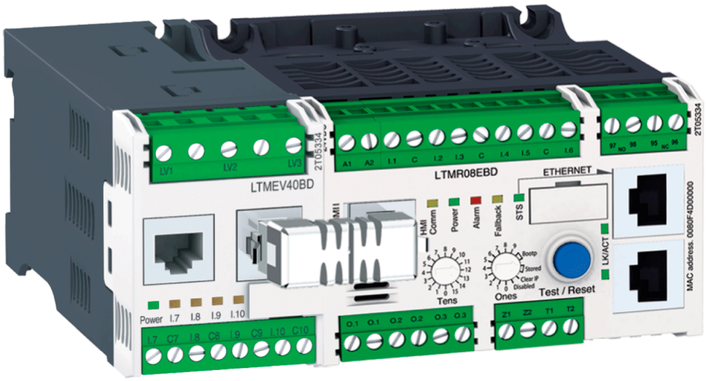
TeSys T DTM for FDT Container

Online Help

1672614EN–02
08/2022



Legal Information

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Safety Information

Important Information

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, service, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

DANGER
DANGER indicates a hazardous situation which, if not avoided, **will result in** death or serious injury.

WARNING
WARNING indicates a hazardous situation which, if not avoided, **could result in** death or serious injury.

CAUTION
CAUTION indicates a hazardous situation which, if not avoided, **could result** in minor or moderate injury.

NOTICE
NOTICE is used to address practices not related to physical injury.

Please Note

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

BEFORE YOU BEGIN

Do not use this product on machinery lacking effective point-of-operation guarding. Lack of effective point-of-operation guarding on a machine can result in serious injury to the operator of that machine.

⚠ WARNING

UNGUARDED MACHINERY CAN CAUSE SERIOUS INJURY

- Do not use this software and related automation equipment on packaging equipment which does not have point-of-operation protection.
- Do not reach into machinery during operation.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

This automation equipment and related software is used to control a variety of industrial processes. The type or model of automation equipment suitable for each application will vary depending on factors such as the control function required, degree of protection required, production methods, unusual conditions, government regulations, etc. In some applications, more than one processor may be required, as when backup redundancy is needed.

Only the user can be aware of all the conditions and factors present during setup, operation and maintenance of the machine; therefore, only the user can determine the automation equipment and the related safeties and interlocks which can be properly used. When selecting automation and control equipment and related software for a particular application, the user should refer to the applicable local and national standards and regulations. The Accident Prevention Manual (nationally recognized in the United States of America) also provides much useful information.

In some applications, such as packaging machinery, additional operator protection such as point-of-operation guarding must be provided. This is necessary if the operator's hands and other parts of the body are free to enter the pinch point area and serious injury can occur. Software products cannot protect an operator from injury. For this reason the software cannot be substituted for or take the place of point-of-operation protection.

Ensure that appropriate safeties and interlocks related to point-of-operation protection have been installed and are operational before placing the equipment into service. All interlocks and safeties related to point-of-operation protection must be coordinated with the related automation equipment and software programming.

NOTE: Coordination of safeties and interlocks for point-of-operation is outside the scope of this Defined Function Block (DFB).

⚠ **WARNING:** This product can expose you to chemicals including lead and lead compounds, which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov.

START UP AND TEST

Before using electrical control and automation equipment for regular operation after installation, the system should be given a start up test by qualified personnel to verify correct operation of the equipment. It is important that arrangements for such a check be made and that enough time is allowed to perform complete and satisfactory testing.

⚠ CAUTION

EQUIPMENT OPERATION HAZARD

- Verify that all installation and set up procedures have been completed.
- Before operational tests are performed, remove all blocks or other temporary holding means used for shipment from all component devices.
- Remove tools, meters and debris from equipment.

Failure to follow these instructions can result in injury or equipment damage.

Follow all start up tests recommended in the equipment documentation. Store all equipment documentation for future references.

Software testing must be done in both simulated and real environments.

Verify that the completed system is free from all short circuits and grounds, except those grounds installed according to local regulations (according to the National Electrical Code in the U.S.A, for instance). If high-potential voltage testing is necessary, follow recommendations in equipment documentation to prevent accidental equipment damage.

Before energizing equipment:

- Remove tools, meters and debris from equipment.
- Close the equipment enclosure door.
- Remove ground from incoming power lines.
- Perform all start-up tests recommended by the manufacturer.

OPERATION AND ADJUSTMENTS

The following precautions are from the NEMA Standards Publication ICS 7.1-1995 (English version prevails):

- Regardless of the care exercised in the design and manufacture of equipment or in the selection and ratings of components, there are hazards that can be encountered if such equipment is improperly operated.
- It is sometimes possible to misadjust the equipment and thus produce unsatisfactory or unsafe operation. Always use the manufacturer’s instructions as a guide for functional adjustments. Personnel who have access to these adjustments should be familiar with the equipment manufacturer’s instructions and the machinery used with the electrical equipment.
- Only those operational adjustments actually required by the operator should be accessible to the operator. Access to other controls should be restricted to prevent unauthorized changes in operating characteristics.

About the Book

Document Scope

This online help describes the TeSys T DTM for TeSys T motor management system.

The purpose of this online help is to:

- describe the metering, monitoring, protection, and control functions of the TeSys T motor management system.
- describe the custom logic editor embedded in the TeSys T DTM which allows the customization of the control functions of the TeSys T motor management system.
- provide all the information necessary to implement and support a solution that meets application requirements.

The online help describes the 4 key parts of a successful system implementation:

- installing the TeSys DTM library
- entering and setting parameters
- monitoring the status of the device
- maintaining and upgrading the TeSys T DTM library

The online help is intended for TeSys T DTM users:

- design engineers
- system integrators
- system operators
- maintenance engineers

Validity Note

This document has been updated with the release of SoMove Lite V1.9.2.0 and TeSys DTM library 2.7.6.0.

The availability of some functions depends on the LTM R controller version.

The characteristics presented in this online help should be the same as those that appear online. In line with our policy of constant improvement, we may revise content over time to improve clarity and accuracy. In the event that you see a difference between the online help and online information, use the online information as your reference.

Related Documents

Title of Documentation	Reference Number
TeSys® T LTM R Modbus Motor Management Controller - User Manual	1639501
TeSys® T LTM R Profibus DP Motor Management Controller - User Manual	1639502
TeSys® T LTM R CANopen Motor Management Controller - User Manual	1639503
TeSys® T LTM R DeviceNet Motor Management Controller - User Manual	1639504
TeSys® T LTM R Ethernet Motor Management Controller - User Manual	1639505

Title of Documentation	Reference Number
TeSys® T LTM CU Control Operator Unit - User Manual	1639581
TeSys® T LTM R Motor Management Controller TeSys T DTM Custom Logic Editor - User Manual	1639507

You can download these technical publications and other technical information from our website at www.se.com/ww/en/download/ .

