an accelerated trip during phase loss and unbalance over 20%, there are no good reasons to wait for the trip to occur through TOL protection. By the use of phase loss protection a motor can be tripped without waiting for thermal calculation. Indeed, phase loss protection should be parameterised to trip in shorter time than TOL does.

Parameters involved in Phase loss protection are as below:

Function	Starter configuration
Available parameters	Function Enable /Disable
	Alarm Level
	Trip Level
	Trip Delay
	Trip Reset Mode

Picture 9. Phase loss protection.



INSUM[®]

MCU Parameter Description

Notes:

8.1 Function Enable, Disable

Function	Phase loss protection
MMI text	Function
Related MCU	1 and 2
Range	Enabled / Disabled / Trip only / Alarm only
Default setting	Enabled
Related parameter	Phase loss protection / Parameters Motor data / Motor startup time Motor data / Softstart ramp time Starter configuration / Number of phases (3 phase applications)
Description	see hereunder

Phase loss protection function can be disabled with the help of this parameter. When disabled, protection function does not have any functionality in the MCU and all other parameters of the function (*Alarm level*, *Trip level*, *Trip delay* and *Trip reset mode*) are hidden in MMI and greyed out in the OS.

This function is disabled automatically during single-phase selection with *Number of phases* parameter and during *Softstart ramp time*.

8.2 Alarm Level

Function	Phase loss protection
MMI text	Alarm level
Related MCU	1 and 2
Range	5 (1) 90%
Default setting	80 %
Related parameter	Phase loss protection / Function enable, disable
Description	see hereunder

To avoid motor failure by phase loss, the MCU calculates the 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, a 'Phase Loss Alarm Lx' warning message is sent to the fieldbus.

The 'Phase Loss Alarm Lx' clears automatically on restoration of normal condition. In case of extensive change on motor load, the function may report unnecessary alarm messages due to high change in measured current. These nuisance alarm messages can be filtered by decreasing the actual alarm level setting.

8.3 Trip Level

Function	Phase loss protection
MMI text	Trip level
Related MCU	1 and 2
Range	5 (1) 90%
Default setting	70 %
Related parameter	Phase loss protection / Function enable, disable Phase loss protection / Trip delay
Description	see hereunder

When the ratio $I_{L\text{MIN}} / I_{L\text{MAX}}$ corresponds to the value set on *Trip level*, the MCU will trip after the elapse of *Trip delay* time with a message 'Phase Loss Trip Lx'. If normal conditions are restored before the trip, the MCU will go back to normal operation.

INSUM[®]

MCU Parameter Description

Notes:

8.4 Trip Delay

Function	Phase loss protection
MMI text	Trip level
Related MCU	1 and 2
Range	0 (1) 60 s
Default setting	10 s
Related parameter	Phase loss protection / Function enable, disable Phase loss protection / Trip level
Description	see hereunder

After *Trip level* condition is reached, the MCU will delay the trip for the time defined by pre-parameterised *Trip delay*. A message 'Phase loss trip Lx' is generated. With this delay, a short phase current loss can be filtered. The MCU can be reset according to the *Trip reset mode* parameter.

8.5 Trip Reset Mode

Function	Phase loss protection
MMI text	Trip reset mode
Related MCU	1 and 2
Range	Auto, Remote, Local, Remote & Local
Default setting	Remote & Local
Related parameter	Phase loss protection / Function enable, disable
Description	see hereunder

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

Auto reset: The "Phase Loss Trip" is reset automatically after the trip.

Remote reset: The "Phase loss trip" reset is only possible via the fieldbus (MMI, PCS via GW or OS).

Local reset: Phase loss trip reset is only possible via the device I/O. By operating "RESET" switch connected to pin X13: 15 resets the trip in the local mode. The local mode is activated with pin X13: 16.

Notes:

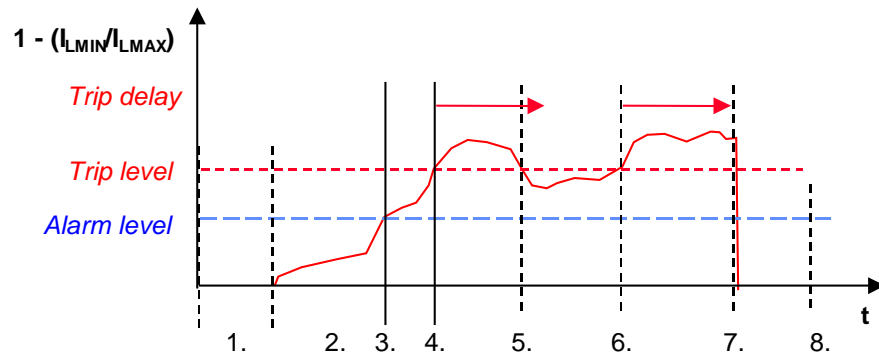
9 Unbalance Protection

Unbalance protection function protects the motor against a small degree of unbalance in the motor phases. The function monitors the ratio between $1 - I_{LMIN}/I_{LMAX}$. 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 loss protection.

Parameters involved in unbalance protection are as below:

Function	Starter configuration
Available parameters	Function Enable, Disable Alarm Level Trip Level Trip Delay Trip Reset Mode

Picture 10. Unbalance protection



- | | |
|--|------------------------------------|
| 1. Motor startup time | 5. Trip delay cleared |
| 2. Normal operation
(Unbalance protection active) | 6. Trip delay active |
| 3. Alarm message | 7. Contactor trip and trip message |
| 4. Trip delay active | 8. Reset according to reset mode |

9.1 Function Enable, Disable

Function	Unbalance protection
MMI text	Function
Related MCU	2
Range	Enabled / Disabled / Trip only / Alarm only
Default setting	Enabled
Related parameter	Unbalance protection / Parameters Starter configuration / Number of phases (3 phase applications) Motor data / Motor startup time Motor data / Motor startup time N2 Motor data / Softstart ramp time
Description	see hereunder

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 MCU and all other parameters of the function (*Alarm level*, *Trip level*, *Trip delay* and *Trip reset mode*) are hidden in MMI and greyed out.

This function is disabled automatically during single-phase selection by using the *Number of phases* parameter and during time specified by *Motor startup time* parameter, as well.

INSUM[®]

MCU Parameter Description

Notes:

9.2 Alarm Level

Function	Unbalance protection
MMI text	Alarm level
Related MCU	2
Range	10 (1) 50 %
Default setting	20 %
Related parameter	Unbalance / Function enable, disable
Description	see hereunder

To avoid a motor failure by phase unbalance, the MCU calculates a ratio between the lowest phase current to the highest phase current ($1-I_{L\text{MIN}}/I_{L\text{MAX}}$) from the measured currents of all the three phases. If the condition set by this parameter is true, an 'Unbalance Alarm' warning message is sent to the fieldbus.

The "Unbalance alarm" clears automatically after normal status is attained. In case of extensive change on motor load, the function may report unnecessary alarm messages due to high change in measured current. These nuisance alarm messages can be filtered by increasing the actual alarm level setting.

9.3 Trip Level

Function	Unbalance protection
MMI text	Trip level
Related MCU	2
Range	10 (1) 50 %
Default setting	30 %
Related parameter	Unbalance / Function enable, disable Unbalance / Trip delay
Description	see hereunder

When the ratio ' $1-I_{L\text{MIN}}/I_{L\text{MAX}}$ ' corresponds to the value set for this parameter, MCU will start a countdown set by *Trip delay* parameter after which a trip occurs with a message 'Unbalance Trip'. If normal conditions are restored before the trip, the MCU will go back to normal operation.

9.4 Trip Delay

Function	Unbalance protection
MMI text	Trip delay
Related MCU	2
Range	1 (1) 60 s
Default setting	10 s
Related parameter	Unbalance / Function enable, disable Unbalance / Trip level
Description	see hereunder

After the *Trip level* level is reached, the MCU will delay the trip for the time set by this parameter. After the set *Trip delay*, the MCU will trip the motor and give a message 'Unbalance trip'. With this delay, short phase unbalances can be filtered. The MCU can later be reset according to the *Trip reset mode* parameter.

INSUM[®]

MCU Parameter Description

Notes:

9.5 Trip Reset Mode

Function	Unbalance protection
MMI text	Trip reset mode
Related MCU	2
Range	Auto / Remote / Local / Remote & Local
Default setting	Remote & Local
Related parameter	Unbalance protection / Function enable, disable
Description	see hereunder

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 parameterisation.

Auto reset: The "Unbalance Trip" is reset automatically after the trip.

Remote reset: Unbalance trip reset is only possible via the fieldbus (MMI, PCS via GW or OS).

Local reset: Unbalance trip reset is only possible via the device I/O. By operating "RESET" switch connected to pin X13: 15 resets the trip in the local mode. The local mode is activated with pin X13: 16.

INSUM[®]

MCU Parameter Description

Notes:

10 Underload Protection

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

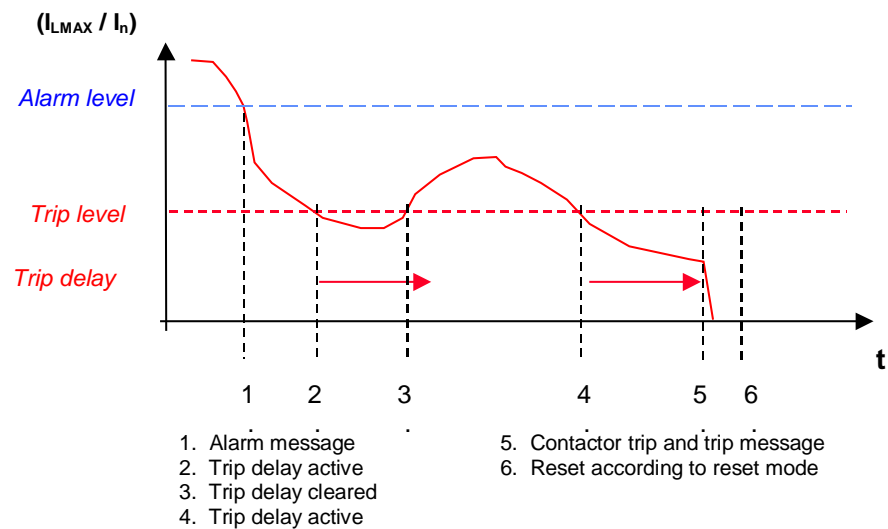
The motors on underload draw mainly the magnetising current and a small load current to overcome frictional losses. Therefore, the other reason to isolate the motors on underload is to reduce the reactive load on the power system network.

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

Parameters involved in underload protection are as below:

Function	Starter configuration
Available parameters	Enabled /Disable Alarm Level Trip Level Trip Delay Trip Reset Mode

Picture 11. Underload protection.



10.1 Function Enable, Disable

Function	Underload protection
MMI text	Function
Related MCU	1 and 2
Range	Enabled / Disabled / Trip only / Alarm only
Default setting	Enabled
Related parameter	Motor data / Softstart ramp time Motor data / Autotrafo start time
Description	see hereunder

Underload protection function can be disabled with the help of this parameter. When disabled, protection function does not have any functionality in the MCU and all other parameters of the function (*Alarm level*, *Trip level*, *Trip delay* and *Trip reset mode*) are hidden in MMI and greyed out in OS. Function is disabled during *Autotrafo start time* and *Softstart ramp time*.

INSUM[®]

MCU Parameter Description

Notes:

10.2 Alarm Level

Function	Underload protection
MMI text	Alarm level
Related MCU	1 and 2
Range	15 (1) 90%
Default setting	30 %
Related parameter	Underload protection / Function enable, disable
Description	see hereunder

If the highest phase current (I_{LMAX}) of the measured three phase currents is detected below the *Alarm level*, then a warning message "U/L Alarm" is created to inform the operator of the underload condition.

"U/L Alarm" clears automatically on restoration of normal condition.

10.3 Trip Level

Function	Underload protection
MMI text	Trip level
Related MCU	1 and 2
Range	15 (1) 90%
Default setting	20 %
Related parameter	Underload protection / Function enable, disable Underload protection / Trip delay
Description	see hereunder

When current I_{LMAX} reaches the *Trip level*, the MCU trips the motor after elapse of *Trip delay* time. A message 'U/L Trip' is generated after the trip. If normal conditions are restored before the trip, the MCU will go back to normal operation.

10.4 Trip Delay

Function	Underload protection
MMI text	Trip delay
Related MCU	1 and 2
Range	0 (1) 600 s
Default setting	10 s
Related parameter	Underload protection / Function enable, disable Underload protection / Trip level
Description	see hereunder

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.

INSUM[®]

MCU Parameter Description

Notes:

10.5 Trip Reset Mode

Function	Underload protection
MMI text	Trip Reset Mode
Related MCU	1 and 2
Range	Auto / Remote / Local / Remote & Local
Default setting	Remote & Local
Related parameter	Underload protection / Function enable, disable
Description	see hereunder

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

Auto reset: The "U/L Trip" is reset automatically after the trip.

Remote reset: The "U/L Trip" reset is only possible via the fieldbus (MMI, PCS via GW or OS).

Local reset: The "U/L Trip" reset is only possible via the device I/O. By operating "RESET" switch connected to pin X13: 15 resets the trip in the local mode. The local mode is activated with pin X13: 16.

INSUM[®]

MCU Parameter Description

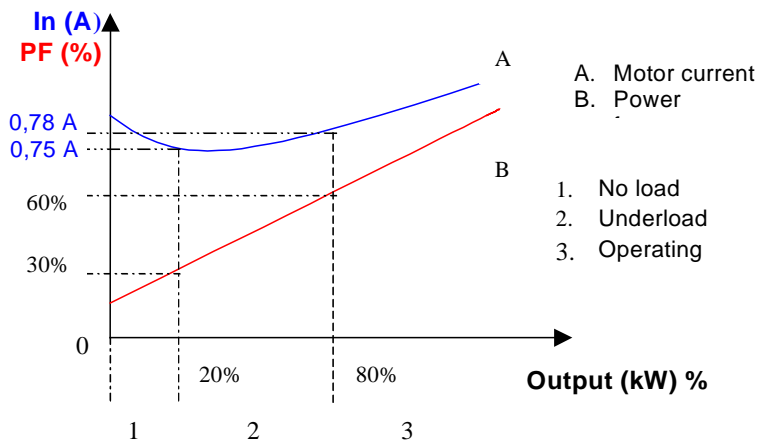
Notes:

11 Cosphi Underload Protection

This function monitors the process against loss of load especially with small motors where current is not much related to low load. In contrast to the "Underload protection" that responds to the load current; the "Cosphi underload protection" is based on the power factor of the motor. During underload the reactive component of the current being fixed, the power factor reduces substantially along with the slight reduction of active current.

The figure below illustrates the necessity for Cosphi underload protection for small motors as power factor indicates better underload.

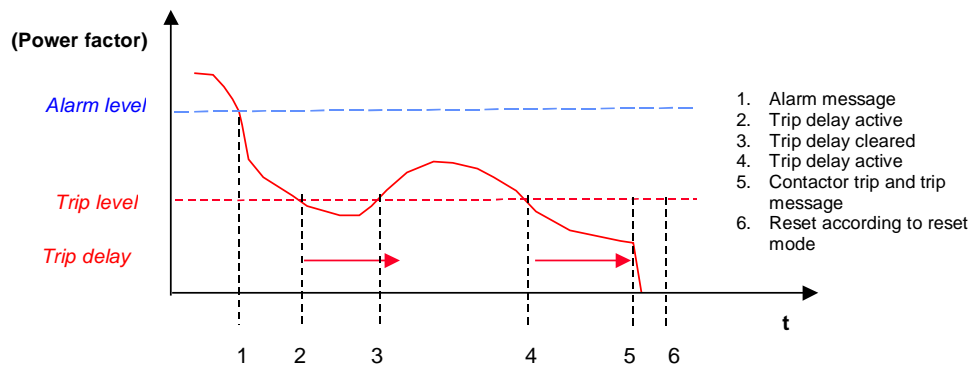
Picture 12. Load curve for motor 0.25/0.3 kW, 3*400VY, 50Hz, Type 3GAA072001-ASA.



Parameters involved in cosphi underload protection are as below:

Function	Starter configuration
Available parameters	Function Enable, Disable Alarm Level Trip Level Trip Delay Trip Reset Mode

Picture 13. Cosphi underload protection.



INSUM[®]

MCU Parameter Description

Notes:

11.1 Function Enable, Disable

Function	Cosphi underload protection
MMI text	Function
Related MCU	2
Range	Enabled / Disabled / Trip only / Alarm only
Default setting	Disabled
Related parameter	Underload cosphi / Parameters Motor data / Motor startup time Motor data / Motor startup time N2 Motor data / Softstart ramp time
Description	see hereunder

The Cosphi underload protection function can be disabled with the help of this parameter. When disabled, this protection function does not have any functionality in the MCU and all other parameters of the function (*Alarm level*, *Trip level*, *Trip delay* and *Trip reset mode*) are hidden in the MMI and greyed out in the OS.

Protection is disabled during

- the time defined by *Motor startup time*
- the time defined by *Motor startup time N2*
- the time defined by *Softstart ramp time*

11.2 Alarm Level

Function	Cosphi underload protection
MMI text	Alarm level
Related MCU	2
Range	0.01 (0.01) 1
Default setting	0.8
Related parameter	Cosphi underload protection / Function enable, disable
Description	see hereunder

If the power factor (cosphi) of phase L1 falls below the *Alarm level*, then a warning message 'U/L cosphi alarm' is created to inform the operator of the underload condition.

"U/L cosphi Alarm" clears automatically after normal status is attained.

11.3 Trip Level

Function	Cosphi underload protection
MMI text	Trip level
Related MCU	2
Range	0.01 (0.01) 1
Default setting	0.6
Related parameter	Cosphi underload protection / Function enable, disable Cosphi underload protection / Trip delay
Description	see hereunder

When the power factor (cosphi) of phase L1 reaches the *Trip level*, the MCU starts a countdown set by the *Trip delay* parameter after which a trip of the motor will follow.

INSUM[®]

MCU Parameter Description

Notes:

11.4 Trip Delay

Function	Cosphi underload protection
MMI text	Trip delay
Related MCU	2
Range	0 (1) 60 s
Default setting	10 s
Related parameter	Cosphi underload protection / Function enable, disable Cosphi underload protection / Trip level
Description	see hereunder

The trip is delayed by the time set by this parameter. If underload cosphi condition is not back to normal before *Trip delay* time elapses, a trip along with the "U/L cosphi Trip" message is generated. With this delay, short underload cosphi situations can be filtered.

11.5 Trip Reset Mode

Function	Cosphi underload protection
MMI text	Trip reset mode
Related MCU	2
Range	Auto / Remote / Local / Remote & Local
Default setting	Remote & Local
Related parameter	Cosphi underload protection / Function enable, disable
Description	see hereunder

An Underload cosphi trip can be reset in multiple ways. Depending on the control philosophy, it is possible to reset the trip as desired by suitable parameterisation.

Auto reset: The "U/L cosphi trip" resets automatically after the trip.

Remote reset: The "U/L cosphi trip" reset is only possible via the fieldbus (MMI, PCS via GW or OS).

Local reset: The "U/L cosphi trip" reset is only possible via the device I/O. By operating "RESET" switch connected to pin X13: 15 resets the trip in the local mode. The local mode is activated with pin X13: 16.

INSUM[®]

MCU Parameter Description

Notes:

12 No Load Protection

The no load protection function protects the process against sudden loss of load. Though this condition does not harm the motor, but requires a switch off to safe guard the process.

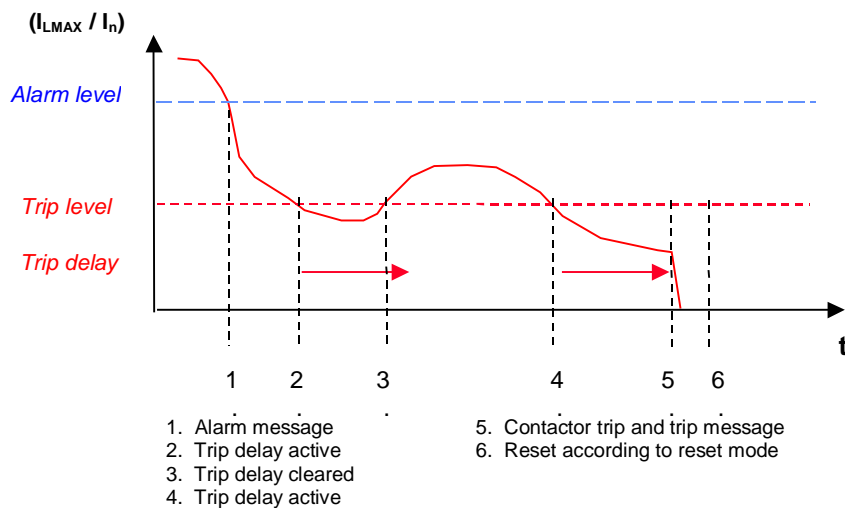
The no load current is of the order of 0.2 to 0.6 I_n depending on the size and speed of the motor. The no load current of slow speed motors is high and that of large motors is low.

The no load protection function is based on the highest phase current measured by the current measurement unit. The no load protection function detects missing current with respect to the contactor and the main switch ON feedback and executes actions as parameterised.

Parameters involved in no load protection are as below:

Function	Starter configuration
Available parameters	Enabled / Disable Alarm Level Trip Level Trip Delay Trip Reset Mode

Picture 14. No load protection.



12.1 Function Enable, Disable

Function	No load protection
MMI text	Function
Related MCU	1 and 2
Range	Enabled / Disabled / Trip only / Alarm only
Default setting	Enabled
Related parameter	No load / Parameters Motor data / Softstart ramp time
Description	see hereunder

No load protection function can be disabled with the help of this parameter. When disabled, protection function does not have any functionality in the MCU and all other parameters of the function (*Alarm level*, *Trip level*, *Trip delay* and *Trip reset mode*) are hidden in the MMI and greyed out in the OS. Function is disabled during *Autotrafo start time* and *Softstart ramp time*.

INSUM[®]

MCU Parameter Description

Notes:

12.2 Alarm Level

Function	No load protection
MMI text	Alarm level
Related MCU	1 and 2
Range	15 (1) 50 %
Default setting	20 %
Related parameter	No load protection / Function enable, disable
Description	see hereunder

If the highest phase current (I_{LMAX}) of the measured three phase currents is detected below the *Alarm level*, then a warning message 'N/L Alarm' is created to inform the operator of the no load condition.

"N/L Alarm" clears automatically on restoration of normal condition.

12.3 Trip Level

Function	No load protection
MMI text	Trip level
Related MCU	1 and 2
Range	15 (1) 50 %
Default setting	15 %
Related parameter	No load protection / Function enable, disable No load protection / Trip delay
Description	see hereunder

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 MCU trips the motor with a 'N/L Trip' message.

12.4 Trip Delay

Function	No load protection
MMI text	Trip delay
Related MCU	1 and 2
Range	0 (1) 600 s
Default setting	5 s
Related parameter	No load protection / Function enable, disable No load protection / Trip level
Description	see hereunder

When the current I_{LMAX} reach the no load *Trip level*, the MCU trips the motor after elapse of *Trip delay* time. A message 'N/L Trip' is generated after the trip. If normal conditions are restored before the trip, the MCU will go back to normal operation. With this delay, a short noload situations can be filtered.

INSUM[®]

MCU Parameter Description

Notes:

12.5 Trip Reset Mode

Function	No load protection
MMI text	Trip reset mode
Related MCU	1 and 2
Range	Auto / Remote / Local / Remote & Local
Default setting	Remote & Local
Related parameter	No load protection / Function enable, disable
Description	see hereunder

The no load trip can be reset in multiple ways depending on the control philosophy. It is possible to reset the trip as desired by suitable parameterisation.

Auto reset: The 'N/L Trip' is reset automatically after the trip.

Remote reset: No Load trip reset is only possible via the fieldbus (MMI, PCS via GW or OS).

Local reset: No Load trip reset is only possible via the device I/O. By operating "RESET" switch connected to pin X13: 15 resets the trip in the local mode. The local mode is activated with pin X13: 16.

INSUM[®]

MCU Parameter Description

Notes:

13 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 safety hazard to personnel. The earth faults are mainly caused due to ageing 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. The monitoring of the earth faults is done with current measurement via residual current transformer.

The residual current transformer method is normally employed for either isolated systems or for systems earthed with high impedance. The sensitive protection against earth faults is possible. The low current threshold helps to protect the stator winding from earth faults at the neutral end. The sensitivity of the earth fault current measurement can vary depending on the resistance across the secondary of the transformer. In general, measurement through residual current transformer provides higher sensitivity compared to vector sum method, introduced below.

Table 9. The values of resistances are as given below.

Sensitivity	Burden
0.1 - 1.0 A	300 ohms
1.1 - 5.0 A	180 ohms
5.5 - 50.0 A	33 ohms

The power rating of the burden shall be 0.5W, the accuracy $\pm 1\%$ or better. The standard split core toroidal current transformer P/N 701143/801 by ABB Sace is to be used. The split core current transformer facilitates connections on to the cables or busbars even after termination / assembly.

Table 10. The RCT toroidal transformer types.

Name	Type	Diameter
Closed	1SDA 037394R0001	60 mm
Closed	1SDA 037395R0001	110 mm
Riped	1SDA 037396R0001	110 mm
Riped	1SDA 037397R0001	180 mm
Riped	1SDA 037398R0001	230 mm

Selectable with parameters but not supported due to the low accuracy is the calculation of the earth fault current by means of the vector sum method. This method is normally employed for solidly earthed systems or for systems earthed through low impedance. This method uses the phase current transformers for measuring the earth fault current and does not require an additional residual current transformer. In a balanced healthy system, the summation of three phase currents is zero. During the earth fault, the neutral current corresponding to the earth current flow executes the trip command. This method is also called as Holmgreen. With this option earth fault protection can be used to indicate extensive earth fault current min. 15% of *Nominal current* setting.

Note! Calculated earth fault option is not supported for common use.

The earth fault protection is bypassed during starting to avoid nuisance tripping due to harmonics caused by saturation of the current transformers.

Parameters involved in the earth fault protection are as below:

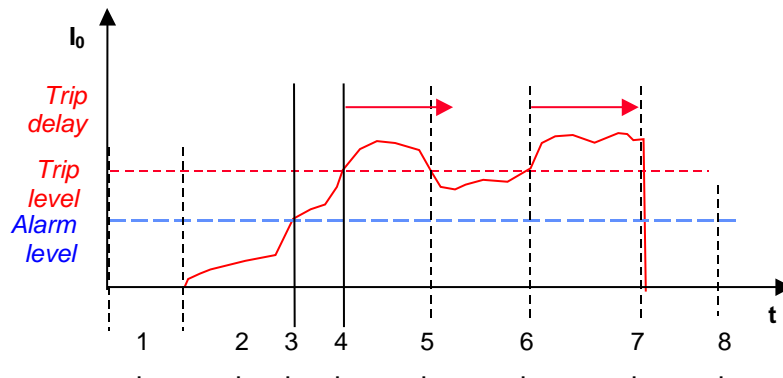
Function	Starter configuration
Available parameters	Function Enable, Disable Method Residual CT Primary Alarm Level Trip Level Trip Delay Trip Reset Mode

INSUM[®]

MCU Parameter Description

Notes:

Picture 15. Earth fault protection.



1. Motor startup time
2. Normal operation (Earth fault protection active)
3. Alarm message
4. Trip delay active
5. Trip delay cleared
6. Trip delay active
7. Contactor trip and trip message
8. Reset according to reset mode

13.1 Function Enable, Disable

Function	Earth fault protection
MMI text	Function
Related MCU	2
Range	Enabled / Disabled / Trip only / Alarm only
Default setting	Disabled
Related parameter	Earth fault / Parameters Motor data / Motor startup time Motor data / Softstart ramp time
Description	see hereunder

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 MCU and all other parameters of the function (*Method*, *Residual CT primary*, *Alarm level*, *Trip level*, *Trip delay*, and *Trip reset mode*) are hidden in MMI and greyed out in OS.

Protection function is disable during motor start specified by *Motor startup time* parameter.

13.2 Method

Function	Earth fault protection
MMI text	Method
Related MCU	2
Range	Calculation / Measurement
Default setting	Calculation
Related parameter	Earth fault / Residual CT primary Starter configuration / Number of phases (3 phase applications)
Description	see hereunder

The earth fault protection function is based either on the vector sum of the measured currents (calculation) or residual current transformer (measurement) measurement. When single phase application is implemented only measurement *Method* can be implemented.

INSUM[®]

MCU Parameter Description

Notes:

The sensitive earth fault protection is possible by the 'measurement' method. In this method an additional residual current transformer is provided to measure the earth leakage current. The 10 V p-p maximum voltage output of the residual current transformer is connected to pin I₀A and I₀B of MCU2 wired either to connectors X14: 13,14 when RCT is located inside the drawer unit or to connector X13: 33,34 if RCT is located outside the drawer unit. This method can detect minor insulation fault leading to alarm or trip at an early stage.

The protection can be bypassed during starting with the help of *Trip delay* to avoid nuisance tripping due to saturation of the current transformers.

Note! See restrictions for the use of calculated earth fault functionality in the paragraph "Earth Fault protection".

13.3 Residual CT Primary

Function	Earth fault protection
MMI text	Residual CT range
Related MCU	2
Range	1 A / 5 A / 50 A
Default setting	1 A
Related parameter	Earth fault protection / Measurement method
Description	see hereunder

The parameter defines the maximum primary current of the RCT. This parameter is active when 'measurement' method is selected.

13.4 Alarm Level

Function	Earth fault protection
MMI text	Alarm level
Related MCU	2
Range	0.1 (0.1) < <i>Residual CT primary</i> , max. 50 A
Default setting	0.8
Related parameter	Earth fault protection / Function enable, disable Earth fault protection / Residual CT primary Motor data / Motor startup time
Description	see hereunder

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

INSUM[®]

MCU Parameter Description

Notes:

13.5 Trip Level

Function	Earth fault protection
MMI text	Trip level
Related MCU	2
Range	0.1 (0.1) < <i>Residual CT primary</i> , max. 50 A
Default setting	1 A
Related parameter	Earth fault protection / Function enable, disable Earth fault protection / Trip delay
Description	see hereunder

When the earth fault current remains above the *Trip level* for a pre-set *Trip delay* time, the MCU will generate a trip command with a message 'Earth fault trip'. If normal conditions are restored before the *Trip delay* time elapses, the MCU will go back to normal operation.

13.6 Trip Delay

Function	Earth fault protection
MMI text	Trip delay
Related MCU	2
Range	0.2 (0.2) 60.0 s
Default setting	10.0 s
Related parameter	Earth fault protection / Function enable, disable Earth fault protection / Trip level
Description	see hereunder

When the earth fault current rises above the *Trip level*, the MCU will execute a trip command after elapse of the time specified in the *Trip delay* parameter. The trip is followed with a message "E/F Trip". The count down 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 parameterisation of the *Trip reset mode*.

13.7 Trip Reset Mode

Function	Earth fault protection
MMI text	Trip reset mode
Related MCU	2
Range	Auto / Remote / Local / Remote & Local
Default setting	Remote & Local
Related parameter	Earth fault protection / Function enable, disable
Description	see hereunder

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 parameterisation.

Auto reset: The "Earth fault trip" resets automatically after the trip.

Remote reset: The trip reset is only possible via the fieldbus (MMI, PCS via GW or OS).

Local reset: The trip reset is only possible via the device I/O. By operating "RESET" switch connected to pin X13: 15 resets the trip in the local mode. The local mode is activated with pin X13: 16.

Notes:

14 Thermistor Protection

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 Thermistor protection responds to the change in thermistor resistance due to temperature rise in the windings. The Thermistor 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. It's resistance increases sharply in the range of its rated operating temperature (TNF). For a temperature change of 10°C, the resistance changes ten times.

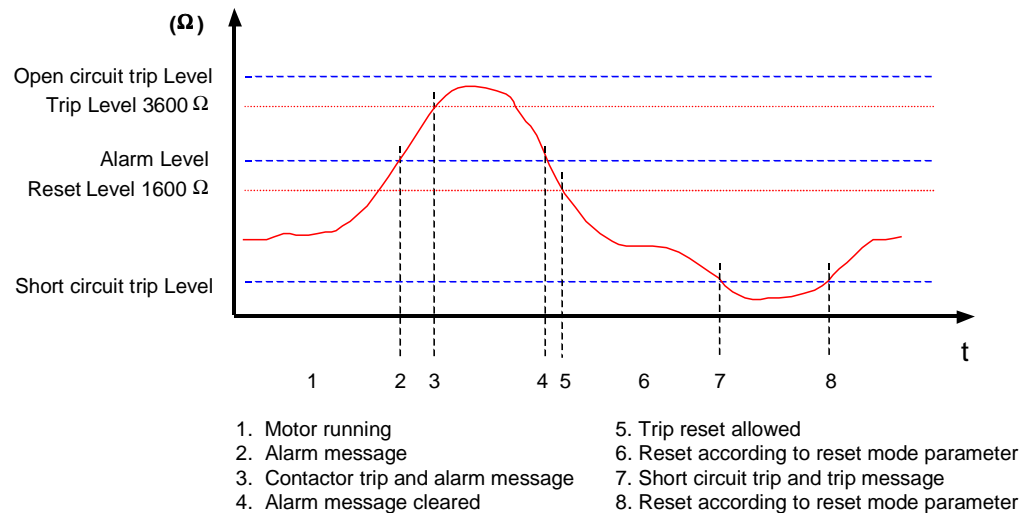
The MCU senses this abrupt change in the resistance to execute a trip command. A trip will follow when 3600 Ω resistance is detected by the measurement and reset is allowed when resistance is under 1600 Ω. These limits can not be changed.

When thermistor protection is activated there is an internal supervision which detects open or short circuit faults from thermistor circuit. With thermistor resistance values above 12 kΩ there is indication and trip for open circuit protection as selected by parameters. Short circuit level can be selected within given range by the user.

Parameters involved in thermistor protection are as below:

Function	Starter configuration
Available parameters	Temperature protection Enable, Disable
	Loop supervision Enable, Disable
	Cable compensation
	Alarm Level
	Short circuit trip level
	Temperature protection Trip Reset Mode
	Loop supervision Trip Reset Mode

Picture 16. Thermistor protection.



INSUM[®]

MCU Parameter Description

Notes:

14.1 Temperature Protection Enable, Disable

Function	Thermistor (PTC) protection
MMI text	Temperature protect.
Related MCU	2
Range	Enabled / Disabled / Trip only / Alarm only
Default setting	Disabled
Related parameter	TOL protection / Thermal model Thermistor protection / Temperature protection parameters Thermistor protection / Loop supervision enable, disable
Description	see hereunder

The Thermistor protection function can be disabled with the help of this parameter. When disabled, the protection function does not have any functionality in the MCU and all other parameters of the function are hidden in MMI and greyed out in the OS.

The functionality of the PTC is limited by the *Thermal model* selection, i.e. standard or EEx e thermal model. For available settings refer to table below.

Table 11. Different Thermistor protection options available.