Presentation of the TeSys T DTM

Introduction

Overview

This section describes the prerequisites for using the TeSys T motor management system with SoMove and the TeSys T DTM.

Presentation of the TeSys T Motor Management System

Product Overview

The TeSys T motor management system offers protection, control, and monitoring capabilities for single-phase and 3-phase AC induction motors.

The system is flexible, modular, and can be configured to meet the requirements of applications in industry. The system is designed to meet the needs of integrated protections systems with open communications and a global architecture.

Highly accurate sensors and solid-state full motor protection provide better utilization of the motor. Complete monitoring functions enable analysis of motor operating conditions and faster responses to help prevent system downtime.

The system offers diagnostic and statistics functions and configurable alarms and trips, allowing better predictive maintenance of components, and provides data to continuously improve the entire system.

Examples of Supported Machine Segments

The motor management system supports the following machine segments:

Machine Segment	Examples

Process and special machine segments	Water and waste water treatment
	• water treatment (blowers and agitators)
	Metal, minerals, and mining
	• cement
	• glass
	• steel
	• ore extraction
	Oil and gas
	• oil and gas processing
	  ◦ petrochemical
	  ◦ refineries, offshore platforms
	Microelectronic
	Pharmaceutical
	Chemical industry
	• cosmetics
	• detergents
	• fertilizers
	• paint
	Transportation industry
	• automotive transfer lines
	• airports
	Other industries
	• tunnel machines
	• cranes

Complex machine segments	Includes highly automated or coordinated machines used in: • pumping systems • paper conversion • printing lines • HVAC

Supported Industries

The motor management system supports the following industries and associated business sectors:

Industry	Sectors	Application
Building	• office buildings • shopping centers • industrial buildings • ships • hospitals • cultural facilities • airports	Control and manage the building facilities: • critical HVAC systems • water • air • gas • electricity • steam
Industry	• metal, mineral, and mining: cement, glass, steel, ore-extraction • microelectronic • petrochemical • ethanol • chemical: pulp and paper industry • pharmaceutical • food and beverage	• control and monitor pump motors • control ventilation • control load traction and movements • view status and communicate with machines • process and communicate the data captured • remotely manage data for one or several sites via the internet
Energy and Infrastructure	• water treatment and transportation • transportation infrastructure for people and freight: airports, road tunnels, subways, and tramways • power generation and transport	• control and monitor pump motors • control ventilation • remotely control wind turbine • remotely manage data for one or several sites via the internet

TeSys T Motor Management System

The hardware components of the system are the LTM R controller, the LTM E expansion module and the LTM CU Control Operator Unit.

The system can be configured and controlled:

- using an HMI (Human Machine Interface) device: Magelis® XBT or TeSys® T LTM CU
- using a PC running an FDT container or SoMove with the TeSys T DTM
- using a PLC connected to the system via the communication network
- using the Ethernet web server of the LTM R Ethernet controller

Components such as external motor load current transformers and ground current transformers add additional range to the system.

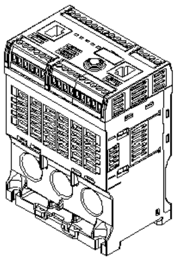
LTM R Controller

The microprocessor-based LTM R controller is the central component in the system that manages the control, protection, and monitoring functions of single-phase or 3-phase AC induction motors.

The LTM R controller is designed to work over the following fieldbus protocols:

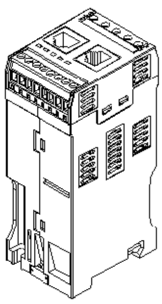
- Modbus (reference code = M)
- Profibus DP (reference code = P)
- CANopen (reference code = C)
- DeviceNet (reference code = D)
- Ethernet (reference code = E)

The following table lists the 6 LTM R controller models using one of the above communication protocols. To obtain the comprehensive reference number, replace • by the reference code of the relevant protocol.

LTM R Controller	Functional Description	Reference Number
	• current sensing 0.4...100 A • current inputs • 6 discrete logic inputs • 4 relay outputs: 3 SPST, 1 DPST • connections for a ground current sensor • connection for a motor temperature sensor • connection for network • connection for HMI device or expansion module • current protection, metering, and monitoring functions • motor control functions • power indicator • trip and alarm LED indicators • network communication and alarm indicators • HMI communication LED indicator • test and reset function	LTMR08•BD (24 VDC, 0.4...8 A FLC) LTMR27•BD (24 VDC, 1.35...27 A FLC) LTMR100•BD (24 VDC, 5...100 A FLC) LTMR08•FM (100...240 VAC, 0.4...8 A FLC) LTMR27•FM (100...240 VAC, 1.35...27 A FLC) LTMR100•FM (100...240 VAC, 5...100 A FLC)

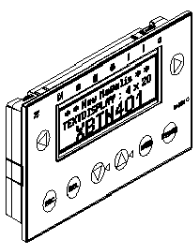
LTM E Expansion Module

There are 2 models of LTM E expansion modules that provide voltage monitoring functionality and 4 additional logic inputs. The LTM E expansion modules are powered by the LTM R controller via a connector cable.

LTM E Expansion Module	Functional Description	Reference Number
	• voltage sensing 110...690 VAC • 3 voltage inputs • 4 additional discrete logic inputs • additional voltage protection, metering, and monitoring functions • power LED indicator • logic input status LED indicators Additional components required for an optional expansion module: • LTM R controller to LTM E connection cable	LTMEV40BD (24 VDC logic inputs) LTMEV40FM (100...240 VAC logic inputs)

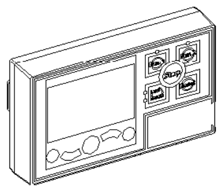
HMI Device: Magelis XBTN410

The system uses the Magelis® XBTN410 HMI device with a liquid crystal display.

Magelis® XBTN410	Functional Description	Reference Number
	• system configuration through menu entries • display of parameters, alarms, and trips Additional components required for an optional HMI device: • separate power source • LTM R / LTM E to HMI communication cable • Magelis XBTL1000 programming software	XBTN410 (HMI) XBTZ938 (cable) XBTL1000 (software)

HMI Device: LTM CU Control Operator Unit

The system uses the TeSys® T LTM CU Control Operator Unit HMI device with a liquid crystal display and contextual navigation keys. The LTM CU is internally powered by the LTM R. Refer to the *TeSys T LTM CU Control Operator Unit User Manual* for more information.

LTM CU Control Operator Unit	Functional Description	Reference Number
	• system configuration through menu entries • display of parameters, alarms, and trips • motor control Additional components required for an optional HMI device: • LTM R / LTM E to HMI communication cable	LTM CU
		LTM9CU•0 (HMI communication cable)
		LTM9KCU kit for portable LTM CU

SoMove with the TeSys T DTM

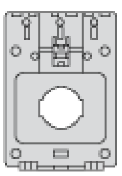
SoMove software is a Microsoft® Windows®-based application, using the open FDT/DTM technology.