Parameter	Value	Thermal model	
		Standard	EEx e
<i>Temperature protection enable, disable</i>	Enabled	Yes	Yes
	Disabled	Yes	Yes
	Trip only	Yes	Yes
	Alarm only	Yes	No

14.2 Loop Supervision Enable, Disable

Function	Thermistor protection
MMI text	Loop supervision.
Related MCU	2
Range	Enabled / Disabled / Trip only / Alarm only
Default setting	Disabled
Related parameter	Thermistor protection / Temperature enable, disable Thermistor protection / Loop supervision parameters
Description	see hereunder

This parameter activates and defines the indication for thermistor loop protection. Protection supervises the loop integrity for loosen screw contacts and for short circuit faults between thermistor wires. There are separate indications for open circuit and short circuit faults.

Open circuit trip indication activates when resistance in thermistor circuit exceeds fixed burden level. Short circuit level is selected with a dedicated parameter.

INSUM[®]

MCU Parameter Description

Notes:

Table 12. Different options available for loop supervision.

Parameter	Value	Thermal model	
		Standard	EEx e
Loop supervision enable, disable	Enabled	Yes	Yes
	Disabled	Yes	Yes
	Trip only	Yes	Yes
	Alarm only	Yes	No

14.3 Cable Compensation

Function	Thermistor protection
MMI text	Cable capacity
Related MCU	2
Range	0 (5) 250
Default setting	15
Related parameter	Thermistor protection / Temperature protection enable, disable
Description	see hereunder

This parameter defines the PTC cable compensation capacitance.

If the cable capacitance of PTC-sensor's instrumentation cable from motor to MCU is too high, it has to be compensated to get the correct values. Compensation is done via this parameter. Practically this parameter describes the capacitance value of the cable.

The need for compensation is, in a great deal, depending on the cable length but also because of the cable type. Since it varies from cable to cable there are some of the most commonly used cables listed in the tables with capacitance values in order to simplify the check and compensation routine, if necessary, during MCU installation. These "look-up" tables (PTC capacitance compensation tables 1..3) can be found from appendix "PTC cable compensation tables".

There are available tables for the maximum allowed cable lengths for some commonly used cables. Look for the correct cable type and read value from column "Max. cable length with factory setting (15)". If cable length is shorter than the value in the PTC capacitance compensation table 1, no further actions are required.

If you can find longer installed cables, please select correct lookup table (PTC capacitance compensation table 2a, table 2b, etc). Same cable types are listed in these tables. Now, select the correct cable type and find a row which stands for the required cable length range. When the right range is found (eg. 550 m cable, you can select any range which covers 550 meters), the right parameter value can be found for *Cable compensation* parameter from the most left-side column, i.e. from [Value] field.

If you have cable which is not listed in the PTC capacitance compensation table 1, the nominal capacitance of the specific cable type must be obtained from cable manufacturer. With this value the parameter *Cable compensation* can be defined by using PTC capacitance compensation table 3. Select the nominal capacitance range according to cable actual capacitance (cable manufacturers data). Then find out what is the maximum length of the cable when the value of the parameter is 15 (factory setting). With shorter cables no further actions are required. For longer cables you can find the right value of the parameter by selecting the corresponding cable length range and then read the parameter value from the most left-side column [Value].

For special applications or if no answers from data tables are found, the right parameter value can be calculated with following equations:

- l_c = Length of the cable [m]
- C_n = Nominal capacitance of the used cable [nF/km]
- C_c = Capacitance of the used cable [nF]
- P = Value of the parameter "PTC Capacity", range 0...250, step 5

INSUM[®]

MCU Parameter Description

Notes:

Equation 1

$$C_C = C_n \times l_c$$

Equation 2

$$P = \text{round } C_C \text{ to number, which is divisible by 5}$$

Use equation 1 to calculate the capacitance of the cable. Round the result according to equation 2.

14.4 Alarm Level

Function	Thermistor protection
MMI text	Alarm level
Related MCU	2
Range	1.0 (0.1) 12.0 kOhm
Default setting	1.6 KOhm
Related parameter	Thermistor protection / Temperature protection enable, disable
Description	see hereunder

This parameter defines the alarm level for the Thermistor protection function. The limit causes a message "PTC temperature alarm" to be issued to the fieldbus 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, i.e. resistance restores below *Alarm level*.

14.5 Short Circuit Trip Level

Function	Thermistor protection
MMI text	Short circuit level
Related MCU	2
Range	55 (1) 1000 Ohm
Default setting	55
Related parameter	Thermistor protection / Loop supervision enable, disable
Description	see hereunder

This parameter defines the short circuit resistance of the sensor loop for PTC short circuit trip. The limit causes a message 'PTC short circuit trip' and trips when the result of the loop integrity test for thermistor connection is below the given level.

INSUM[®]

MCU Parameter Description

Notes:

14.6 Temperature Protection Trip Reset Mode

Function	Thermistor protection
MMI text	Temp. trip reset mode
Related MCU	2
Range	Auto / Remote / Local / Remote & Local
Default setting	Remote & Local
Related parameter	Thermistor protection / Temperature protection enable, disable
Description	see hereunder

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

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: Trip reset is only possible via the fieldbus (MMI, PCS via GW or OS) after the PTC loop resistance reaches the trip reset level.

Local reset: Trip reset is only possible via the device I/O. By operating "RESET" switch connected to pin X13: 15 resets the trip in the local mode. The local mode is activated with pin X13: 16.

14.7 Loop Supervision Trip Reset Mode

Function	Thermistor protection
MMI text	Loop trip reset mode
Related MCU	2
Range	Auto / Remote / Local / Remote & Local
Default setting	Remote & Local
Related parameter	Thermistor protection / Loop supervision enable, disable Thermistor protection / Short circuit trip level
Description	see hereunder

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

Auto reset: The 'short circuit trip' or 'open circuit trip' resets automatically after the sensor loop resistance goes above the threshold set for the trip.

Remote reset: Trip reset is only possible via the fieldbus (MMI, PCS via GW or OS) after the PTC loop resistance reaches the trip reset level.

Local reset: Trip reset is only possible via the device I/O. By operating "RESET" switch connected to pin X13: 15 resets the trip in the local mode. The local mode is activated with pin X13: 16.

INSUM[®]

MCU Parameter Description

Notes:

15 Undervoltage Protection

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 same for some period owing to its inertia.

According to the energy conservation law,

$$\begin{aligned} \text{Mechanical energy} &= \text{Electrical energy} \\ &= V_L * I_L * \cos\phi \end{aligned}$$

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 would help 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 phaseloss before switching ON the motor.

Note! The voltage unit needs to be connected to the MCU2 and uses lowest of the measured phase voltages.

Parameters involved in undervoltage protection are as below:

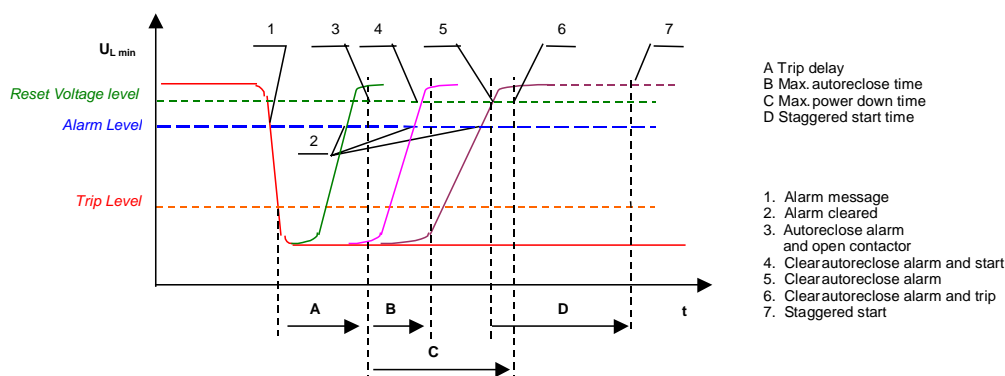
Function	Starter configuration
Available parameters	Function Enable, Disable
	External VT Installed
	External VT Primary
	External VT Secondary
	Nominal voltage
	Alarm Level
	Trip Level
	Trip Delay
	Reset Voltage Level
	Max. Autoreclose Time
	Max. Powerdown Time
	Staggered Start Time
	Trip Reset Mode

INSUM[®]

MCU Parameter Description

Notes:

Picture 17. Undervoltage protection.



If the voltage restores above the start level, following conditions apply:

- If timing < A, motor not stopped
- If timing > A and < A+B, motor immediate start applies
- If timing > A+B and < A+C, staggered start applies

15.1 Function Enable, Disable

Function	Undervoltage protection
MMI text	Function
Related MCU	2
Range	Enabled / Disabled / Trip only / Alarm only
Default setting	Disabled
Related parameter	Undervoltage / Parameters
Description	see hereunder

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 MCU and all other parameters of the function (*Alarm level, Trip level, Trip delay, Reset voltage level, Max. autoreclose time, Max. power down time, Staggered start time, and Trip reset mode*) are hidden.

15.2 External VT Installed

Function	Undervoltage protection
MMI text	Ext. VT installed
Related MCU	2
Range	No / Yes
Default setting	No
Related parameter	Starter configuration / External VT primary Starter configuration / External VT secondary Starter configuration / Nominal voltage
Description	see hereunder

The voltage measurement in MCU2 unit can measure voltages up to 690 V with voltage unit. If voltages above 690 V should be measured an external voltage transformer is required and with this parameter primary and secondary values for voltage transformer can be activated.

Note! External voltage transformer is considered out of use if *External VT Primary* and *External VT Secondary* parameters has the same value or either has a value zero. That is even when *External VT Installed* is set to "Yes".

INSUM[®]

MCU Parameter Description

Notes:

15.3 External VT Primary

Function	Undervoltage protection
MMI text	Ext. VT primary
Related MCU	2
Range	1000 (100) 12000 V
Default setting	6600 V
Related parameter	Starter configuration / External VT installed Starter configuration / External VT secondary Starter configuration / Nominal voltage
Description	see hereunder

While using an external voltage transformer for motor nominal voltages > 690 V, the nominal primary voltage of the external voltage transformer is defined by this parameter.

15.4 External VT Secondary

Function	Undervoltage protection
MMI text	Ext. VT secondary
Related MCU	2
Range	200 (1) 690 V
Default setting	380 V
Related parameter	Starter configuration / External VT installed Starter configuration / External VT primary Starter configuration / Nominal voltage
Description	see hereunder

While using an external voltage transformer for motor nominal voltages > 690 V, the nominal secondary voltage of the external voltage transformer is defined by this parameter.

For example: Rated U_n = 10 kV and external current transformer 12 kV / 690 V.

Set *External VT installed* = Yes,
Set *External VT primary* = 12 kV
Set *External VT secondary* = 690 V
Set *Nominal voltage* = 10 kV

15.5 Nominal Voltage

Function	Undervoltage protection
MMI text	Nominal voltage
Related MCU	1 and 2
Range	230 (1) 400 V 230 (1) 690 V 600 (1) 12000 V
Default setting	380 V
Related parameter	Starter configuration / External VT parameters
Description	see hereunder

This is the rated voltage (U_n) of the mains supply for motor. The rated voltage can be set within this range.

In the case of external voltage transformer is installed the range is from 0.6 to 12.0 kV.

INSUM[®]

MCU Parameter Description

Notes:

15.6 Alarm Level

Function	Undervoltage protection
MMI text	Alarm level
Related MCU	2
Range	50 (1) 100 %
Default setting	80 %
Related parameter	Undervoltage / Function enable, disable
Description	see hereunder

This parameter defines the voltage level for an undervoltage alarm. The undervoltage protection is based on the lowest of the measured phase voltages. An alarm 'Undervoltage alarm' is generated when the lowest of the measured voltages is below the parametrised *Alarm level* (refer figure 13, point 1).

15.7 Trip Level

Function	Undervoltage protection
MMI text	Trip level
Related MCU	2
Range	50 (1) 100 %
Default setting	65 %
Related parameter	Undervoltage / Function enable, disable Undervoltage / Trip delay
Description	see hereunder

This parameter defines the trip level for the undervoltage protection function. When the lowest of the measured phase voltages goes below the *Trip level*, the MCU will start counting a *Trip delay*.

15.8 Trip Delay

Function	Undervoltage protection
MMI text	Trip delay
Related MCU	2
Range	0.2 (0.1) 5.0 s
Default setting	1.0 s
Related parameter	Undervoltage / Max. power down time
Description	see hereunder

This parameter defines the time from the undervoltage *Trip level* to the execution of the trip command. When the lowest of the measured phase voltages goes below the *Trip level* for a time specified in the *Trip delay*, the MCU will open the contactor. An alarm message "Autoreclosure alarm" is generated and the counting of *Maximum power down time* begins.

INSUM[®]

MCU Parameter Description

Notes:

15.9 Reset Voltage Level

Function	Undervoltage protection
MMI text	Reset voltage level
Related MCU	2
Range	50 (1) 100 %
Default setting	90 %
Related parameter	Undervoltage / Trip delay Undervoltage / Max. autoreclose time Undervoltage / Max. power down time Undervoltage / Staggered start time
Description	see hereunder

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 figure).

15.10 Max. Autoreclose Time

Function	Undervoltage protection
MMI text	Reclosure enable time
Related MCU	2
Range	0.0 (0.1) 5.0 s
Default setting	0.2 s
Related parameter	Undervoltage / Function enable, disable Undervoltage / Trip reset mode Undervoltage / Trip delay Undervoltage / Reset voltage level Undervoltage / Max. powerdown time
Description	see hereunder

Max. autoreclose time is the time after the undervoltage *Trip delay* during which the motor immediately re-starts on restoration of voltage above the *Reset voltage level*.

15.11 Maximum Power Down Time

Function	Undervoltage protection
MMI text	Restart enable time
Related MCU	2
Range	0 (1) 1200 s
Default setting	5 s
Related parameter	Undervoltage / Function enable, disable Undervoltage / Trip reset mode Undervoltage / Trip delay Undervoltage / Reset voltage level Undervoltage / Max. autoreclose time Undervoltage / Staggered start time
Description	see hereunder

The *Max. powerdown time* starts after the *Trip delay* time has elapsed. It is the maximum waiting time of the MCU for the power resumption. The motor would restart after *Staggered start delay* on voltage restoration above the *Reset voltage level* between end of *Max autoreclose time* and *Max. power down time*. The MCU issues an undervoltage trip message if the voltage recover above the reset voltage level after the *Max. powerdown time*.. The trip can be reset based on the parameterisation of the *Trip reset mode*.

INSUM[®]

MCU Parameter Description

Notes:

15.12 Staggered Start Time

Function	Undervoltage protection
MMI text	Staggered start time
Related MCU	2
Range	0 (0.1) 1200 s
Default setting	5.0 s
Related parameter	Undervoltage / Function enable, disable Undervoltage / Trip reset mode Undervoltage / Trip delay Undervoltage / Reset voltage level Undervoltage / Max. autoreclose time Undervoltage / Max. power down time
Description	See hereunder

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 "C-B" (refer figure 13). 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.

15.13 Trip Reset Mode

Function	Undervoltage protection
MMI text	Trip reset mode
Related MCU	2
Range	Auto / Remote / Local / Remote & Local
Default setting	Remote & Local
Related parameter	Undervoltage / Function enable, disable
Description	see hereunder

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

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

Remote reset: Trip reset is only possible via the fieldbus (MMI, PCS or OS) after the voltage goes above the reset voltage level.

Local reset: Trip reset is only possible via the device I/O. By operating "RESET" switch connected to pin X13: 15 resets the trip in the local mode. The local mode is active with pin X13: 16 kept low.

Notes:

16 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 pre-set value. The permissible motor starts per hour can be obtained from the manufacturers motor and apparatus data sheet. However, the minimum waiting time between two starts shall be complied.

The parameterisation 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 the advantage of this protection function can be taken of supervising the number of starts. On some other cases process may put requirements for the motor start number thus this protection can be employed.

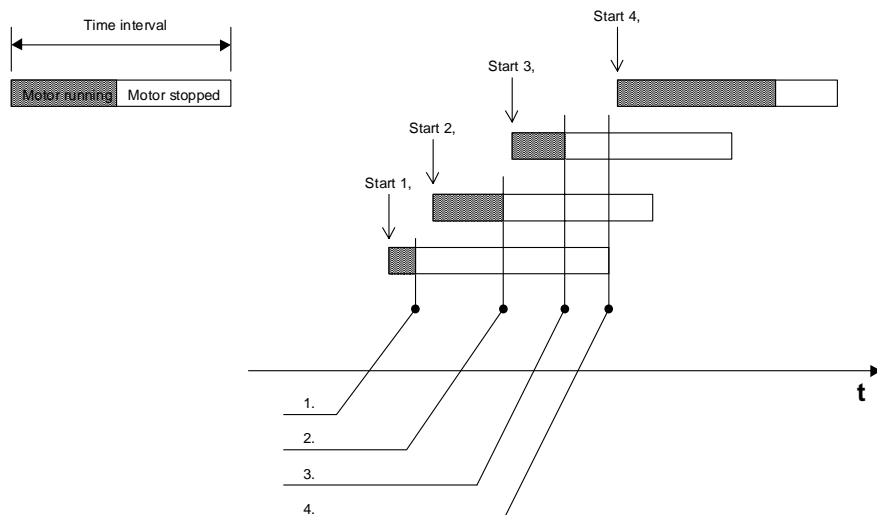
As an example: The following picture presents the start limitation protection functionality. Allowed maximum number of starts, *Number of starts*, is 3 within *Time interval*.

1. Normal situation, after stop command motor can be started normally, "Start 2". Every start activates an internal timer for the time defined by *Time interval* parameter. The number of active timers are reviewed after every stop command and compared to value of *Number of starts* parameter. Stop command can thus exist during active or elapsed timer.
2. Two timers are still active, thus stop command generates alarm message and one more start is allowed, "Start 3".
3. The 3rd start has been executed. A contactor trip and trip message will follow when motor is stopped while there are two active timers, here starting from "Start 1".
4. 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".

The parameters involved with the protection function are,

Function	Starter configuration
Available parameters	Function Enable, Disable
	Time interval
	Number of starts
	Trip reset mode

Picture 18. Start limitation protection.



INSUM[®]

MCU Parameter Description

Notes:

16.1 Function Enable, Disable

Function	Start limitation protection
MMI text	Function
Related MCU	2
Range	Enabled / Disabled / Trip only / Alarm only
Default setting	Disabled
Related parameter	Start limitation / Parameters
Description	see hereunder

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 MCU and all other parameters of the function (*Time interval*, *Number of starts*, and *Trip reset mode*) are hidden.

16.2 Time Interval

Function	Start limitation protection
MMI text	Time interval
Related MCU	2
Range	0 (1) 600 min
Default setting	60 min
Related parameter	Start limitation / Number of starts
Description	see hereunder

During this *Time interval* the number of starts is limited by setting the parameter *Number of starts*.

16.3 Number of Starts

Function	Start limitation protection
MMI text	Number of starts
Related MCU	2
Range	1 (1) 100
Default setting	3
Related parameter	Start limitation / Time interval
Description	see hereunder

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 parameterised time interval will define the time between two consecutive starts.

INSUM[®]

MCU Parameter Description

Notes:

16.4 Trip Reset Mode

Function	Start limitation protection
MMI text	Trip reset mode
Related MCU	2
Range	Auto / Remote / Local / Remote & Local
Default setting	Remote & Local
Related parameter	Start limitation / Function enable, disable.
Description	see hereunder

This parameter defines the trip reset modes for the start limitation protection trip.

Auto: The 'Start limitation trip' is reset automatically after trip.

Remote: The 'Start limitation trip' can be reset via the fieldbus (MMI, PCS or OS).

Local: The 'Start limitation trip' is only possible via the device I/O. By operating "RESET" switch connected to pin X13: 15 resets the trip in the local mode. The local mode is active with pin X13: 16 kept low.

INSUM[®]

MCU Parameter Description

Notes:

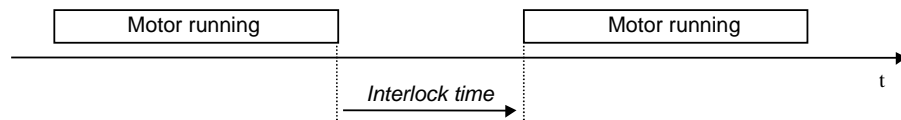
17 Start Interlock Protection

Start interlock protection is available to help the intelligent control of the delay between previous stop command and new start command. With this function user can define the delay during which the unit will not allow to start motor but gives an indication to the user. Trip and alarm functionality are selectable.

The parameters involved with the protection function are,

Function	Starter configuration
Available parameters	Function Enable, Disable Interlock time Trip reset mode

Picture 19. Start interlock protection principle.



17.1 Function Enable, Disable

Function	Start interlock protection
MMI text	Function
Related MCU	2
Range	Enabled / Disabled / Trip only / Alarm only
Default setting	Disabled
Related parameter	Start interlock / Parameters
Description	see hereunder

The start interlock protection function can be disabled with the help of this parameter. When disabled, the protection function does not have any functionality in the MCU and all other parameters of the function (*Interlock time* and *Trip reset mode*) are hidden.

17.2 Interlock Time

Function	Start interlock protection
MMI text	Interlock time
Related MCU	2
Range	1 (1) 600 min
Default setting	10 min
Related parameter	Start interlock / Function enable, disable
Description	see hereunder

The *Interlock time* starts from the last stop command and makes the unit to discard the start command until the time has elapsed.

INSUM[®]

MCU Parameter Description

Notes:

17.3 Trip Reset Mode

Function	Start interlock protection
MMI text	Trip reset mode
Related MCU	2
Range	Auto / Remote / Local / Remote & Local
Default setting	Remote & Local
Related parameter	Start interlock / Function enable, disable
Description	see hereunder

This parameter defines the trip reset modes for the start interlock protection trip.

Auto: The 'Start interlock trip' is reset automatically after trip.

Remote: The 'Start interlock trip' can be reset via the fieldbus (MMI, PCS or OS).

Local: The 'Start interlock trip' is only possible via the device I/O. By operating "RESET" switch connected to pin X13: 15 resets the trip in the local mode. The local mode is active with pin X13: 16 kept low.

INSUM[®]

MCU Parameter Description

Notes:

18 Maintenance Functions

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. This would reap high benefits to the user in terms of reduced process down time and loss due to stoppage of production.

Maintenance function indicates the operation of the motor in terms of hours run and the usage of contactor 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.

- *Preset CCx cycles* can be set to zero after maintenance and keep the current alarm level (hours or cycles)
- *Preset CCx cycles alarm* can be increased to a new value that fulfils the next required service conditions (hours or cycles)

Parameters under 'Maintenance function' are as below:

Function	Starter configuration
Available parameters	Preset Hours Run
	Motor Hours Run Alarm
	Preset CCa Cycles
	Preset CCa Cycles Alarm
	Preset CCb Cycles
	Preset CCb Cycles Alarm
	Preset CCc Cycles
	Preset CCc Cycles Alarm

18.1 Preset Hours Run

Function	Maintenance
MMI text	Preset hours run
Related MCU	1 and 2
Range	0 (10) 10'000'000 h
Default setting	0 h
Related parameter	Maintenance function / Preset hours run alarm
Description	see hereunder

Preset hours run parameter can be used to set up a value to a counter, which calculates the motor running time in hours. Preset hours run parameter is possible to be reset after maintenance, as an example.

18.2 Motor Hours Run Alarm

Function	Maintenance
MMI text	Motor hours run alarm
Related MCU	1 and 2
Range	0 (10) 10'000'000 h
Default setting	10'000 h
Related parameter	Maintenance function / Preset hours run NV heartbeat base
Description	see hereunder

INSUM[®]

MCU Parameter Description

Notes:

The user can set a period after which a preventive maintenance is desired. When the 'Preset Hours Run' counter exceeds the *Preset hours run alarm* level a message 'Maintenance hours run' is generated for the corresponding MCU. This helps to lubricate and maintain the bearings of the motor within the correct service interval.

18.3 Preset CCa Cycles

Function	Maintenance
MMI text	Preset CCa cycles
Related MCU	1 and 2
Range	0 (10) 10'000'000
Default setting	0
Related parameter	Maintenance function / Preset CCa cycles alarm
Description	see hereunder

Preset CCa cycles can be used to set up a value to a counter, which calculates the operating cycles of contactor 1. The counter can be reset to zero after maintenance.

Each cycle consists of a close-open operation of a contactor.

18.4 CCa Cycles Alarm Level

Function	Maintenance
MMI text	Ca cycles alarm level
Related MCU	1 and 2
Range	0 (10) 10'000'000
Default setting	10'000
Related parameter	Maintenance function / Preset CCa cycles NV heartbeat base
Description	see hereunder

When contactor CCa has run through the set value of cycles in *preset CCa cycles alarm* counter, the corresponding MCU generates a message 'Maintenance CCa'. This helps in carrying out preventive maintenance of power contacts for the contactor to control output CCa. The electrical life[#] of the contactor can be set to this parameter in terms of control cycles.

18.5 Preset CCb Cycles

Function	Maintenance
MMI text	Preset CCb cycles
Related MCU	1 and 2
Range	0 (10) 10'000'000
Default setting	0
Related parameter	Maintenance function / Preset CCb cycles alarm Starter configuration / Starter type
Description	see hereunder

Preset CCb cycles can be used to set up a value to a counter, which calculates the operating cycles of contactor connected to control output CCb. It is possible to be reset this counter to zero after maintenance.

This parameter is disabled during non-reversible starter type selection under starter configuration function

INSUM[®]

MCU Parameter Description

Notes:

18.6 CCb Cycles Alarm Level

Function	Maintenance
MMI text	CCb cycles alarm level
Related MCU	1 and 2
Range	0 (10) 10'000'000
Default setting	10'000
Related parameter	Maintenance function / Preset CCb cycles Starter configuration / Starter type NV heartbeat base
Description	see hereunder

When contactor CCb has run through the set value of cycles in *preset CCb cycles alarm* counter, the corresponding MCU generates a message 'Maintenance CCb'. This helps in carrying out preventive maintenance of power contacts for the contactor connected to control output CCb.

Also refer to parameter *Preset CCa cycles alarm* for more details.

18.7 Preset CCc Cycles

Function	Maintenance
MMI text	Preset CCc cycles
Related MCU	2
Range	0 (10) 10'000'000
Default setting	0
Related parameter	Maintenance function / Preset CCc cycles alarm Starter configuration / Starter type
Description	see hereunder

Preset CCc cycles can be used to set up a value to a counter, which calculates the operating cycles of contactor connected to control output CCc. It is possible to be reset this counter to zero after maintenance.

This parameter is disabled during non-reversible starter type selection under starter configuration function.

18.8 CCc Cycles Alarm Level

Function	Maintenance
MMI text	CCc cycles alarm level
Related MCU	2
Range	0 (10) 10'000'000
Default setting	10'000
Related parameter	Maintenance function / Preset CCc cycles Starter configuration / Starter type NV heartbeat base
Description	see hereunder

When contactor CCc has run through the set value of cycles in *preset CCc cycles alarm* counter, the corresponding MCU generates a message 'Maintenance CCc'. For more details refer to parameter *preset CCa cycles alarm*. This helps in carrying out preventive maintenance of power contacts for the contactor connected to control output CCc.

INSUM®

MCU Parameter Description

Notes:

19 Control Access

There are different stations like PCS (via INSUM Gateways), MMI, INSUM OS or Motor Control Panels from where the motor can be started or stopped or trips can be reset.

With the Control Access functionality it can be decided which one of these *stations* is allowed to control a MCU/motor at a given time. When Control Access is used each MCU "knows" which *station* momentarily has the authority to control it. Commands coming from an unauthorised *station* will not be passed to the motor.

To use Control Access a hierarchy has to be defined between the *stations* in an INSUM system. These priorities determine the "rules" for passing Control Access between *stations*. Passing of Control Access is done with a dedicated set of telegrams. In most cases the GW will receive the highest priority because it is the *station* connecting the INSUM system to a PCS.

For one INSUM system (comprising up to 128 MCU's and its *stations*) one "Control Access setting" has to be defined. Then Control Access parameters in all MCU's and all *stations* belonging to the system have to be set accordingly.

Stations are devices connected to the ICU (INSUM Communication Unit devices such as Gateways, MMI) and also the INSUM OS. ICU devices are referred here as 'SU'-devices (SU = Switchgear Unit).

In addition to those devices controlling the MCU's via bus, each MCU can be controlled via its hardware inputs if Pin X13: 16 = Local. The Local control has automatically the highest priority in the system.

Note! The setting of reset mode parameters and usage of Control Access can interfere with each other.

For example: GW (PCS) have CA for MCU 2/5.
 In MCU 2/5 TOL Protection / Trip Reset mode: Local
 -> Reset command from GW is accepted by MCU because GW has "CA", but as the Reset mode is only "Local" and not "Bus", the Reset will not be performed and TOL trip remains.

Please refer to 'INSUM Control Access Guide' document for further information.

The parameters under Control Access function are as below:

Function	Starter configuration
Available parameters	Function Enable / Disable SU Lifelist Timeout Station Priority

19.1 Function Enable /Disable

Function	Control Access
MMI text	Enabled / disabled
Related MCU	1 and 2
Range	Enabled / Disabled
Default setting	Disabled
Related parameter	Control access / Parameters System / SU lifelist timeout
Description	see hereunder

Control Access function can be disabled with the help of this parameter. When disabled, all other parameters of the function (*Station priority*, *Station Lifelist Timeout*) are hidden in MMI, greyed out in OS.

When disabled only the "simple" way of Control Access is used:
 If pin X13: 16 is set to Local, only commands via binary inputs will be accepted by the MCU. If pin X13: 16 is set to bus (remote), only commands via the fieldbus inputs will be accepted by the MCU. The MCU does not differentiate from which station (GW, MMI or OS) a control command is sent.

INSUM[®]

MCU Parameter Description

Notes:

When enabled the full Control Access functionality is used. If pin X13: 16 is set to bus (remote) the MCU only accepts control commands from the station "owning" CA at that time. Control commands can be Start, Stop, Reset.

19.2 SU Lifelist Timeout

Function	Control Access
MMI text	SU lifelist timeout
Related MCU	1 and 2
Range	1 (1) 255 s
Default setting	20 s
Related parameter	Control access parameters in MCU, GW, MMI, OS SU devices – SU lifelist heartbeat
Description	see hereunder

All SU devices connected to the backbone bus send cyclically "Lifesign heartbeats" to each other. Each SU device is supervising these Lifesigns and creates a "SU LifeList" telling which of the SU devices is "alive" on the bus. The SU device having the highest station priority is sending this "SU LifeList" down to all MCU's with the cycle time defined by the "SU lifelist heartbeat".

When the time defined by *SU lifelist timeout* expires and the actual "CA-owner" is not marked "alive" anymore the Control Access will be set to "release" state for that MCU. When the time defined by *SU lifelist timeout* expires until a new "SU LifeList" is received, the Control Access will be set to "release" state for that MCU. "Release" state means that any station regardless its priority can take over Control Access for that MCU.

Note: *SU lifelist timeout* of MCU's should be at least 2-3 times "SU lifelist heartbeat" of SU devices.

19.3 Station Priority

Function	Control Access
MMI text	Address priority 1:...16:
Related MCU	1 and 2
Range	Subnet 0(1)255 / Node 0(1)127
Default setting	0, 0
Related parameter	Control access parameters in MCU, GW, MMI, OS SU devices - CA priority
Description	see hereunder

This list of parameters defines the priorities between the stations controlling a MCU.

The hierarchy defined should be the same for all MCU's in one INSUM system. To give a station a certain priority its LON subnet/node address has to be filled in at the respective priority entry.

Priority 1 is automatically occupied by the local control (hardware inputs of MCU).

20 System

INSUM relies on event driven messages. This means: Each time a change in status or a change of an analogue value above a predefined hysteresis occurs, the telegram carrying the specific information is immediately updated by the MCU. In addition, all data sent to SU devices (GW, MMI, and OS) are updated in a slow background cycle. The cyclic update serves to give newly hooked up SU devices an image of the

INSUM[®]

MCU Parameter Description

Notes:

system. It is also used to supervise MCU communication towards SU devices (detection of communication loss).

Note! The parameter *Status heartbeat* and *Nv heartbeat base* are to be selected carefully to reduce unnecessary bus loading.

The parameters involved with “system” are as below:

Function	Starter configuration
Available parameters	Failsafe Timeout Status Heartbeat Nv Heartbeat base I Report Deadband

20.1 Failsafe Timeout

Function	System
MMI text	Failsafe timeout
Related MCU	1 and 2
Range	1 (1) 100 s
Default setting	5 s
Related parameter	---
Description	see hereunder

If communication failure between PCS, SU and MCUs is longer than the time period defined in this parameter, the MCU failsafe functionality is activated. MCU continuously monitor communication with SUs by receiving 'heart beat' from them. This parameter allows setting the time period in which the MCUs should expect the 'heartbeat' signal from the SU.

Note! This parameter must be synchronised with the 'heart rate' of the SU to avoid problems. (As a general rule, *Failsafe timeout* > 3 x heart rate).

20.2 Status Heartbeat

Function	System
MMI text	Status heartbeat
Related MCU	1 and 2
Range	1.0 (0.1) 60.0 s
Default setting	2.0 s
Related parameter	SU devices - Field device timeout
Description	see hereunder

This parameter sets the interval at which the most important data the motor status (nvoMotorStateExt), is to be sent repeatedly by the MCU. *Status heartbeat* must correspond with the parameter “Field device timeout” in SU devices (GW, MMI, and OS).

INSUM[®]

MCU Parameter Description

Notes:

20.3 NV Heartbeat Base

Function	System
MMI text	NV heartbeat base
Related MCU	1 and 2
Range	1.0 (0.1) 60.0 s
Default setting	2.0 s
Related parameter	---
Description	see hereunder

All data (nv's – network variables) sent from the MCU towards the SU devices (GW, MMI, OS) is periodically updated in a slow background cycle. The "nv heartbeat base" parameter defines the base timer for different time slots used for sending different groups of data. The assignment of the data to the time slots is defined as follows:

Table 13. NV heartbeat base reported network variables.

Cycle		Network variable name	Unit	NV index	MCU2
4x NV heartbeat base	Actual Control Access owner	nvoActualCA1	--	45	
	Alarm bit field	nvoAlarmReport	--	51	
	Current report	nvoCurrRep	--	17	
	Phase currents	-	A	-	
	Phase currents	-	%	-	
	Earth fault	-	A	-	
12x NV heartbeat base	Voltage report	nvoVoltRep	--	55	X
	Phase voltages	-	V	-	
	Frequency	-	Hz	-	
	Power report	nvoPowRep	--	56	X
	Active power	-	W	-	
	Reactive power	-	Var	-	
	Power factor	-	--	-	
72x NV heartbeat base	Apparent power	nvoAppPwr	kVA	67	X
	CCc switching cycles	nvoNbrOfOp3	--	39	X
	CCa switching cycles	nvoNbrOfOp1	--	41	
	CCb switching cycles	nvoNbrOfOp2	--	43	
	Motor run hours	nvoCumRunT	Hour	33	
	Thermal capacity	novCalcProcValue	%	19	
	GPI1 feedback	nvoGpIn1	--	74	X
	GPI2 feedback	nvoGpIn2	--	75	X
	GPO1 feedback	nvoGPOut1Fb	--	71	X
	GPO2 feedback	nvoGPOut2Fb	--	73	X
	Configuration CRC	nvoParFileCRC16	--	76	
	Time to trip	nvoTimeToTrip	sec	20	
	Time to reset	nvoTimeToReset	sec	21	

INSUM[®]

MCU Parameter Description

Notes:

20.4 I Report Deadband

Function	System
MMI text	I Report Deadband
Related MCU	1 and 2
Range	1 (1) 100 %
Default setting	10 %
Related parameter	---
Description	see hereunder

INSUM uses an event driven mechanism and sends new analogue data when a certain change in hysteresis occurred. The MCU sends all current related data (nvoCurrRep) when changes in measured values are detected beyond the dead band defined by this parameter.