SoMove contains many DTMs. A specific DTM exists for the TeSys T motor management system.

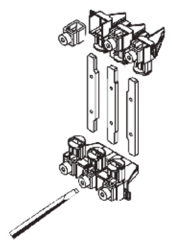
SoMove with the TeSys T DTM	Functional Description	Reference Number
	• system configuration through menu entries • display of parameters, alarms, and trips • motor control • customization of operating modes Additional components required for the SoMove FDT container: • a PC • separate power source • LTM R / LTM E / LTM CU to PC communication cables	SoMove with the TeSys T DTM
		TCSMCNAM3M002P (cable kit)

Load Current Transformers

External load current transformers expand the current range for use with motors greater than 100 full load Amperes.

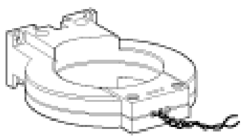
Schneider Electric Load Current Transformers	Primary	Secondary	Inside Diameter		Reference Number
			mm	in.	
	100	1	35	1.38	LT6CT1001
	200	1	35	1.38	LT6CT2001
	400	1	35	1.38	LT6CT4001
	800	1	35	1.38	LT6CT8001
	**NOTE:** The following load current transformers are also available: Schneider Electric LUTC0301, LUTC0501, LUTC1001, LUTC2001, LUTC4001, and LUTC8001.				

The lug-lug kit provides bus bars and lug terminals that adapt the pass through wiring windows and provide line and load terminations for the power circuit.

Square D Lug-lug Kit	Description	Reference Number
	Square D Lug-lug Kit	MLPL9999

Ground Current Transformers

External ground current transformers measure ground current trip conditions.

Schneider Electric Vigirex Ground Current Transformers	Type	Maximum Current	Inside Diameter		Transformation Ratio	Reference Number
			mm	in.		
	TA30	65 A	30	1.18	1000:1	50437
	PA50	85 A	50	1.97		50438
	IA80	160 A	80	3.15		50439
	MA120	250 A	120	4.72		50440
	SA200	400 A	200	7.87		50441
	PA300	630 A	300	11.81		50442
	POA	85 A	46	1.81		50485
	GOA	250 A	110	4.33		50486

Definitions

FDT (Field Device Tool)

FDT technology:

- standardizes the communication and configuration interface between all field devices and host systems
- provides a common environment for accessing the devices features

For more information about FDT technology, refer to the following website: http://www.fdtgroup.org/index.php

FDT Container

The FDT container is software that uses the FDT technology. It is used to:

- install a DTM library to add new devices
- modify an already installed DTM library to update existing devices

DTM (Device Type Manager)

The DTM is a software module installed in an FDT container for a specific device. It provides a unified structure for:

- accessing device parameters
- configuring and operating the devices
- diagnosing problems

The TeSys T or TeSys U DTM can be in extended mode or in basic mode, depending on the FDT container used:

- The extended mode is only available with SoMove, and gives access to all functions of the DTM.
- The basic mode is available with other compatible FDT containers, and gives access to certain functions of the DTM.

DTM Library

A DTM library is a set of DTMs that works with an FDT container.

The TeSys DTM library includes:

- TeSys T DTM
- TeSys U DTM

SoMove Project File

A SoMove project file is a configuration file for a pre-determined device, that can be created offline and saved for later use.

A project file contains the following information:

- device type
- selected characteristics, such as firmware version
- all parameters settings

  NOTE:

  - The project file does not contain the customized program.
  - This file is saved with the extension **.psx*.

For more information on how to create a project, see the *SoMove Lite online help*.

Installing SoMove and the TeSys DTM Library

Overview

The installation of SoMove includes some DTMs such as the TeSys DTM library.

The TeSys DTM library includes:

- TeSys T DTM
- TeSys U DTM

These DTM are automatically installed during the SoMove installation process.

Downloading SoMove

SoMove can be downloaded from the Schneider Electric website (www.se.com) by entering `SoMove Lite` in the **Search** field.

Installing SoMove

Step	Action
1	Unzip the downloaded file: the SoMove file is unzipped in a folder named *SoMove_Lite - V.X.X.X.X* (where X.X.X.X is the version number). Open this folder and double-click **setup.exe**.
2	In the **Choose Setup Language** dialog box, select the installation language.
3	Click **OK**.

Step	Action
4	In the **Welcome to the Installation Wizard for SoMove Lite** dialog box, click the **Next** button.
5	If an **Install Shield Wizard** dialog box appears and informs you that you must install Modbus driver, click the **Install** button. **Result:** Modbus driver is installed automatically.
6	In the **Readme and Release Notes** dialog box, click the **Next** button.
7	In the **Readme** dialog box, click the **Next** button.
8	In the **License Agreement** dialog box: • Read carefully the license agreement. • Select **I accept the terms** in the license agreement option. • Click the **Next** button.
9	In the **Customer Information** dialog box: • Enter the following information in the corresponding fields: ◦ First name ◦ Last name ◦ Company name • Select an installation option: ◦ Either the **Anyone who uses this computer** option if SoMove Lite is used by all users of this computer, or ◦ **Only for me** if SoMove Lite is used only by you. • Click the **Next** button.
10	In the **Destination Folder** dialog box: • If necessary, modify the SoMove Lite destination folder by clicking the **Change** button. • Click the **Next** button.
11	In the **Shortcuts** dialog box: • If you want to create a shortcut on the desktop and/or in the quick launch bar, select the corresponding options. • Click the **Next** button.
12	In the **Ready to Install the Program** dialog box, click the **Install** button. **Result:** The SoMove Lite components are installed automatically: • Modbus communication DTM library which contains the communication protocol • DTM libraries which contain different drive catalogs • SoMove Lite itself
13	In the **Installation Wizard Completed** dialog box, click the **Finish** button. **Result:** SoMove Lite is installed on your computer.

Installing Update TeSys DTM Library

Overview

The TeSys DTM library includes:

- TeSys T DTM
- TeSys U DTM

These DTM are automatically installed during the SoMove installation process.

Downloading TeSysDTMLibrary

TeSysDTMLibrary can be downloaded from the Schneider Electric website (www.se.com) by entering `TeSysDTMLibrary` in the **Search** field.