Note! Changing this parameter causes large changes in the busload.

INSUM[®]

MCU Parameter Description

Notes:

21 Device Data

This group provides the internal data of the MCU and other relevant data of the INSUM system. The parameters belonging to this group are read only and no parameterisation is possible.

The parameters involved with "Device Data" are as below:

Function	Starter configuration
Available parameters	Software ID Parameter file version Start inhibit level Current unit (CU) Voltage unit (VU) TOL trip reset count TOL bypass counter Diagnostics

21.1 Software ID

The firmware version momentarily loaded in the MCU is indicated by this read only parameter. Display of firmware version is to simplify assistance in case of technical questions related to MCUs.

21.2 Parameter file version

All parameter values are stored in one "binary file" inside the MCU. MMI, OS and GW can upload and download this file and interpret it. In case of changes in the structure/format of this file the file version number will be incremented. So interpretation can be adapted.

21.3 Start inhibit level

Based on the parameter setting of *Startup I ratio*, *Motor startup time*, and *Trip class (t6)*, the MCU calculates the Start Inhibit Level which also represents the reset level for TOL trip. It can be read from this parameter.

21.4 Current unit (CU)

The internal current transformer range is automatically detected by the MCU and then stored in this read only parameter.

21.5 Voltage unit (VU)

The internal voltage transformer range is automatically detected by the MCU and then stored in this read only parameter.

21.6 TOL trip reset count

The number of TOL trip reset is stored into this read only parameter.

21.7 TOL bypass counter

The number of TOL bypass commands is stored into this read only parameter.

21.8 Diagnostics

Diagnostics counters 1...4. For internal use only.

INSUM®

MCU Parameter Description

Notes:

22 I/O Configuration

The binary inputs are fed to the MCU either to control or for supervision of the starter. These binary inputs can be parameterised to normally open (NO) or normally closed (NC). This increases the flexibility of the I/O configuration and reduction of additional auxiliary relays.

The actual input state in default

Table 14. Following are the inputs that can be parameterised:

Input name	Pin	Default configuration	Available
Start 1	X13:12	Normally open	MCU1&2
Start 2	X13:13	Normally open	MCU1&2
Stop	X13:14	Normally closed	MCU1&2
Reset	X13:15	Normally open	MCU1&2
Local	X13:16	Normally open	MCU1&2
Em-stop	X13:17	Normally closed	MCU1&2
Test/service	X14:1	Normally open	MCU1&2
Main switch	X14:2	Normally open	MCU1&2
MCB	X14:6	Normally open	MCU1&2
CFa (/KM11)	X14:7	Normally open	MCU1&2
CFb (/KM21)	X14:8	Normally open	MCU1&2
CFc / Torque (/KM31)	X14:9 or X13:20	Normally open	MCU2
External trip input	X14:3	Normally open	MCU1&2
Limit 1	X13:18	Normally open	MCU2
Limit 2	X13:19	Normally open	MCU2
Rotation monitor	X13:23	Normally open	MCU2

INSUM[®]

MCU Parameter Description

Notes:

23 General purpose I/O

MCU2 unit can be used to read in or control I/O external device. This is achieved via configurable general purpose I/O interface. This interface consists of two input interface and two relay output interface. Practically general purpose I/O implementation requires logical bindings over fieldbus interface in order to transfer read data or execute control according to received data.

Parameters in MCU2 involved with general purpose I/O configuration are as follows:

Function	Starter configuration
Available parameters	GPO1 ON value GPO1 OFF value GPO2 ON value GPO2 OFF value GPI1 ON value GPI1 OFF value GPI2 ON value GPI2 OFF value

23.1 GpO1 ON Value

Function	General purpose I/O
MMI text	GpO1 contact open
Related MCU	2
Range	0 (1) 255
Default setting	4
Related parameter	General purpose output / GpO1 OFF value
Description	see hereunder

This parameter defines the value that will activate the general purpose output relay 1 (pin X13:3) when received through network interface.

23.2 Gp O1 OFF Value

Function	General purpose I/O
MMI text	GpO1 contact closed
Related MCU	2
Range	0 (1) 255
Default setting	0
Related parameter	General purpose output / GpO1 ON value
Description	see hereunder

This parameter defines the value that will deactivate the general purpose output relay 1 (pin X13:3) when received through network interface.

INSUM[®]

MCU Parameter Description

Notes:

23.3 GpO2 ON Value

Function	General purpose I/O
MMI text	GpO2 contact open
Related MCU	2
Range	0 (1) 255
Default setting	4
Related parameter	General purpose output / GpO2 OFF value
Description	see hereunder

This parameter defines the value that will activate the general purpose output relay 2 (pin X13:5) when received through network interface.

23.4 GpO2 OFF Value

Function	General purpose I/O
MMI text	GpO2 contact closed
Related MCU	2
Range	0 (1) 255
Default setting	0
Related parameter	General purpose output / GpO2 ON value
Description	see hereunder

This parameter defines the value that will deactivate the general purpose output relay 2 (pin X13:5) when received through network interface.

23.5 GpI1 ON Value

Function	General purpose I/O
MMI text	GpI1 ON value
Related MCU	2
Range	0 (1) 255
Default setting	4
Related parameter	General purpose input / GpI1 OFF value
Description	see hereunder

This parameter defines the value that will be issued to fieldbus through output variable when general purpose input 1 (pin X13:21 or X14:10) is activated.

23.6 GpI1 OFF Value

Function	General purpose I/O
MMI text	GpI1 OFF value
Related MCU	2
Range	0 (1) 255
Default setting	0
Related parameter	General purpose input / GpI1 ON value
Description	see hereunder

This parameter defines the value that will be issued to fieldbus through output variable when general purpose input 1 (pin X13:21 or X14:10) is deactivated.

INSUM[®]

MCU Parameter Description

Notes:

23.7 Gpl2 ON Value

Function	General purpose I/O
MMI text	Gpl2 ON value
Related MCU	2
Range	0 (1) 255
Default setting	4
Related parameter	General purpose input / Gpl2 OFF value
Description	see hereunder

This parameter defines the value that will be issued to fieldbus through output variable when general purpose input 2 (pin X13:22 or X14:11) is activated.

23.8 Gpl2 OFF Value

Function	General purpose I/O
MMI text	Gpl2 OFF value
Related MCU	2
Range	0 (1) 255
Default setting	0
Related parameter	General purpose input / Gpl2 ON value
Description	see hereunder

This parameter defines the value that will be issued to fieldbus through output variable when general purpose input 2 (pin X13:22 or X14:11) is deactivated.

INSUM[®]

MCU Parameter Description

Notes:

Appendix A. MCU trip curves

Table 1. Look-up table of trip time from cold condition, balanced network. $T_{AMB} = 40^{\circ}\text{C}$.

I / In	t6 = 5 s	t6 = 7 s	t6 = 10 s	t6 = 15 s	t6 = 20 s	t6 = 25 s	t6 = 30 s	t6 = 35 s	t6 = 40 s
1.15	552 s	772 s	1103 s	1655 s	2207 s	2758 s	3310 s	3861 s	4413 s
1.16	459 s	643 s	918 s	1377 s	1837 s	2296 s	2755 s	3214 s	3673 s
1.17	406 s	568 s	812 s	1217 s	1623 s	2029 s	2434 s	2840 s	3246 s
1.18	368 s	516 s	737 s	1105 s	1473 s	1842 s	2210 s	2578 s	2947 s
1.19	340 s	476 s	679 s	1019 s	1359 s	1699 s	2038 s	2378 s	2718 s
1.20	317 s	443 s	633 s	950 s	1266 s	1583 s	1900 s	2216 s	2533 s
1.40	148 s	207 s	296 s	444 s	592 s	740 s	888 s	1036 s	1184 s
1.60	96.5 s	135 s	193 s	289 s	386 s	482 s	578 s	675 s	771 s
1.80	69.9 s	97.8 s	140 s	209 s	279 s	349 s	418 s	488 s	558 s
2.00	53.6 s	75.0 s	107 s	160 s	214 s	267 s	321 s	374 s	428 s
2.20	42.7 s	59.7 s	85.2 s	128 s	170 s	213 s	255 s	298 s	340 s
2.40	34.9 s	48.8 s	69.7 s	104 s	139 s	174 s	209 s	244 s	278 s
2.60	29.2 s	40.8 s	58.2 s	87.3 s	116 s	145 s	174 s	203 s	232 s
2.80	24.8 s	34.7 s	49.5 s	74.1 s	98.7 s	123 s	148 s	173 s	197 s
3.00	21.4 s	29.9 s	42.6 s	63.8 s	85.0 s	106 s	127 s	149 s	170 s
3.20	18.6 s	26.0 s	37.1 s	55.5 s	74.0 s	92.4 s	111 s	129 s	148 s
3.40	16.4 s	22.9 s	32.6 s	48.8 s	65.0 s	81.2 s	97.5 s	114 s	130 s
3.60	14.5 s	20.3 s	28.9 s	43.3 s	57.6 s	72.0 s	86.4 s	101 s	115 s
3.80	13.0 s	18.1 s	25.8 s	38.6 s	51.5 s	64.3 s	77.1 s	89.9 s	103 s
4.00	11.7 s	16.3 s	23.2 s	34.7 s	46.2 s	57.8 s	69.3 s	80.8 s	92.3 s
4.20	10.6 s	14.7 s	21.0 s	31.4 s	41.8 s	52.2 s	62.6 s	73.0 s	83.4 s
4.40	9.6 s	13.4 s	19.1 s	28.5 s	38.0 s	47.4 s	56.9 s	66.3 s	75.8 s
4.60	8.8 s	12.2 s	17.4 s	26.0 s	34.6 s	43.3 s	51.9 s	60.5 s	69.1 s
4.80	8.1 s	11.2 s	16.0 s	23.8 s	31.7 s	39.6 s	47.5 s	55.4 s	63.3cs
5.00	7.4 s	10.3 s	14.7 s	21.9 s	29.2 s	36.5 s	43.7 s	51.0 s	58.2 s
5.20	6.9 s	9.5 s	13.6 s	20.3 s	27.0 s	33.7 s	40.3 s	47.0 s	53.7 s
5.40	6.4 s	8.8 s	12.6 s	18.8 s	25.0 s	31.2 s	37.4 s	43.6 s	49.8 s
5.60	5.9 s	8.2 s	11.7 s	17.4 s	23.2 s	28.9 s	34.7 s	40.4 s	46.2 s
5.80	5.5 s	7.7 s	10.9 s	16.2 s	21.6 s	26.9 s	32.3 s	37.7 s	43.0 s
6.00	5.2 s	7.2 s	10.2 s	15.2 s	20.2 s	25.2 s	30.2 s	35.2 s	40.2 s
6.20	4.8 s	6.7 s	9.5 s	14.2 s	18.9 s	23.5 s	28.2 s	32.9 s	37.6 s
6.40	4.5 s	6.3 s	8.9 s	13.3 s	17.7 s	22.1 s	26.5 s	30.9 s	35.2 s
6.60	4.3 s	5.9 s	8.4 s	12.5 s	16.6 s	20.8 s	24.9 s	29.0 s	33.1 s
6.80	4.0 s	5.6 s	7.9 s	11.8 s	15.7 s	19.5 s	23.4 s	27.3 s	31.2 s

INSUM[®]

MCU Parameter Description

Notes:

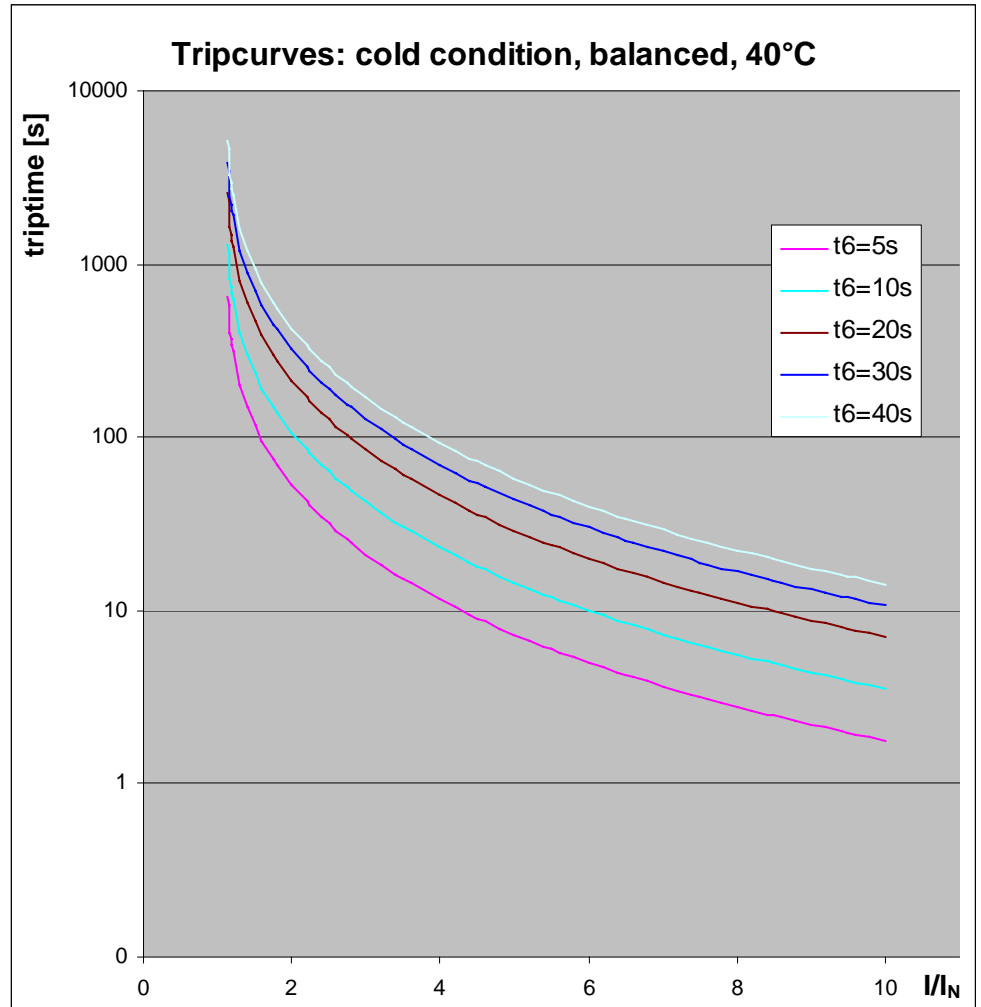
I / In	t6 = 5 s	t6 = 7 s	t6 = 10 s	t6 = 15 s	t6 = 20 s	t6 = 25 s	t6 = 30 s	t6 = 35 s	t6 = 40 s
7.00	3.8 s	5.3 s	7.5 s	11.1 s	14.8 s	18.4 s	22.1 s	25.7 s	29.4 s
7.20	3.6 s	5.0 s	7.1 s	10.5 s	14.0 s	17.4 s	20.9 s	24.3 s	27.8 s
7.40	3.4 s	4.7 s	6.7 s	10.0 s	13.2 s	16.5 s	19.8 s	23.0 s	26.3 s
7.60	3.3 s	4.5 s	6.3 s	9.4 s	12.5 s	15.6 s	18.7 s	21.8 s	24.9 s
7.80	3.1 s	4.3 s	6.0 s	9.0 s	11.9 s	14.8 s	17.8 s	20.7 s	23.7 s
8.00	2.9 s	4.1 s	5.7 s	8.5 s	11.3 s	14.1 s	16.9 s	19.7 s	22.5 s
8.20	2.8 s	3.9 s	5.5 s	8.1 s	10.8 s	13.4 s	16.1 s	18.7 s	21.4 s
8.40	2.7 s	3.7 s	5.2 s	7.7 s	10.3 s	12.8 s	15.3 s	17.9 s	20.4 s
8.60	2.6 s	3.5 s	5.0 s	7.4 s	9.8 s	12.2 s	14.6 s	17.0 s	19.4 s
8.80	2.5 s	3.4 s	4.8 s	7.1 s	9.4 s	11.7 s	14.0 s	16.3 s	18.6 s
9.00	2.4 s	3.2 s	4.6 s	6.8 s	9.0 s	11.2 s	13.4 s	15.6 s	17.8 s
9.20	2.3 s	3.1 s	4.4 s	6.5 s	8.6 s	10.7 s	12.8 s	14.9 s	17.0 s
9.40	2.2 s	3.0 s	4.2 s	6.2 s	8.2 s	10.2 s	12.2 s	14.3 s	16.3 s
9.60	2.1 s	2.9 s	4.0 s	6.0 s	7.9 s	9.8 s	11.7 s	13.7 s	15.6 s
9.80	2.0 s	2.8 s	3.9 s	5.7 s	7.6 s	9.4 s	11.3 s	13.1 s	15.0 s
10.00	1.9 s	2.7 s	3.7 s	5.5 s	7.3 s	9.1 s	10.8 s	12.6 s	14.4 s

INSUM[®]

MCU Parameter Description

Notes:

Picture 1. Trip curve from cold condition, balanced network. $T_{AMB} = 40^{\circ}\text{C}$.