Installing Update TeSys DTM Library

Step	Action
1	Unzip the downloaded file. Open this folder and double-click **setup.exe**. The TeSysDTMLibrary file is unzipped in a folder named *TeSysDTMLibrary - V.X.X.X.X* (where X.X.X.X is the version number).
2	In the **Choose Setup Language** dialog box, select the installation language.
3	Click **OK**.
4	In the **Welcome to the Installation Wizard for TeSysDTMLibrary** dialog box, click the **Next** button.
5	In the **Readme and Release Notes** dialog box, click the **Next** button.
6	In the **License Agreement** dialog box: • Read carefully the license agreement. • Select **I accept the terms** in the license agreement option. • Click the **Next** button.
7	In the **Customer Information** dialog box: • Enter the following information in the corresponding fields: ◦ First name ◦ Last name ◦ Company name • Select an installation option: ◦ Either the **Anyone who uses this computer** option if TeSys DTM library is used by all users of this computer, or ◦ **Only for me** if TeSys DTM library is used only by you. • Click the **Next** button.
8	In the **Destination Folder** dialog box: • If necessary, modify the TeSys DTM library destination folder by clicking the **Change** button. • Click the **Next** button.
9	In the **Setup Type** dialog box: • Select the setup type: recommended **Typical**. • Click the **Next** button.
10	In the **Ready to Install the Program** dialog box, click the **Install** button. **Result:** The TeSys DTM library components are installed automatically.
11	In the **Installation Wizard Completed** dialog box, click the **Finish** button. **Result:** The TeSys DTM library is installed on your computer.

User Interface

Overview

This section describes the different menus and tabs available in SoMove with the TeSys T DTM.

General Description

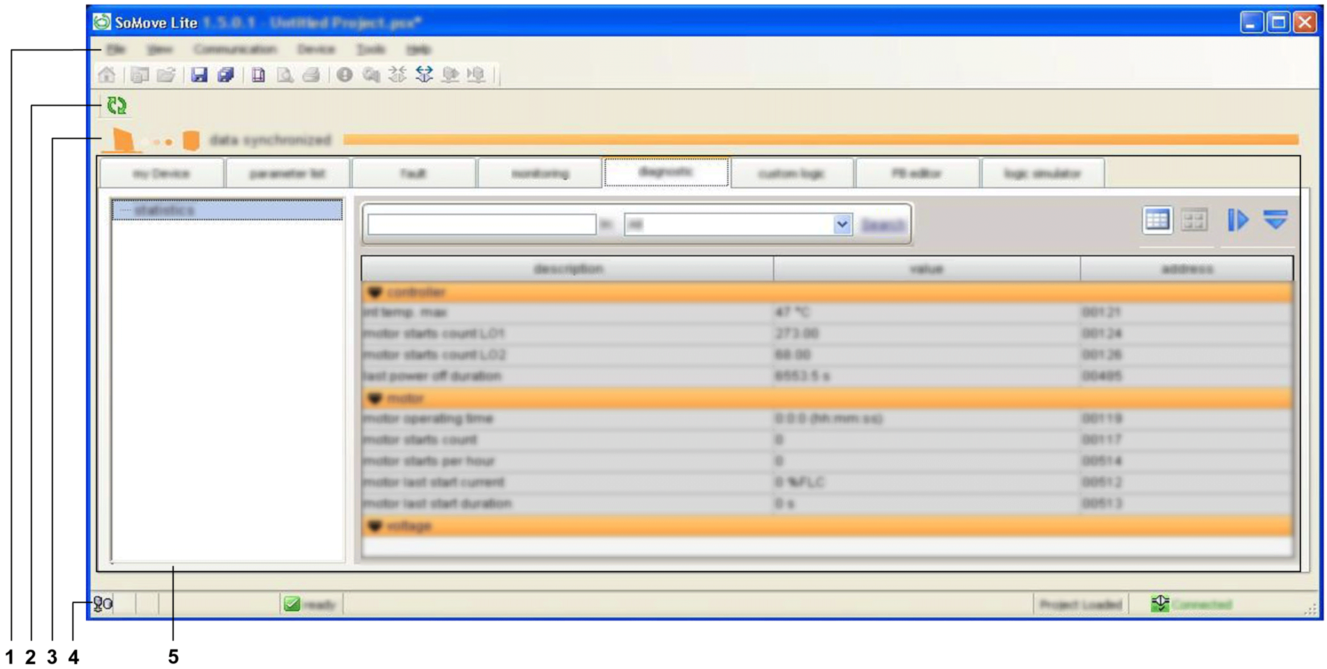
Overview

The TeSys T DTM can be in extended mode or in basic mode, depending on the FDT container used:

- The extended mode is only available with SoMove, and gives access to all functions of the DTM.

- The basic mode is available with other compatible FDT containers, and gives access to certain functions of the DTM.

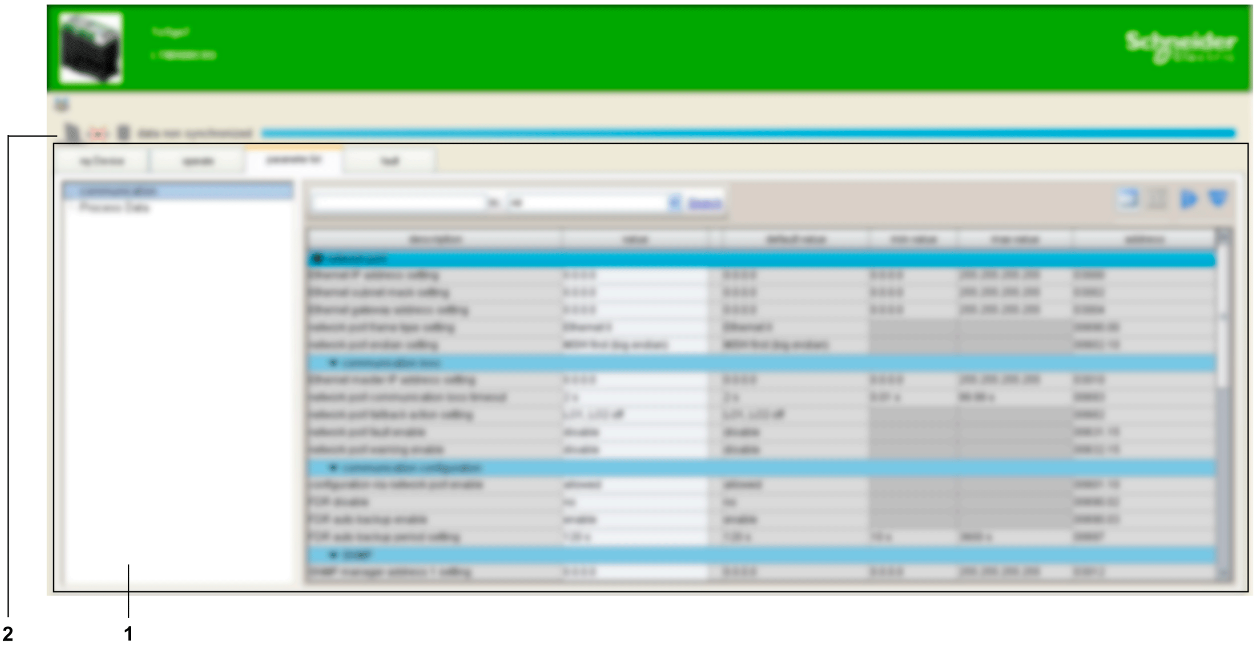
Extended Mode Presentation



The working space is divided into the following zones:

1	menu bar, page 25
2	tool bar, page 25
3	synchronization data area, page 31
4	status bar, page 31
5	tab zone (content depending on the selected tab)

Basic Mode Presentation



The working space is divided into the following zones:

1	tab zone (content depending on the selected tab)
2	synchronization data area, page 31

Tab Zone

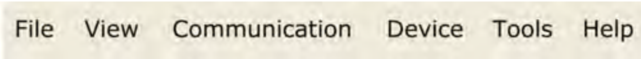
The table below shows the tab zone available for the basic mode and extended mode.