INSUM[®]

MCU Parameter Description

Notes:

Table 2. Look-up table of trip time from cold condition, 100% of phase loss. $T_{AMB} = 40^{\circ}\text{C}$.

I / In	t6 = 5 s	t6 = 7 s	t6 = 10 s	t6 = 15 s	t6 = 20 s	t6 = 25 s	t6 = 30 s	t6 = 35 s	t6 = 40 s
0.73	533 s	747 s	1067 s	1600 s	2133 s	2666 s	3200 s	3733 s	4266 s
0.74	419 s	586 s	837 s	1255 s	1674 s	2092 s	2510 s	2929 s	3347 s
0.75	359 s	503 s	718 s	1077 s	1436 s	1795 s	2154 s	2513 s	2872 s
0.76	319 s	447 s	638 s	958 s	1277 s	1596 s	1915 s	2234 s	2553 s
0.77	290 s	405 s	579 s	869 s	1158 s	1447 s	1737 s	2026 s	2316 s
0.78	266 s	373 s	532 s	798 s	1064 s	1330 s	1596 s	1862 s	2128 s
0.79	247 s	345 s	493 s	740 s	987 s	1233 s	1480 s	1727 s	1973 s
0.80	230 s	323 s	461 s	691 s	921 s	1152 s	1382 s	1612 s	1843 s
1.00	101 s	141 s	201 s	302 s	402 s	503 s	603 s	703 s	804 s
1.20	61.4 s	85.9 s	123 s	184 s	245 s	307 s	368 s	429 s	490 s
1.40	42.3 s	59.2 s	84.5 s	127 s	169 s	211 s	253 s	295 s	337 s
1.60	31.2 s	43.6 s	62.2 s	93.3 s	124 s	155 s	186 s	217 s	248 s
1.80	24.1 s	33.6 s	48.0 s	71.9 s	95.8 s	120 s	144 s	168 s	191 s
2.00	19.2 s	26.8 s	38.2 s	57.2 s	76.3 s	95.3 s	114 s	133 s	152 s
2.20	15.7 s	21.9 s	31.2 s	46.8 s	62.3 s	77.8 s	93.3 s	109 s	124 s
2.40	13.1 s	18.3 s	26.0 s	38.9 s	51.9 s	64.8 s	77.7 s	90.7 s	104 s
2.60	11.1 s	15.5 s	22.0 s	33.0 s	43.9 s	54.8 s	65.8 s	76.7 s	87.6 s
2.80	9.5 s	13.3 s	18.9 s	28.3 s	37.7 s	47.0 s	56.4 s	65.8 s	75.2 s
3.00	8.3 s	11.5 s	16.4 s	24.6 s	32.7 s	40.8 s	48.9 s	57.1 s	65.2 s
3.20	7.3 s	10.1 s	14.4 s	21.5 s	28.6 s	35.8 s	42.9 s	50.0 s	57.1 s
3.40	6.4 s	9.0 s	12.7 s	19.0 s	25.3 s	31.6 s	37.9 s	44.2 s	50.5 s
3.60	5.8 s	8.0 s	11.3 s	16.9 s	22.5 s	28.1 s	33.7 s	39.3 s	44.9 s
3.80	5.2 s	7.2 s	10.2 s	15.2 s	20.2 s	25.2 s	30.2 s	35.2 s	40.2 s
4.00	4.7 s	6.5 s	9.2 s	13.7 s	18.2 s	22.7 s	27.2 s	31.8 s	36.3 s
4.20	4.2 s	5.9 s	8.3 s	12.4 s	16.5 s	20.6 s	24.7 s	28.8 s	32.9 s
4.40	3.9 s	5.4 s	7.6 s	11.3 s	15.0 s	18.8 s	22.5 s	26.2 s	29.9 s
4.60	3.6 s	4.9 s	7.0 s	10.4 s	13.8 s	17.2 s	20.6 s	24.0 s	27.4 s
4.80	3.3 s	4.5 s	6.4 s	9.5 s	12.6 s	15.8 s	18.9 s	22.0 s	25.1 s
5.00	3.0 s	4.2 s	5.9 s	8.8 s	11.6 s	14.5 s	17.4 s	20.3 s	23.1 s
5.20	2.8 s	3.9 s	5.5 s	8.1 s	10.8 s	13.4 s	16.1 s	18.7 s	21.4 s
5.40	2.6 s	3.6 s	5.1 s	7.5 s	10.0 s	12.5 s	14.9 s	17.4 s	19.8 s
5.60	2.4 s	3.4 s	4.7 s	7.0 s	9.3 s	11.6 s	13.9 s	16.1 s	18.4 s
5.80	2.3 s	3.1 s	4.4 s	6.5 s	8.7 s	10.8 s	12.9 s	15.1 s	17.2 s
6.00	2.1 s	2.9 s	4.1 s	6.1 s	8.1 s	10.1 s	12.1 s	14.1 s	16.1 s
6.20	2.0 s	2.8 s	3.9 s	5.7 s	7.6 s	9.5 s	11.3 s	13.2 s	15.0 s

INSUM[®]

MCU Parameter Description

Notes:

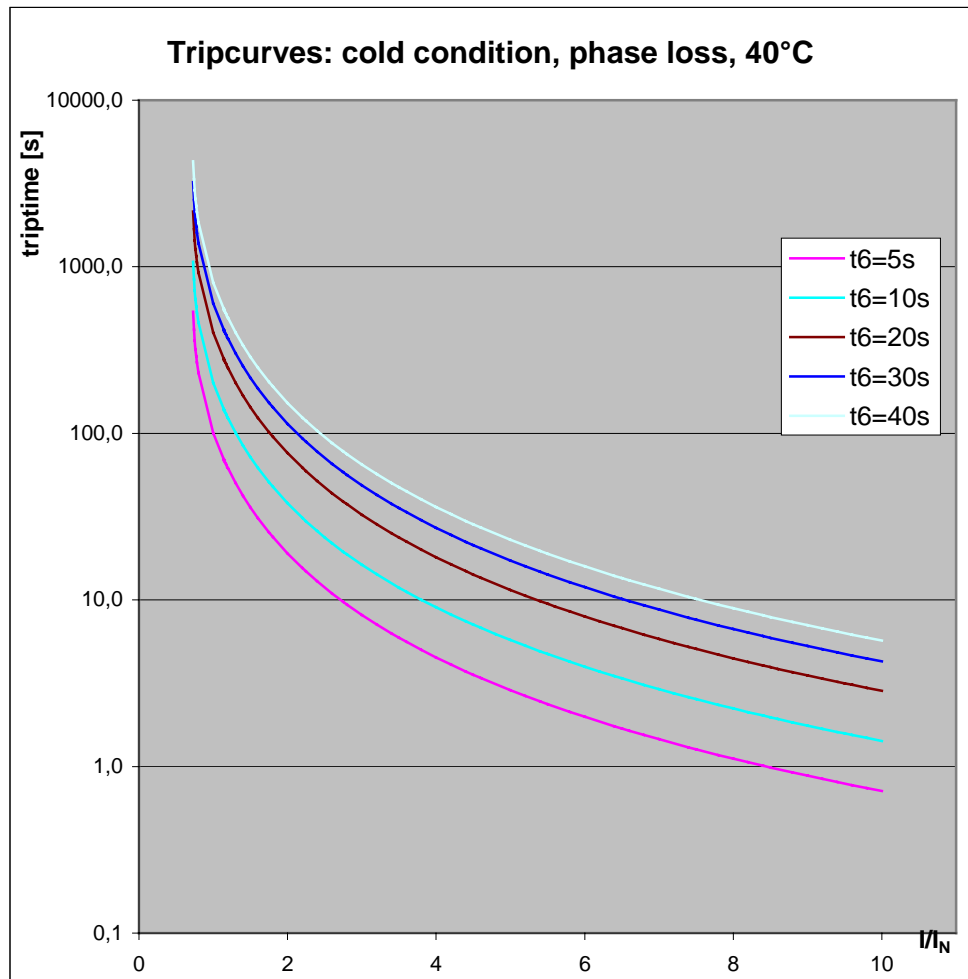
I / In	t6 = 5 s	t6 = 7 s	t6 = 10 s	t6 = 15 s	t6 = 20 s	t6 = 25 s	t6 = 30 s	t6 = 35 s	t6 = 40 s
6.40	1.9 s	2.6 s	3.7 s	5.4 s	7.1 s	8.9 s	10.6 s	12.4 s	14.1 s
6.60	1.8 s	2.5 s	3.4 s	5.1 s	6.7 s	8.4 s	10.0 s	11.6 s	13.3 s
6.80	1.7 s	2.3 s	3.2 s	4.8 s	6.3 s	7.9 s	9.4 s	11.0 s	12.5 s
7.00	1.6 s	2.2 s	3.1 s	4.5 s	6.0 s	7.4 s	8.9 s	10.4 s	11.8 s
7.20	1.5 s	2.1 s	2.9 s	4.3 s	5.7 s	7.0 s	8.4 s	9.8 s	11.2 s
7.40	1.5 s	2.0 s	2.8 s	4.1 s	5.4 s	6.7 s	8.0 s	9.3 s	10.6 s
7.60	1.4 s	1.9 s	2.6 s	3.9 s	5.1 s	6.3 s	7.6 s	8.8 s	10.0s
7.80	1.3 s	1.8 s	2.5 s	3.7 s	4.9 s	6.0 s	7.2 s	8.4 s	9.5 s
8.00	1.3 s	1.7 s	2.4 s	3.5 s	4.6 s	5.7 s	6.8 s	8.0 s	9.1 s
8.20	1.2 s	1.6 s	2.3 s	3.3 s	4.4 s	5.5 s	6.5 s	7.6 s	8.6 s
8.40	1.2 s	1.6 s	2.2 s	3.2 s	4.2 s	5.2 s	6.2 s	7.2 s	8.2 s
8.60	1.1 s	1.5 s	2.1 s	3.1 s	4.0 s	5.0 s	5.9 s	6.9 s	7.9 s
8.80	1.1 s	1.4 s	2.0 s	2.9 s	3.8 s	4.8 s	5.7 s	6.6 s	7.5 s
9.00	1.0 s	1.4 s	1.9 s	2.8 s	3.7 s	4.6 s	5.4 s	6.3 s	7.2 s
9.20	1.0 s	1.3 s	1.8 s	2.7 s	3.5 s	4.4 s	5.2 s	6.1 s	6.9 s
9.40	1.0 s	1.3 s	1.8 s	2.6 s	3.4 s	4.2 s	5.0 s	5.8 s	6.6 s
9.60	0.9 s	1.2 s	1.7 s	2.5 s	3.3 s	4.0 s	4.8 s	5.6 s	6.3 s
9.80	0.9 s	1.2 s	1.6 s	2.4 s	3.1 s	3.9 s	4.6 s	5.4 s	6.1 s
10.00	0.9 s	1.2 s	1.6 s	2.3 s	3.0 s	3.7 s	4.4 s	5.1 s	5.9 s

INSUM[®]

MCU Parameter Description

Notes:

Picture 2. Trip curve from cold condition, 100% phase loss. $T_{AMB} = 40^{\circ}\text{C}$.



INSUM[®]

MCU Parameter Description

Notes:

Table 3. Look-up table of trip time from hot condition (1,05xIn preload for 2 hours), balanced network.
T_{AMB} = 40°C.

I / In	t6 = 5 s	t6 = 7 s	t6 = 10 s	t6 = 15 s	t6 = 20 s	t6 = 25 s	t6 = 30 s	t6 = 35 s	t6 = 40 s
1.15	446 s	624 s	891 s	1336 s	1782 s	2227 s	2673 s	3119 s	3565 s
1.16	356 s	498 s	712 s	1067 s	1423 s	1779 s	2134 s	2490 s	2847 s
1.17	305 s	427 s	610 s	915 s	1220 s	1525 s	1830 s	2135 s	2441 s
1.18	270 s	378 s	540 s	810 s	1080 s	1350 s	1620 s	1891 s	2162 s
1.19	244 s	341 s	488 s	731 s	975 s	1219 s	1463 s	1707 s	1952 s
1.20	223 s	312 s	446 s	669 s	892 s	1115 s	1338 s	1561 s	1785 s
1.40	86.2 s	121 s	172 s	258 s	344 s	430 s	517 s	603 s	689 s
1.60	51.9 s	72.5 s	104 s	155 s	207 s	259 s	310 s	362 s	414 s
1.80	35.9 s	50.2 s	71.6 s	107 s	143 s	179 s	215 s	250 s	286 s
2.00	26.7 s	37.4 s	53.3 s	79.9 s	106 s	133 s	160 s	186 s	213 s
2.20	20.9 s	29.2 s	41.6 s	62.3 s	83.1 s	104 s	125 s	145 s	166 s
2.40	16.9 s	23.5 s	33.6 s	50.3 s	67.0 s	83.7 s	100 s	117 s	134 s
2.60	14.0 s	19.5 s	27.7 s	41.50 s	55.3 s	69.1 s	82.9 s	96.8 s	111 s
2.80	11.8 s	16.4 s	23.4 s	35.0 s	46.6 s	58.2 s	69.8 s	81.5 s	93.2 s
3.00	10.1 s	14.1 s	20.0 s	29.9 s	39.9 s	49.8 s	59.7 s	69.7 s	79.7 s
3.20	8.8 s	12.2 s	17.3 s	25.9 s	34.5 s	43.1 s	51.7 s	60.3 s	69.0 s
3.40	7.7 s	10.7 s	15.2 s	22.7 s	30.2 s	37.7 s	45.3 s	52.8 s	60.4 s
3.60	6.8 s	9.4 s	13.4 s	20.1 s	26.7 s	33.3 s	40.0 s	46.6 s	53.3 s
3.80	6.1 s	8.4 s	12.0 s	17.9 s	23.8 s	29.7 s	35.6 s	41.5 s	47.5 s
4.00	5.4 s	7.6 s	10.7 s	16.0 s	21.3 s	26.6 s	31.9 s	37.2 s	42.5 s
4.20	4.9 s	6.8 s	9.7 s	14.5 s	19.2 s	24.0 s	28.8 s	33.6 s	38.4 s
4.40	4.5 s	6.2 s	8.8 s	13.1 s	17.4 s	21.8 s	26.1 s	30.4 s	34.8 s
4.60	4.1 s	5.7 s	8.0 s	12.0 s	15.9 s	19.8 s	23.8 s	27.7 s	31.7 s
4.80	3.8 s	5.2 s	7.4 s	11.0 s	14.6 s	18.2 s	21.8 s	25.4 s	29.0 s
5.00	3.5 s	4.8 s	6.8 s	10.1 s	13.4 s	16.7 s	20.0 s	23.3 s	26.6 s
5.20	3.2 s	4.4 s	6.3 s	9.3 s	12.3 s	15.4 s	18.4 s	21.5 s	24.6 s
5.40	3.0 s	4.1 s	5.8 s	8.6 s	11.4 s	14.2 s	17.1 s	19.9 s	22.7 s
5.60	2.8 s	3.8 s	5.4 s	8.0 s	10.6 s	13.2 s	15.8 s	18.5 s	21.1 s
5.80	2.6 s	3.6 s	5.0 s	7.4 s	9.9 s	12.3 s	14.7 s	17.2 s	19.6 s
6.00	2.4 s	3.3 s	4.7 s	7.0 s	9.2 s	11.5 s	13.8 s	16.0 s	18.3 s
6.20	2.3 s	3.1 s	4.4 s	6.5 s	8.6 s	10.7 s	12.9 s	15.0 s	17.1 s
6.40	2.1 s	2.9 s	4.1 s	6.1 s	8.1 s	10.1 s	12.1 s	14.1 s	16.1 s
6.60	2.0 s	2.8 s	3.9 s	5.7 s	7.6 s	9.5 s	11.3 s	13.2 s	15.1 s
6.80	1.9 s	2.6 s	3.7 s	5.4 s	7.2 s	8.9 s	10.7 s	12.4 s	14.2 s

INSUM[®]

MCU Parameter Description

Notes:

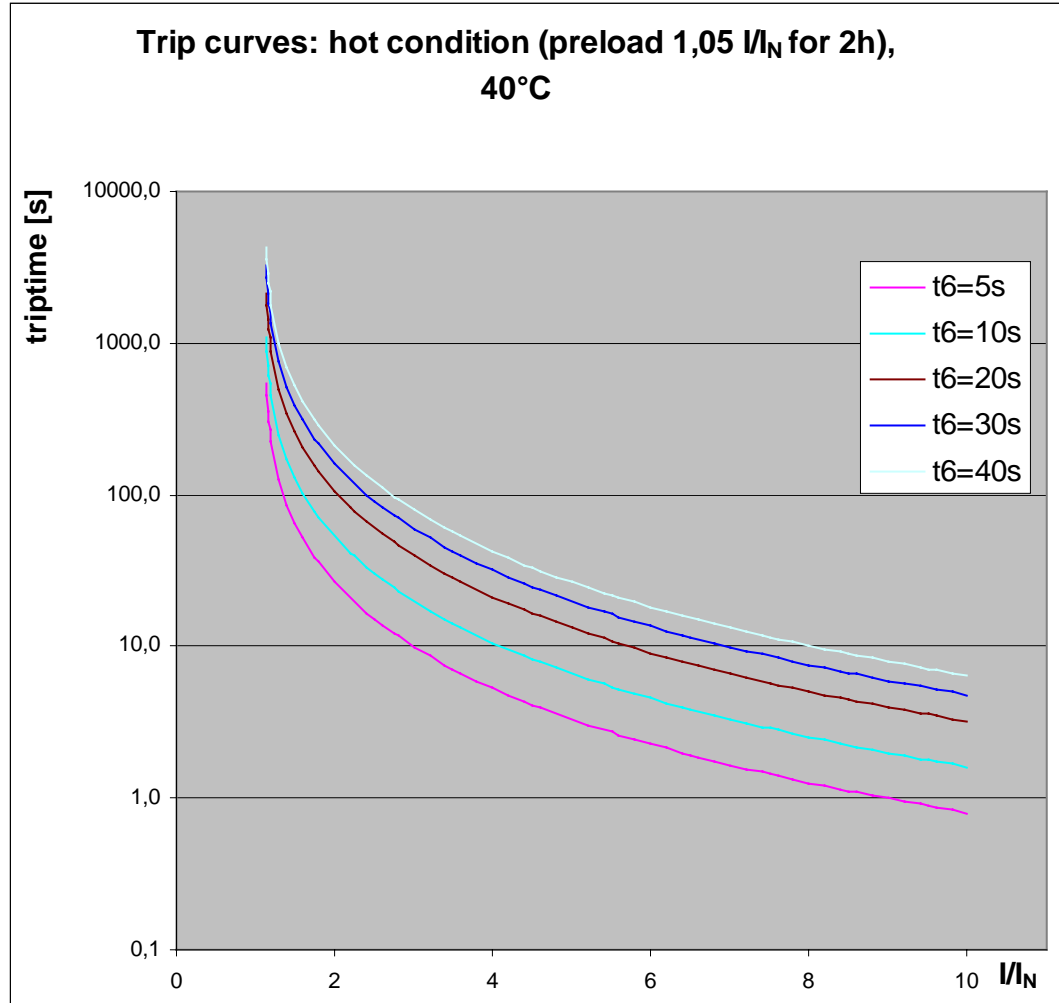
I / In	t6 = 5 s	t6 = 7 s	t6 = 10 s	t6 = 15 s	t6 = 20 s	t6 = 25 s	t6 = 30 s	t6 = 35 s	t6 = 40 s
7.00	1.8 s	2.5 s	3.5 s	5.1 s	6.8 s	8.4 s	10.1 s	11.7 s	13.4 s
7.20	1.7 s	2.3 s	3.3 s	4.8 s	6.4 s	8.0 s	9.5 s	11.1 s	12.7 s
7.40	1.6 s	2.2 s	3.1 s	4.6 s	6.1 s	7.5 s	9.0 s	10.5 s	12.0 s
7.60	1.6 s	2.1 s	3.0 s	4.4 s	5.7 s	7.1 s	8.5 s	9.9 s	11.4 s
7.80	1.5 s	2.0 s	2.8 s	4.1 s	5.5 s	6.8 s	8.1 s	9.4 s	10.8 s
8.00	1.4 s	1.9 s	2.7 s	3.9 s	5.2 s	6.5 s	7.7 s	9.0 s	10.2 s
8.20	1.4 s	1.8 s	2.6 s	3.8 s	4.9 s	6.1 s	7.3 s	8.5 s	9.8 s
8.40	1.3 s	1.8 s	2.4 s	3.6 s	4.7 s	5.9 s	7.0 s	8.1 s	9.3 s
8.60	1.2 s	1.7 s	2.3 s	3.4 s	4.5 s	5.6 s	6.7 s	7.8 s	8.9 s
8.80	1.2 s	1.6 s	2.2 s	3.3 s	4.3 s	5.3 s	6.4 s	7.4 s	8.5 s
9.00	1.2 s	1.5 s	2.1 s	3.1 s	4.1 s	5.1 s	6.1 s	7.1 s	8.1 s
9.20	1.1 s	1.5 s	2.1 s	3.0 s	4.0 s	4.9 s	5.8 s	6.8 s	7.8 s
9.40	1.1 s	1.4 s	2.0 s	2.9 s	3.8 s	4.7 s	5.6 s	6.5 s	7.4 s
9.60	1.0 s	1.4 s	1.9 s	2.8 s	3.6 s	4.5 s	5.4 s	6.3 s	7.1 s
9.80	1.0 s	1.3 s	1.8 s	2.7 s	3.5 s	4.3 s	5.2 s	6.0 s	6.8 s
10.00	1.0 s	1.3 s	1.8 s	2.6 s	3.4 s	4.2 s	5.0 s	5.8 s	6.6 s

INSUM[®]

MCU Parameter Description

Notes:

Picture 3. Trip curve from hot condition (1,05I_N preload for 2 hours), balanced network. T_{AMB} = 40°C.



INSUM[®]

MCU Parameter Description

Notes:

Appendix B. PTC cable compensation tables

Table 1. PTC capacitance compensation for commonly used cable types.

Cable data	Capacitance	Max. cable length with factory setting (15)	Look-up table
Cable type	[nF/km]	[m]	¹⁾
JAMAK n*2*0,5	85	350	Table 2
JAMAK-C n*2*0,5	85	350	Table 2
MCMK 2*1.5/1.5 and MMJ 2*1.5	250	120	Table 3
MMO n*1.5/2.5	150	200	Table 2
NOMAK, >4 pair	85	350	Table 2
NOMAK, 2/4 pair	90	330	Table 2
NOMAK-E, >4 pair	85	350	Table 2
NOMAK-E, 2/4 pair	90	330	Table 2
LiYCY n*2*0,5	110	270	Table 3
Je-LiYCY n*2*0,5	130	230	Table 3
LiYCY n*0,5	160	180	Table 3
LiYY n*0,5	145	200	Table 3
AWG 20 style UL2464	200	150	Table 4

¹⁾ for other cable lengths

NOTICE 1

The information about the cable capacitances in PTC capacitance compensation tables 1 to 4 is subject to change without notice and should not be considered as a commitment by ABB Control Oy 'Low Voltage Products'.

Represented values are based on general information of cable manufacturers.

NOTICE 2

For other cable types, please find out nominal capacitance given by cable manufacturer and select correct parameter value by using PTC capacitance compensation tables 5 to 8.

Table 2. PTC capacitance compensation for cable types.

Parameter [Value]	Capacitance [nF]	Cable type											
		NOMAK, > 4pair			NOMAK, 2/4pair			JAMAK			MMO 7-40*1.5		
		85 nF/km			90 nF/km			85 nF/km			150 nF/km		
		[m]			[m]			[m]			[m]		
15	15	0	...	350	0	...	300	0	...	350	0	...	200
25	25	150	...	450	150	...	400	150	...	450	100	...	250
50	50	450	...	750	400	...	700	450	...	750	250	...	400
75	75	750	...	1050	700	...	1000	750	...	1050	400	...	600
100	100	1000	...	1350	950	...	1250	1000	...	1350	600	...	750
125	125	1300	...	1600	1250	...	1550	1300	...	1600	750	...	900
150	150	1600	...	1900	1500	...	1800	1600	...	1900	900	...	1100
175	175	1900	...	2200	1800	...	2100	1900	...	2200	1100	...	1250
200	200	2200	...	2500	2100	...	2350	2200	...	2500	1250	...	1400
225	225	2500	...	2800	2350	...	2650	2500	...	2800	1400	...	1600
250	250	2800	...	3100	2650	...	2900	2800	...	3100	1600	...	1750

INSUM[®]

MCU Parameter Description

Notes:

Table 3. PTC capacitance compensation for cable types.

Parameter [Value]	Capacitance [nF]	Cable type											
		MCMK 2*1.5/1.5				LiYCY n*2*0,5			Je-LiYCYn*2*0,5			LiYCY n*0,5	
		250 nF/km		110 nF/km		130 nF/km		160 nF/km					
		[m]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[m]
15	15	0	...	100	0	...	250	0	...	200	0	...	150
25	25	50	...	150	100	...	350	100	...	300	100	...	250
50	50	150	...	250	350	...	550	300	...	500	250	...	400
75	75	250	...	350	550	...	800	500	...	650	400	...	550
100	100	350	...	450	800	...	1000	700	...	850	550	...	700
125	125	450	...	550	1000	...	1250	850	...	1050	700	...	850
150	150	550	...	650	1250	...	1500	1050	...	1250	850	...	1000
175	175	650	...	750	1500	...	1700	1250	...	1450	1000	...	1150
200	200	750	...	850	1700	...	1950	1450	...	1650	1200	...	1300
225	225	850	...	950	1950	...	2150	1650	...	1800	1350	...	1500
250	250	950	...	1050	2150	...	2400	1850	...	2000	1500	...	1650

Table 4. PTC capacitance compensation for cable types.

Parameter [Value]	Capacitance [nF]	Cable type										
		LiYY, n*0,5			style UL2464 n*0,56							
		145 nF/km		200 nF/km								
		[m]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[m]
15	15	0	...	200	0	...	150					
25	25	100	...	250	50	...	200					
50	50	250	...	400	200	...	300					
75	75	450	...	600	300	...	450					
100	100	600	...	750	450	...	550					
125	125	800	...	950	550	...	700					
150	150	950	...	1100	700	...	800					
175	175	1150	...	1300	800	...	950					
200	200	1300	...	1450	950	...	1050					
225	225	1450	...	1650	1050	...	1200					
250	250	1650	...	1800	1200	...	1300					

INSUM[®]

MCU Parameter Description

Notes:

Table 5. PTC capacitance compensation for general cable with capacitance 50...100 nF/km.

Parameter [Value]	Capacitance [nF]	Nominal capacitance of cable				
		50...60 nF/km [m]	60...70 nF/km [m]	70...80 nF/km [m]	80...90 nF/km [m]	90...100 nF/km [m]
0	0	0 ... 250	0 ... 200	0 ... 150	0 ... 150	0 ... 150
5	5	0 ... 300	0 ... 250	0 ... 250	0 ... 200	0 ... 200
10	10	0 ... 400	0 ... 350	0 ... 300	0 ... 250	0 ... 250
15	15	0 ... 500	0 ... 400	0 ... 350	0 ... 300	0 ... 300
20	20	100 ... 550	100 ... 500	100 ... 400	100 ... 350	100 ... 350
25	25	200 ... 650	200 ... 550	150 ... 500	150 ... 400	150 ... 400
30	30	300 ... 750	250 ... 600	250 ... 550	200 ... 500	200 ... 450
35	35	400 ... 800	350 ... 700	300 ... 600	250 ... 550	250 ... 500
40	40	500 ... 900	450 ... 750	400 ... 650	350 ... 600	300 ... 550
45	45	600 ... 1000	500 ... 850	450 ... 750	400 ... 650	350 ... 600
50	50	700 ... 1050	600 ... 900	500 ... 800	450 ... 700	400 ... 650
55	55	800 ... 1150	700 ... 1000	600 ... 850	500 ... 750	450 ... 700
60	60	900 ... 1250	750 ... 1050	650 ... 900	600 ... 800	500 ... 750
65	65	1000 ... 1300	850 ... 1100	750 ... 1000	650 ... 850	600 ... 800
70	70	1100 ... 1400	950 ... 1200	800 ... 1050	700 ... 900	650 ... 850
75	75	1200 ... 1500	1000 ... 1250	900 ... 1100	750 ... 1000	700 ... 900
80	80	1300 ... 1550	1100 ... 1350	950 ... 1150	850 ... 1050	750 ... 950
85	85	1400 ... 1650	1200 ... 1400	1000 ... 1250	900 ... 1100	800 ... 1000
90	90	1500 ... 1750	1250 ... 1500	1100 ... 1300	950 ... 1150	850 ... 1050
95	95	1600 ... 1800	1350 ... 1550	1150 ... 1350	1000 ... 1200	900 ... 1100
100	100	1700 ... 1900	1450 ... 1600	1250 ... 1400	1100 ... 1250	950 ... 1150
105	105	1800 ... 2000	1500 ... 1700	1300 ... 1500	1150 ... 1300	1000 ... 1200
110	110	1900 ... 2050	1600 ... 1750	1400 ... 1550	1200 ... 1350	1100 ... 1250
115	115	2000 ... 2150	1700 ... 1850	1450 ... 1600	1250 ... 1400	1150 ... 1300
120	120	2100 ... 2250	1750 ... 1900	1500 ... 1650	1350 ... 1500	1200 ... 1350
125	125	2200 ... 2300	1850 ... 2000	1600 ... 1750	1400 ... 1550	1250 ... 1400
130	130	2300 ... 2400	1950 ... 2050	1650 ... 1800	1450 ... 1600	1300 ... 1450
135	135	2400 ... 2500	2000 ... 2100	1750 ... 1850	1500 ... 1650	1350 ... 1500
140	140	2500 ... 2550	2100 ... 2200	1800 ... 1900	1600 ... 1700	1400 ... 1550
145	145	2600 ... 2650	2200 ... 2250	1900 ... 2000	1650 ... 1750	1450 ... 1600
150	150	2700 ... 2750	2250 ... 2350	1950 ... 2050	1700 ... 1800	1500 ... 1650
155	155	2800 ... 2800	2350 ... 2400	2000 ... 2100	1750 ... 1850	1600 ... 1700
160	160	2900 ... 2900	2450 ... 2500	2100 ... 2150	1850 ... 1900	1650 ... 1750
165	165	3000 ... 3000	2500 ... 2550	2150 ... 2250	1900 ... 2000	1700 ... 1800
170	170	3100 ... 3050	2600 ... 2600	2250 ... 2300	1950 ... 2050	1750 ... 1850
175	175	3200 ... 3150	2700 ... 2700	2300 ... 2350	2000 ... 2100	1800 ... 1900
180	180	3300 ... 3250	2750 ... 2750	2400 ... 2400	2100 ... 2150	1850 ... 1950
185	185	3400 ... 3300	2850 ... 2850	2450 ... 2500	2150 ... 2200	1900 ... 2000
190	190	3500 ... 3400	2950 ... 2900	2500 ... 2550	2200 ... 2250	1950 ... 2050
195	195	3600 ... 3500	3000 ... 3000	2600 ... 2600	2250 ... 2300	2000 ... 2100
200	200	3700 ... 3550	3100 ... 3050	2650 ... 2650	2350 ... 2350	2100 ... 2150
205	205	3800 ... 3650	3200 ... 3100	2750 ... 2750	2400 ... 2400	2150 ... 2200
210	210	3900 ... 3750	3250 ... 3200	2800 ... 2800	2450 ... 2500	2200 ... 2250
215	215	4000 ... 3800	3350 ... 3250	2900 ... 2850	2500 ... 2550	2250 ... 2300
220	220	4100 ... 3900	3450 ... 3350	2950 ... 2900	2600 ... 2600	2300 ... 2350
225	225	4200 ... 4000	3500 ... 3400	3000 ... 3000	2650 ... 2650	2350 ... 2400
230	230	4300 ... 4050	3600 ... 3500	3100 ... 3050	2700 ... 2700	2400 ... 2450
235	235	4400 ... 4150	3700 ... 3550	3150 ... 3100	2750 ... 2750	2450 ... 2500
240	240	4500 ... 4250	3750 ... 3600	3250 ... 3150	2850 ... 2800	2500 ... 2550
245	245	4600 ... 4300	3850 ... 3700	3300 ... 3250	2900 ... 2850	2600 ... 2600
250	250	4700 ... 4400	3950 ... 3750	3400 ... 3300	2950 ... 2900	2650 ... 2650

INSUM[®]

MCU Parameter Description

Notes:

Table 6. PTC capacitance compensation for general cable with capacitance 100...150 nF/km.