Tab Name	Description	Basic Mode	Extended Mode
my Device	Tab displays the device modules and characteristics tab, page 33	XX	XX
operate	Tab displays the operate data tab, page 34	XX	XX
parameter list	Tabs display the LTM R controller parameters and status	X	XX
trip		XX	XX
monitoring		–	XX
diagnostic		–	XX
custom logic	Tab to create or modify a structured text program, page 232	–	XX
FB diagram	Tab to create or modify an FBD program, page 284	–	XX
logic simulator	Tab to simulate and debug a custom logic program before transferring it into the LTM R controller, page 296	–	XX
– Not available **X** Available with restrictions **XX** Available without restrictions			

Menu Bar and Tool Bar

Menu Bar

These functions are available with the extended mode using SoMove. The menu bar, at the top of the working space, is represented below:



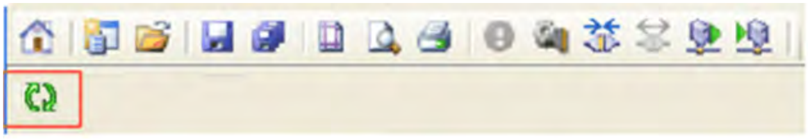
Only the functions specific to the LTM R controller are described here:

- **Device** menu that contains the TeSys T DTM specific functions according to the connection mode.
- **File** menu where the SoMove **Configuration Recovery** function is adapted to the TeSys T DTM.

Other menus are generic and are described in the *SoMove Lite online help*.

Tool Bar

The tool bar, at the top of the working space directly beneath the menu bar, is specific to the DTM:



The buttons of the tool bar enable the user to directly access the main functions without using the menu bar.

The tool bar Refresh button  is used to refresh all parameters from the connected LTM R controller.

Device Menu in the Disconnected Mode

Submenu	Function	Description
Maintenance , page 303	**Firmware update**	Updates the firmware of the LTM R controller
custom logic , page 232	**New custom program**	Creates a new empty structured text program
	Open custom program	Opens the configuration directory to select an existing structured text program
	Save custom program	Saves the modifications made to the structured text program
	Save custom program as	Saves the modifications made to the structured text program to a chosen directory
	Close custom program	Closes the currently open structured text program
	Compile custom program	Compiles the currently open structured text program

Submenu	Function	Description
FB diagram , page 271	**New FB diagram**	Creates a new empty FBD program
	Open FB diagram	Opens the configuration directory to select an existing FBD program
	Save FB diagram	Saves the modifications made to the FBD program
	Save FB diagram as	Saves the modifications made to the FBD program to a chosen directory
	Compile FB diagram to ST program	Transforms the currently open FBD program to a structured text file
	FBD editor	Allows users to manipulate FBD blocks (**Copy**, **Cut**, **Paste**, **Delete**, **Select all**, and **Unselect**)
	View\Show grid	Displays the grid lines
	View\Hide grid	Hides the grid lines
	View\Properties windows	Displays the properties of the selected object
	View\Toolbox	Displays the different categories of blocks
	View\Zoom out	Displays more of the program
	View\Zoom in	Displays the program in more detail
	View\Zoom to	Displays a customized view of the program (zooms to 50%, 75%, 100%, 150%, 200%, or 400%)
	Tools\Renumber links	Sorts link numbers in ascending order
	Tools\Show all links	Displays which blocks are linked together
	Tools\Hide all links	Provides a better overall view of the blocks
	Tools\Renumber Function Blocks	Sorts block numbers in ascending order

Device Menu in the Connected Mode

Submenu	Function	Description
File transfer , page 203	**backup command**	Specific function of the LTM R Ethernet controller that copies the operating parameter file in the controller to the server
	restore command	Specific function of the LTM R Ethernet controller that copies the operating parameter file on the server to the controller
Command , page 27	**run1**	Activates the function associated to the output O.1
	run2	Activates the function associated to the output O.2
	stop	De-activates outputs
	loc/rem	Switches between local and remote control mode
	enter configuration	Allows modification of main parameters in the connected mode
	exit configuration	Exits the previous state.
Reset , page 169	**trip reset**	Resets detected trips
password , page 29	**create password**	Creates a new password
	modify password	Modifies the password
	delete password	Deletes the password
Maintenance	**Set Device Date & Time**	Synchronizes the date and time of the LTM R controller with the date and time of the PC
	test , page 306	Simulates a thermal trip

Submenu	Function	Description
custom logic , page 232	**New custom program**	Creates a new empty structured text program
	Open custom program	Opens the configuration directory to select an existing structured text program
	Save custom program	Saves the modifications made to the structured text program
	Save custom program as	Saves the modifications made to the structured text program to a chosen directory
	Close custom program	Closes the currently open structured text program
	Compile custom program	Compiles the currently open structured text program
	Device custom program to PC	Transfers a structured text program from the connected LTM R controller to the custom logic editor
	PC Custom program to device	Transfers a structured text program from the custom logic editor to the connected LTM R controller
FB diagram , page 271	–	See the description of the **FB diagram** submenu in the disconnected mode
clear , page 180	**clear all**	Erases all parameters (history, statistics, network, etc.) except the Motor LO1 and LO2 Closings Count and Controller Internal Temperature Max parameters
	clear LTMR settings	Restores the LTM R controller protection factory settings
	clear network settings	Restores the network port factory settings (address, etc.)
	clear statistics	Erases statistics except the Motor LO1 and LO2 Closings Count and Controller Internal Temperature Max parameters
	clear Th capa level	Erases thermal information to bypass a thermal trip for emergency restart, page 79

Configuration Recovery

The Configuration Recovery function allows loading a PowerSuite 2 project file using the TeSys T DTM in SoMove.

Step	Action
1	Click **File > Open**.
2	In the file type selection list, select **PS2 Configuration Files**.
3	Open the PowerSuite 2 project file *.impr* to recover.

NOTE: Missing information in the PowerSuite 2 project file can be completed during the recovery process if some parameters cannot be retrieved from the PowerSuite 2 project file.

More details about this function can be found in the *SoMove Lite online help*.

Command Submenu

Overview

This function is available with the extended mode using SoMove. The **command** submenu functions allow to:

- control the LTM R controller logic outputs
- choose between local and remote mode
- enter the configuration mode

Output Control Functions

Control functions **run1**, **run2**, and **stop** are used to control LTM R controller outputs O.1 and O.2.

The result of these functions depends on the following parameters:

- the motor operating mode
- the device status
- the control mode
- the channel setting

The following table lists the functions for each operating mode:, page 147

Operating Mode	Assignment	run1	run2	stop
Overload	2-wire (maintained)	No action	No action	No action
	3-wire (impulse)			
Independent	2-wire (maintained)	Control motor (O.1)	Control O.2	Stop motor (open O.1) and open O.2 while pressed
	3-wire (impulse)	Start motor (close O.1)	Close O.2	Stop motor (open O.1) and open O.2
Reverser	2-wire (maintained)	Forward run	Reverse run	Stop while pressed
	3-wire (impulse)	Start motor forward	Start motor reverse	Stop motor
Two-step	2-wire (maintained)	Control motor	No action	Stop while pressed
	3-wire (impulse)	Start motor	No action	Stop motor
Two-speed	2-wire (maintained)	Low speed control	High speed control	Stop while pressed
	3-wire (impulse)	Low speed start	High speed start	Stop motor

Local and Remote Control Function

The **loc/rem** control function is used to switch between the local and remote control modes.

This function does not depend on the operating mode.

Configuration Mode

In the disconnected mode, the main parameters can be modified at any time.

In the connected mode, the **enter configuration** command allows entering the configuration mode to:

- set the main parameters of the LTM R controller,
- upload custom logic files.

The **exit configuration** command exits the configuration mode.

NOTE: If an incorrect parameter is set, the device ignores the **exit configuration** command and remains in the configuration mode. The LTM R configuration trip bit is set , page 65.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- The motor is forced to stop when activating the configuration mode.
- Consider the effect on all connected equipment before performing any operations.
- Never assume that the motor is in a certain motor state before commanding a change of state.
- Always positively confirm the motor state before acting on a motor.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Password Management

Overview

This function is available with the extended mode using SoMove, in the connected mode. It allows the creation of a password to avoid modification of LTM R parameters by unauthorized people. When a password is set, unauthorized users can view the displayed information, but cannot edit parameter values.

The password must be an integer from 0001 to 9999.

The password is also required to execute the SoMove **Store to Device** function.

Creating a Password

Step	Action
1	Click **Device** **>** **password** **>** **create password**. The **create password** dialog box opens.
2	In the **enter new password** field, enter a new password.
3	In the **confirm new password** field, enter the new password again.
4	Click **OK** to activate the password and close the dialog box.

Modifying a Password

Step	Action
1	Click **Device** **>** **password** **>** **modify password**. The **modify password** dialog box opens.
2	In the **old password** field, enter the current password.
3	In the **enter new password** field, enter a new password.
4	In the **confirm new password** field, enter the new password again.
5	Click **OK** to activate the new password and close the dialog box.

Deleting a Password

Step	Action
1	Click **Device > password > delete password**. The **delete password** dialog box open.
2	In the **old password** field, enter the current password.
3	Click **OK** to delete the password and close the dialog box.

Device Version Management

Overview

This function is available with the basic mode or with the extended mode using SoMove.

A project is created for a specific firmware version of the LTM R controller and the LTM E expansion module.

A project can be stored to a TeSys T device only when its firmware version is the same as the firmware version set in the project.

If it is not the case, the firmware version set in the project must be modified, and the content of the project must be converted to match the firmware version of the TeSys T device.

Edit Topology Window

This procedure describes how to modify the device firmware in the project:

Step	Action
1	Select the **my Device** tab.
2	Click the **Modify** button.
3	Change the firmware version of the project to match the firmware version of your LTM R controller and/or the LTM E expansion module.
4	Click the **Convert** button.

NOTE: If the firmware versions do not match when doing a **Store to device** command, the **Edit topology** window opens with the connected device firmware version selected.

Configuration Conversion Window

After converting the firmware devices and the content of the project, the **Configuration conversion** window provides which parameters were updated in the application.

There are 3 possible effects on parameters after converting the project:

- A parameter was removed.
- A parameter was added, the factory setting of the parameter is automatically selected.
- A parameter was modified to the factory setting. This happens when the parameter exceeds the minimum or maximum value of the parameter.

NOTE: Always check the parameters which were modified by the conversion in order to match your application needs.

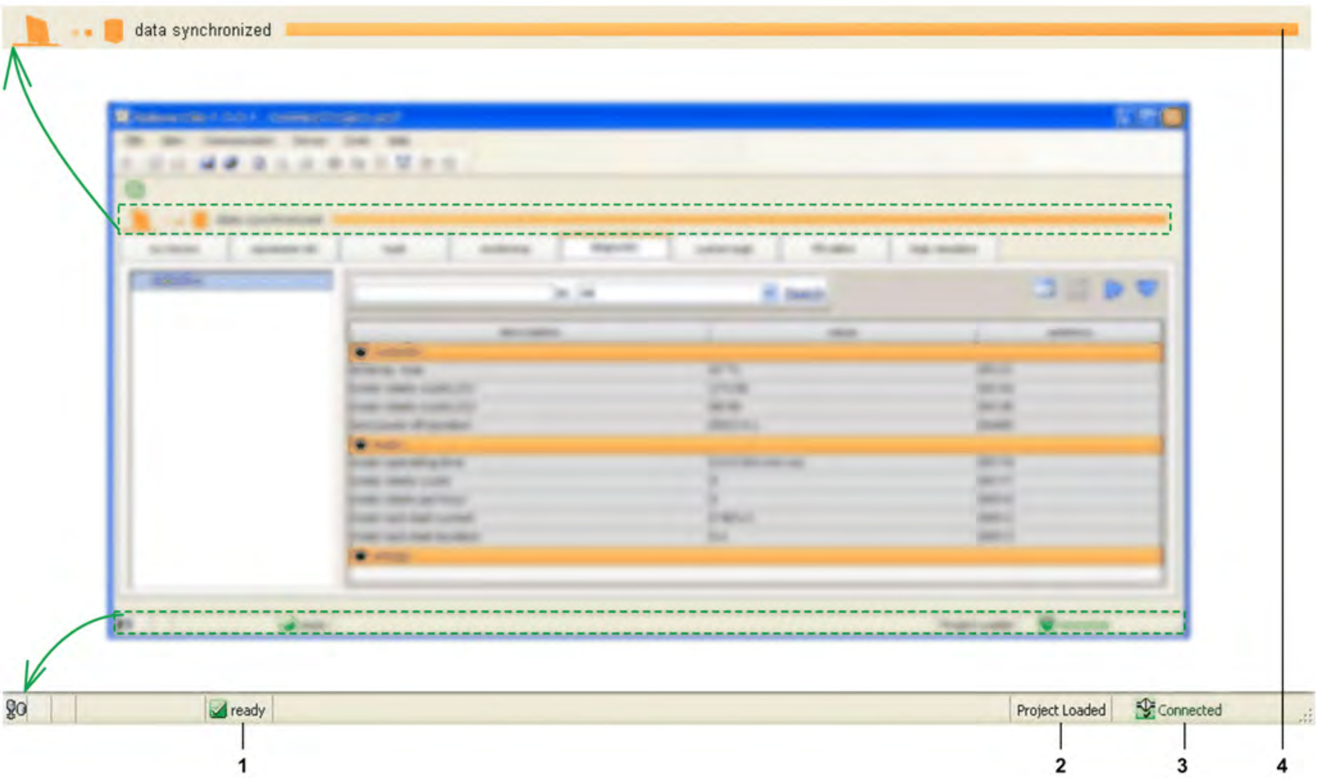
If a parameter is modified and it is not available on the basic mode, it is necessary to use the extended mode with SoMove to modify it.