Parameter [Value]	Capacitance [nF]	Nominal capacitance of cable				
		100...110 nF/km [m]	110...120 nF/km [m]	120...130 nF/km [m]	130...140 nF/km [m]	140...150 nF/km [m]
0	0	0 ... 100	0 ... 100	0 ... 100	0 ... 100	0 ... 100
5	5	0 ... 150	0 ... 150	0 ... 150	0 ... 100	0 ... 100
10	10	0 ... 200	0 ... 200	0 ... 150	0 ... 150	0 ... 150
15	15	0 ... 250	0 ... 250	0 ... 200	0 ... 200	0 ... 200
20	20	50 ... 300	50 ... 250	50 ... 250	50 ... 250	50 ... 200
25	25	100 ... 350	100 ... 300	100 ... 300	100 ... 250	100 ... 250
30	30	150 ... 400	150 ... 350	150 ... 300	150 ... 300	150 ... 300
35	35	200 ... 450	200 ... 400	200 ... 350	200 ... 350	150 ... 300
40	40	250 ... 500	250 ... 450	250 ... 400	200 ... 350	200 ... 350
45	45	300 ... 500	300 ... 500	250 ... 450	250 ... 400	250 ... 400
50	50	350 ... 550	350 ... 500	300 ... 500	300 ... 450	250 ... 400
55	55	400 ... 600	400 ... 550	350 ... 500	350 ... 500	300 ... 450
60	60	450 ... 650	450 ... 600	400 ... 550	350 ... 500	350 ... 500
65	65	500 ... 700	500 ... 650	450 ... 600	400 ... 550	400 ... 500
70	70	550 ... 750	500 ... 700	500 ... 650	450 ... 600	400 ... 550
75	75	600 ... 800	550 ... 750	500 ... 650	500 ... 600	450 ... 600
80	80	650 ... 850	600 ... 750	550 ... 700	500 ... 650	500 ... 600
85	85	700 ... 900	650 ... 800	600 ... 750	550 ... 700	500 ... 650
90	90	750 ... 950	700 ... 850	650 ... 800	600 ... 750	550 ... 700
95	95	800 ... 1000	750 ... 900	700 ... 800	650 ... 750	600 ... 700
100	100	850 ... 1000	800 ... 950	750 ... 850	700 ... 800	650 ... 750
105	105	900 ... 1050	850 ... 1000	750 ... 900	700 ... 850	650 ... 800
110	110	950 ... 1100	900 ... 1000	800 ... 950	750 ... 850	700 ... 800
115	115	1000 ... 1150	950 ... 1050	850 ... 1000	800 ... 900	750 ... 850
120	120	1050 ... 1200	1000 ... 1100	900 ... 1000	850 ... 950	750 ... 900
125	125	1100 ... 1250	1000 ... 1150	950 ... 1050	850 ... 1000	800 ... 900
130	130	1150 ... 1300	1050 ... 1200	1000 ... 1100	900 ... 1000	850 ... 950
135	135	1200 ... 1350	1100 ... 1250	1000 ... 1150	950 ... 1050	900 ... 1000
140	140	1250 ... 1400	1150 ... 1250	1050 ... 1150	1000 ... 1100	900 ... 1000
145	145	1300 ... 1450	1200 ... 1300	1100 ... 1200	1000 ... 1100	950 ... 1050
150	150	1350 ... 1500	1250 ... 1350	1150 ... 1250	1050 ... 1150	1000 ... 1100
155	155	1400 ... 1500	1300 ... 1400	1200 ... 1300	1100 ... 1200	1000 ... 1100
160	160	1450 ... 1550	1350 ... 1450	1250 ... 1300	1150 ... 1250	1050 ... 1150
165	165	1500 ... 1600	1400 ... 1500	1250 ... 1350	1200 ... 1250	1100 ... 1200
170	170	1550 ... 1650	1450 ... 1500	1300 ... 1400	1200 ... 1300	1150 ... 1200
175	175	1600 ... 1700	1500 ... 1550	1350 ... 1450	1250 ... 1350	1150 ... 1250
180	180	1650 ... 1750	1500 ... 1600	1400 ... 1500	1300 ... 1350	1200 ... 1300
185	185	1700 ... 1800	1550 ... 1650	1450 ... 1500	1350 ... 1400	1250 ... 1300
190	190	1750 ... 1850	1600 ... 1700	1500 ... 1550	1350 ... 1450	1250 ... 1350
195	195	1800 ... 1900	1650 ... 1750	1500 ... 1600	1400 ... 1500	1300 ... 1400
200	200	1850 ... 1950	1700 ... 1750	1550 ... 1650	1450 ... 1500	1350 ... 1400
205	205	1900 ... 2000	1750 ... 1800	1600 ... 1650	1500 ... 1550	1400 ... 1450
210	210	1950 ... 2000	1800 ... 1850	1650 ... 1700	1500 ... 1600	1400 ... 1500
215	215	2000 ... 2050	1850 ... 1900	1700 ... 1750	1550 ... 1600	1450 ... 1500
220	220	2050 ... 2100	1900 ... 1950	1750 ... 1800	1600 ... 1650	1500 ... 1550
225	225	2100 ... 2150	1950 ... 2000	1750 ... 1800	1650 ... 1700	1500 ... 1600
230	230	2150 ... 2200	2000 ... 2000	1800 ... 1850	1700 ... 1750	1550 ... 1600
235	235	2200 ... 2250	2000 ... 2050	1850 ... 1900	1700 ... 1750	1600 ... 1650
240	240	2250 ... 2300	2050 ... 2100	1900 ... 1950	1750 ... 1800	1650 ... 1700
245	245	2300 ... 2350	2100 ... 2150	1950 ... 2000	1800 ... 1850	1650 ... 1700
250	250	2350 ... 2400	2150 ... 2200	2000 ... 2000	1850 ... 1850	1700 ... 1750

INSUM[®]

MCU Parameter Description

Notes:

Table 7. PTC capacitance compensation for general cable with capacitance 150...200 nF/km.

Parameter [Value]	Capacitance [nF]	Nominal capacitance of cable											
		150...160 nF/km [m]		160...170 nF/km [m]		170...180 nF/km [m]		180...190 nF/km [m]		190...200 nF/km [m]			
0	0	0	...	50	0	...	50	0	...	50	0	...	50
5	5	0	...	100	0	...	100	0	...	100	0	...	100
10	10	0	...	150	0	...	100	0	...	100	0	...	100
15	15	0	...	150	0	...	150	0	...	150	0	...	150
20	20	50	...	200	50	...	200	50	...	150	50	...	150
25	25	100	...	250	100	...	200	100	...	200	100	...	200
30	30	100	...	250	100	...	250	100	...	250	100	...	200
35	35	150	...	300	150	...	250	150	...	250	150	...	250
40	40	200	...	300	200	...	300	150	...	300	150	...	250
45	45	200	...	350	200	...	350	200	...	300	200	...	300
50	50	250	...	400	250	...	350	250	...	350	200	...	300
55	55	300	...	400	250	...	400	250	...	350	250	...	350
60	60	300	...	450	300	...	400	300	...	400	250	...	350
65	65	350	...	500	350	...	450	300	...	400	300	...	400
70	70	400	...	500	350	...	500	350	...	450	350	...	400
75	75	400	...	550	400	...	500	400	...	500	350	...	450
80	80	450	...	550	450	...	550	400	...	500	400	...	500
85	85	500	...	600	450	...	550	450	...	550	400	...	500
90	90	500	...	650	500	...	600	450	...	550	450	...	500
95	95	550	...	650	500	...	600	500	...	600	450	...	550
100	100	600	...	700	550	...	650	500	...	600	500	...	600
105	105	600	...	750	600	...	700	550	...	650	500	...	600
110	110	650	...	750	600	...	700	600	...	650	550	...	650
115	115	700	...	800	650	...	750	600	...	700	600	...	650
120	120	700	...	800	700	...	750	650	...	750	600	...	700
125	125	750	...	850	700	...	800	650	...	750	650	...	700
130	130	800	...	900	750	...	850	700	...	800	650	...	750
135	135	800	...	900	750	...	850	750	...	800	700	...	750
140	140	850	...	950	800	...	900	750	...	850	700	...	750
145	145	900	...	1000	850	...	900	800	...	850	750	...	800
150	150	900	...	1000	850	...	950	800	...	900	750	...	800
155	155	950	...	1050	900	...	1000	850	...	900	800	...	850
160	160	1000	...	1050	950	...	1000	900	...	950	850	...	850
165	165	1000	...	1100	950	...	1050	900	...	1000	850	...	900
170	170	1050	...	1150	1000	...	1050	950	...	1000	900	...	950
175	175	1100	...	1150	1000	...	1100	950	...	1050	900	...	950
180	180	1100	...	1200	1050	...	1100	1000	...	1050	950	...	1000
185	185	1150	...	1250	1100	...	1150	1000	...	1100	950	...	1050
190	190	1200	...	1250	1100	...	1200	1050	...	1100	1000	...	1050
195	195	1200	...	1300	1150	...	1200	1100	...	1150	1000	...	1100
200	200	1250	...	1300	1200	...	1250	1100	...	1150	1050	...	1100
205	205	1300	...	1350	1200	...	1250	1150	...	1200	1100	...	1150
210	210	1300	...	1400	1250	...	1300	1150	...	1250	1100	...	1150
215	215	1350	...	1400	1250	...	1350	1200	...	1250	1150	...	1200
220	220	1400	...	1450	1300	...	1350	1250	...	1300	1150	...	1250
225	225	1400	...	1500	1350	...	1400	1250	...	1300	1200	...	1250
230	230	1450	...	1500	1350	...	1400	1300	...	1350	1200	...	1250
235	235	1500	...	1550	1400	...	1450	1300	...	1350	1250	...	1300
240	240	1500	...	1550	1450	...	1500	1350	...	1400	1250	...	1300
245	245	1550	...	1600	1450	...	1500	1400	...	1400	1300	...	1350
250	250	1600	...	1650	1500	...	1550	1400	...	1450	1350	...	1300

INSUM[®]

MCU Parameter Description

Notes:

Table 8. PTC capacitance compensation for general cable with capacitance 200...250 nF/km.

Parameter [Value]	Capacitance [nF]	Nominal capacitance of cable														
		200...210 nF/km [m]		210...220 nF/km [m]		220...230 nF/km [m]		230...240 nF/km [m]		240...250 nF/km [m]						
0	0	0	...	50	0	...	50	0	...	50	0	...	50	0	...	50
5	5	0	...	50	0	...	50	0	...	50	0	...	50	0	...	50
10	10	0	...	100	0	...	100	0	...	100	0	...	100	0	...	100
15	15	0	...	100	0	...	100	0	...	100	0	...	100	0	...	100
20	20	50	...	150	50	...	150	50	...	150	50	...	100	50	...	100
25	25	50	...	150	50	...	150	50	...	150	50	...	150	50	...	150
30	30	100	...	200	100	...	200	100	...	150	100	...	150	100	...	150
35	35	100	...	200	100	...	200	100	...	200	100	...	200	100	...	200
40	40	150	...	250	150	...	250	150	...	200	150	...	200	150	...	200
45	45	150	...	250	150	...	250	150	...	250	150	...	250	150	...	200
50	50	200	...	300	200	...	250	200	...	250	200	...	250	150	...	250
55	55	200	...	300	200	...	300	200	...	300	200	...	250	200	...	250
60	60	250	...	350	250	...	300	250	...	300	200	...	300	200	...	300
65	65	250	...	350	250	...	350	250	...	300	250	...	300	250	...	300
70	70	300	...	400	300	...	350	250	...	350	250	...	350	250	...	300
75	75	300	...	400	300	...	400	300	...	350	300	...	350	250	...	350
80	80	350	...	450	350	...	400	300	...	400	300	...	350	300	...	350
85	85	350	...	450	350	...	450	350	...	400	350	...	400	300	...	400
90	90	400	...	500	400	...	450	350	...	450	350	...	400	350	...	400
95	95	400	...	500	400	...	500	400	...	450	350	...	450	350	...	400
100	100	450	...	500	450	...	500	400	...	500	400	...	450	400	...	450
105	105	450	...	550	450	...	500	450	...	500	400	...	500	400	...	450
110	110	500	...	550	500	...	550	450	...	500	450	...	500	400	...	500
115	115	500	...	600	500	...	550	500	...	550	450	...	500	450	...	500
120	120	550	...	600	500	...	600	500	...	550	500	...	550	450	...	500
125	125	550	...	650	550	...	600	500	...	600	500	...	550	500	...	550
130	130	600	...	650	550	...	650	550	...	600	500	...	600	500	...	550
135	135	600	...	700	600	...	650	550	...	650	550	...	600	500	...	600
140	140	650	...	700	600	...	700	600	...	650	550	...	600	550	...	600
145	145	650	...	750	650	...	700	600	...	650	600	...	650	550	...	600
150	150	700	...	750	650	...	750	650	...	700	600	...	650	600	...	650
155	155	700	...	800	700	...	750	650	...	700	650	...	700	600	...	650
160	160	750	...	800	700	...	750	700	...	750	650	...	700	650	...	700
165	165	750	...	850	750	...	800	700	...	750	700	...	750	650	...	700
170	170	800	...	850	750	...	800	750	...	800	700	...	750	650	...	700
175	175	800	...	900	800	...	850	750	...	800	700	...	750	700	...	750
180	180	850	...	900	800	...	850	750	...	800	750	...	800	700	...	750
185	185	850	...	950	850	...	900	800	...	850	750	...	800	750	...	800
190	190	900	...	950	850	...	900	800	...	850	800	...	850	750	...	800
195	195	900	...	1000	900	...	950	850	...	900	800	...	850	750	...	800
200	200	950	...	1000	900	...	950	850	...	900	850	...	850	800	...	850
205	205	950	...	1000	950	...	1000	900	...	950	850	...	900	800	...	850
210	210	1000	...	1050	950	...	1000	900	...	950	850	...	900	850	...	900
215	215	1000	...	1050	1000	...	1000	950	...	1000	900	...	950	850	...	900
220	220	1050	...	1100	1000	...	1050	950	...	1000	900	...	950	900	...	900
225	225	1050	...	1100	1000	...	1050	1000	...	1000	950	...	1000	900	...	950
230	230	1100	...	1150	1050	...	1100	1000	...	1050	950	...	1000	900	...	950
235	235	1100	...	1150	1050	...	1100	1000	...	1050	1000	...	1000	950	...	1000
240	240	1150	...	1200	1100	...	1150	1050	...	1100	1000	...	1050	950	...	1000
245	245	1150	...	1200	1100	...	1150	1050	...	1100	1000	...	1050	1000	...	1000
250	250	1200	...	1250	1150	...	1200	1100	...	1150	1050	...	1100	1000	...	1050

INSUM[®]

MCU Parameter Description

Notes:

Appendix C. Terms and Abbreviations

Abbreviation	Term	Explanation / Comments
	Alarm	Alarm is defined as status transition from any state to abnormal state. Status transition to abnormal state can be data crossing over the predefined alarm limit.
	Backplane	INSUM backbone, holds following INSUM devices: router, gateways, clock, power supply. Part of the INSUM Communication Unit, see ICU
CA	Control Access	A function of INSUM system that allows definition of operating privileges for each device level (e.g. PCS, gateway, field device)
CAT	Control Access Table	Table containing control access privileges
CB	Circuit Breaker	Circuit breaker unit (here: ABB SACE Emax with electronic release PR112-PD/LON)
CT	Current Transformer	Current Transformer
DCS	Distributed Control System	see also PCS
Eth	Ethernet	Layer 1 of the ISO layer model for networks, describing the physical properties (cable, connectors etc.) using TCP/IP protocol
	Event	An event is a status transition from one state to another. It can be defined as alarm, if the state is defined as abnormal or as warning as a pre-alarm state.
FD	Field Device	Term for devices connected to the LON fieldbus (e.g. motor control units or circuit breaker protection)
FU	Field Unit	see Field Device
GPI	General Purpose Input	Digital input on MCU for general use
GPO	General Purpose Output	Digital output on MCU for general use
GPS	Global Positioning System	System to detect local position, universal time and time zone, GPS technology provides accurate time to a system
GW	Gateway	A gateway is used as an interface between LON protocol in INSUM and other communication protocols (e.g. TCP/IP, Profibus, Modbus)
HMI	Human Machine Interface	Generic expression for switchgear level communication interfaces to field devices, either switchboard mounted or hand held
ICU	INSUM Communications Unit	INSUM Communications Unit consists of devices such as backplane, gateways, routers, system clock and power supply. It provides the communication interface within INSUM and between INSUM and control systems. Formerly used expressions: SGC, SU
INSUM	INSUM	Integrated System for User optimized Motor Management. The concept of INSUM is to provide a platform for integration of smart components, apparatus and software tools for engineering and operation of the motor control switchgear
INSUM OS	INSUM Operator Station	Tool to parameterise, monitor and control devices in the INSUM system
ITS	Integrated Tier Switch	The Intelligent Tier Switch is an ABB SlimLine switch fuse with integrated sensors and microprocessor based electronics for measurement and surveillance
LON	Local Operating Network	LON is used as an abbreviation for LonWorks network. A variation of LON is used as a switchgear bus in the INSUM 2 system
LonTalk	LonTalk protocol	Fieldbus communication protocol used in LonWorks

INSUM[®]

MCU Parameter Description

Notes:

Abbreviation	Term	Explanation / Comments
		networks
LonWorks	LonWorks network	A communication network built using LonWorks network technology, including e.g. Neuron chip and LonTalk protocol
MCU	Motor Control Unit	Motor Control Unit is a common name for a product range of electronic motor controller devices (field device) in INSUM. A MCU is located in a MNS motor starter, where its main tasks are protection, control and monitoring of motor and the related motor starter equipment.
MMI	Man Machine Interface	The switchgear level INSUM HMI device to parameterize and control communication and field devices.
MNS	MNS	ABB Modular Low Voltage Switchgear
	Modbus, Modbus RTU	Fieldbus communication protocol
NV,nv	LON Network Variable	Network variable is a data item in LonTalk protocol application containing max. 31 bytes of data.
Nvi, nvi	LON Network Variable input	LON bus input variable
Nvo, nvo	LON Network Variable output	LON bus output variable
OS	Operator Station	see INSUM OS
PCS	Process Control System	High level process control system
PLC	Programmable Local Controller	Low level control unit
PR	Programmable Release	Circuit breaker protection/release unit (here: ABB SACE Emax PR112-PD/LON)
	Profibus DP	Fieldbus communication protocol with cyclic data transfer
	Profibus DP-V1	Fieldbus communication protocol, extension of Profibus DP allowing acyclic data transfer and multi master.
PTB	Physikalisch-Technische Bundesanstalt	Authorized body in Germany to approve Ex-e applications.
PTC	Positive Temperature Coefficient	A temperature sensitive resistor used to detect high motor temperature and to trip the motor if an alarm level is reached.
RCU	Remote Control Unit	Locally installed control device for motor starter, interacting directly with starter passing MCU for local operations.
	Router	Connection device in the LON network to interconnect different LON subnets. Part of the INSUM Communications Unit.
RTC	Real Time Clock	Part of the INSUM System Clock and and optionally time master of the INSUM system
SCADA	Supervisory Control and Data Acquisition	
SGC	Switchgear Controller	Former term used for INSUM Communications Unit
SU	Switchgear Unit	Former term used for INSUM Communications Unit
	System Clock	INSUM device providing time synchronisation between a time master and all MCUs. Part of the INSUM Communication Unit, see ICU
TCP/IP	Transmission Control Protocol / Internet Protocol	Transmission protocol used for data transmission via Ethernet
TFLC	Thermal Full Load Current	See MCU Parameter Description for explanation
TOL	Thermal Overload	See MCU Parameter Description for explanation

INSUM[®]

MCU Parameter Description

Notes:

Abbreviation	Term	Explanation / Comments
	Trip	A consequence of an alarm activated or an external trip command from another device to stop the motor or trip the circuit breaker.
VU	Voltage Unit	Voltage measurement and power supply unit for MCU 2
	Wink	The Wink function enables identification of a device on the LON network. When a device receives a Wink-message via the fieldbus, it responds with a visual indication (flashing LED)



ABB Schaltanlagentechnik GmbH
Wallstadter Str. 59
D - 68526 Ladenburg / Germany

Editor: DEAST/SP
Publication No: 1TGC 901025 M0201

Related Products, News, Local Contacts:
www.abb.com/mns