Status Bar and Synchronization Data Bar

Objective

- The synchronization data bar, above the working space, displays the synchronization status of the data between the LTM R controller and the PC.
- The status bar, at the bottom of the working space, displays the current status of the LTM R controller and information related to SoMove. For more information on the status bar icon for SoMove, see the *SoMove Lite online help*.

Extended Mode Description



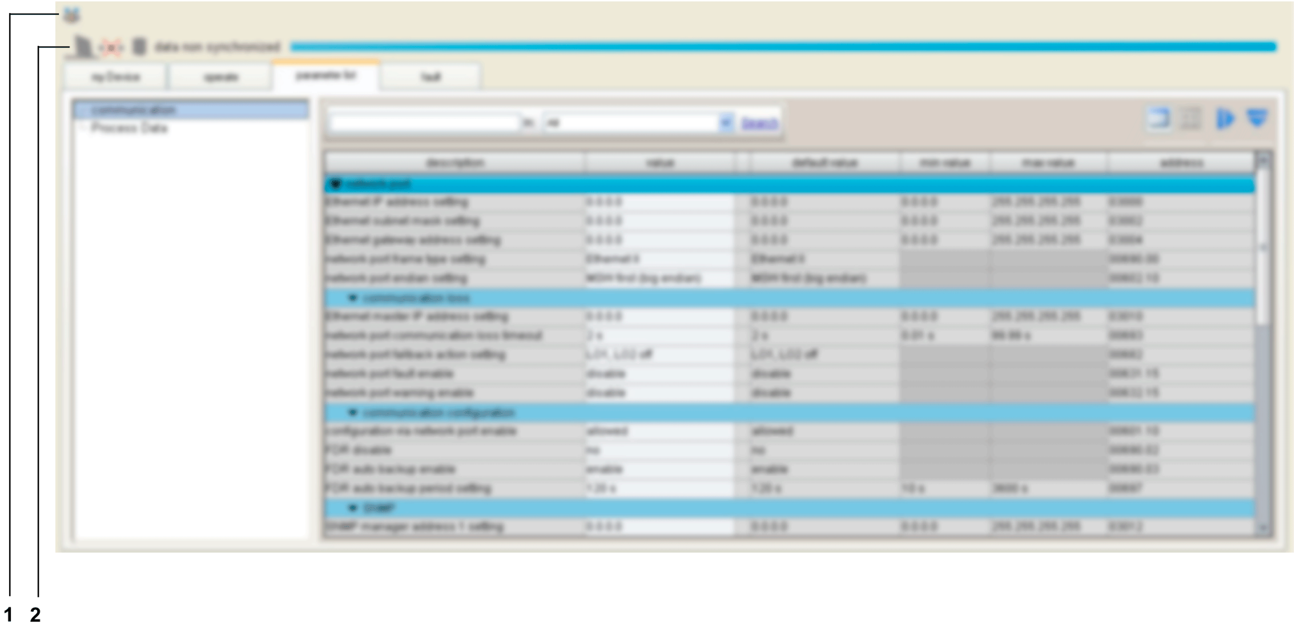
1 LTM R controller status

2 Project status

3 Connection status

4 Synchronization data bar

Basic Mode Description



1 Connection status

2 Synchronization data bar

LTM R Controller Status

This bar is available with the basic mode or with the extended mode using SoMove.

The TeSys T DTM displays the status of the LTM R controller. The status is available only in the connected mode.

The LTM R controller status can be one of the following:

- **in config.**: The LTM R controller is in the configuration mode, page 28.
- **trip**: The LTM R controller is in tripped state.
- **trip**: A trip is detected by the LTM R controller. Details of the trip are available in the **trip** tab, page 41.
- **running**: The LTM R controller detects that the motor is running.
- **starting**: The motor controlled by the LTM R controller is starting up.
- **alarm**: A alarm is detected by the LTM R controller. Details of the alarm are available in the **trip** tab, page 41.
- **ready**: No trip is detected by the LTM R controller.
- **Not ready**: The LTM R controller is in a temporary intermediate state.

Project Status

This bar is available only with the extended mode using SoMove.

The status of the SoMove project can be:

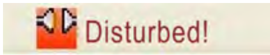
- **Project Loaded**: A project is displayed in the working space.
- **No Project Open**: The project working space is empty.

For more information, see the section about working in the disconnected mode in the *SoMove Lite online help*.

Connection Status

This bar is available with the basic mode or with the extended mode using SoMove.

The connection status indicates the connection mode between the LTM R controller and the PC:

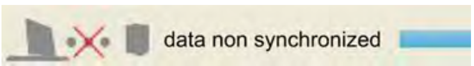
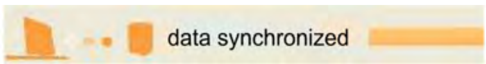
	Disconnected Mode	Disturbed Mode	Connected Mode
Icon			
Description	The LTM R controller is not connected to the PC.	The connection between the LTM R controller and the PC is disturbed or lost.	The LTM R controller is connected to the PC.

Synchronization Data Area

This bar is available with the basic mode or with the extended mode using SoMove.

When the LTM R controller is in the connected mode, displayed data is automatically synchronized.

The synchronization data area indicates the synchronization status of the parameters between the LTM R controller and the PC:

	Disconnected Mode	Connected Mode
Icon		
Description	The LTM R controller is not synchronized with the PC: • Parameters list headers and synchronization data area are blue. • Parameters are not read in real time from the LTM R controller. • All settings can be modified as in configuration mode. • Modified parameters are written locally in the SoMove project on PC. The project should be saved to store these modifications.	The LTM R controller is synchronized with the PC: • Parameters list headers and synchronization data area are orange. • Parameters displayed are read in real time from the LTM R controller. • Some main settings can be modified only in configuration mode, page 28. • Modified parameters are written in real time to the LTM R controller without requiring confirmation.

my Device Tab

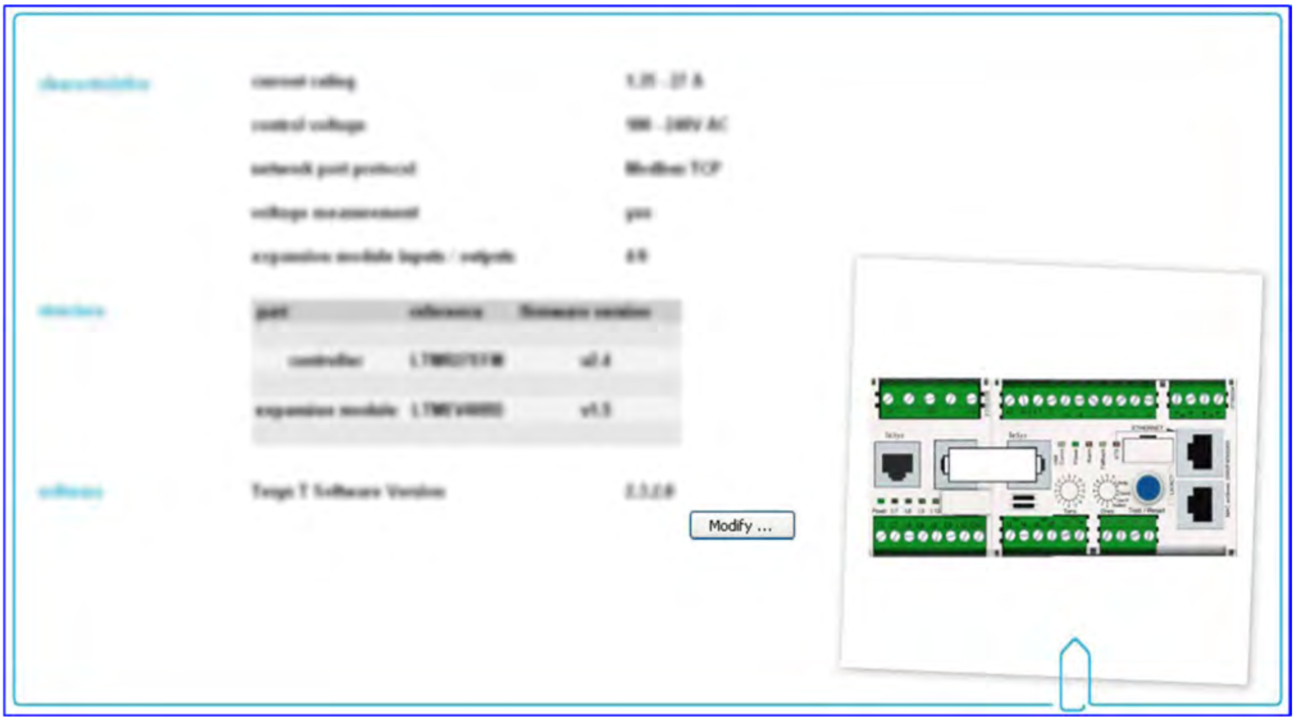
Overview

This tab is available with the basic mode or with the extended mode using SoMove.

The **my Device** tab displays the main characteristics and modules of the selected LTM R controller.

Description

This figure presents the information about the TeSys T motor management system.



Information Displayed

The **my Device** tab displays the following information about the TeSys T motor management system:

- characteristics:
  - current rating in Amperes
  - control voltage: LTM R controller power supply in Volts
  - network port protocol
  - presence of voltage measurement
  - number of logic inputs/outputs from the expansion module
- structure of the TeSys T motor management system:
  - reference number of each module
  - firmware version of each module
  - **Modify** button to convert the current project firmware to match the connected product firmware, page 30
- software:
  - version of the TeSys T DTM
- visual elements:
  - A picture represents the LTM R controller corresponding to the selected type.

operate Tab

Overview

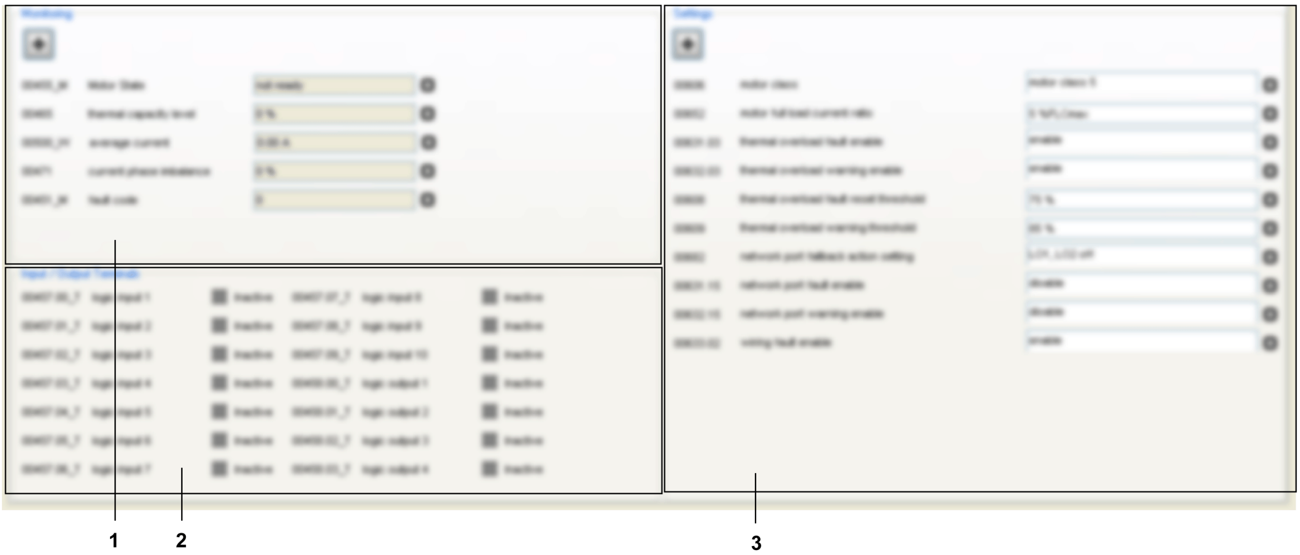
This tab is available with the basic mode or with the extended mode using SoMove.

The **operate** tab is used to set and display the LTM R controller operating data.

Description

The working space is divided in 3 zones:

- Monitoring: to list of parameters to observe in operate tab
- Input / Output Terminals: to simulate the activity on an Input / Output
- Settings: to change parameters online



1 Monitoring area

2 Input / Output Terminals area

3 Settings area

Monitoring Parameters

Add a parameter in the Monitoring area:

Step	Action
1	Click the button.
2	Select the parameter to add in Monitoring.
3	Click the **ADD** button. The parameter is displayed in the Monitoring area.

To remove a parameter from the Monitoring area, click the button in front of the parameter to remove.

Input / Output Terminals Status

The table below shows the status of the input/output of the LTM R controller.

Status Input/Output	Color Status Box	Descriptive Text
Active	Green	Active
Inactive	Grey	Inactive

Settings Parameters

Add a parameter in the Settings area:

Step	Action
1	Click the  button.
2	Select the parameter to add in the Settings area.
3	Click the **ADD** button. The parameter is displayed in the Settings area.

To remove a parameter from the Settings area, click the button  in front of the parameter to remove.

Tab Zone

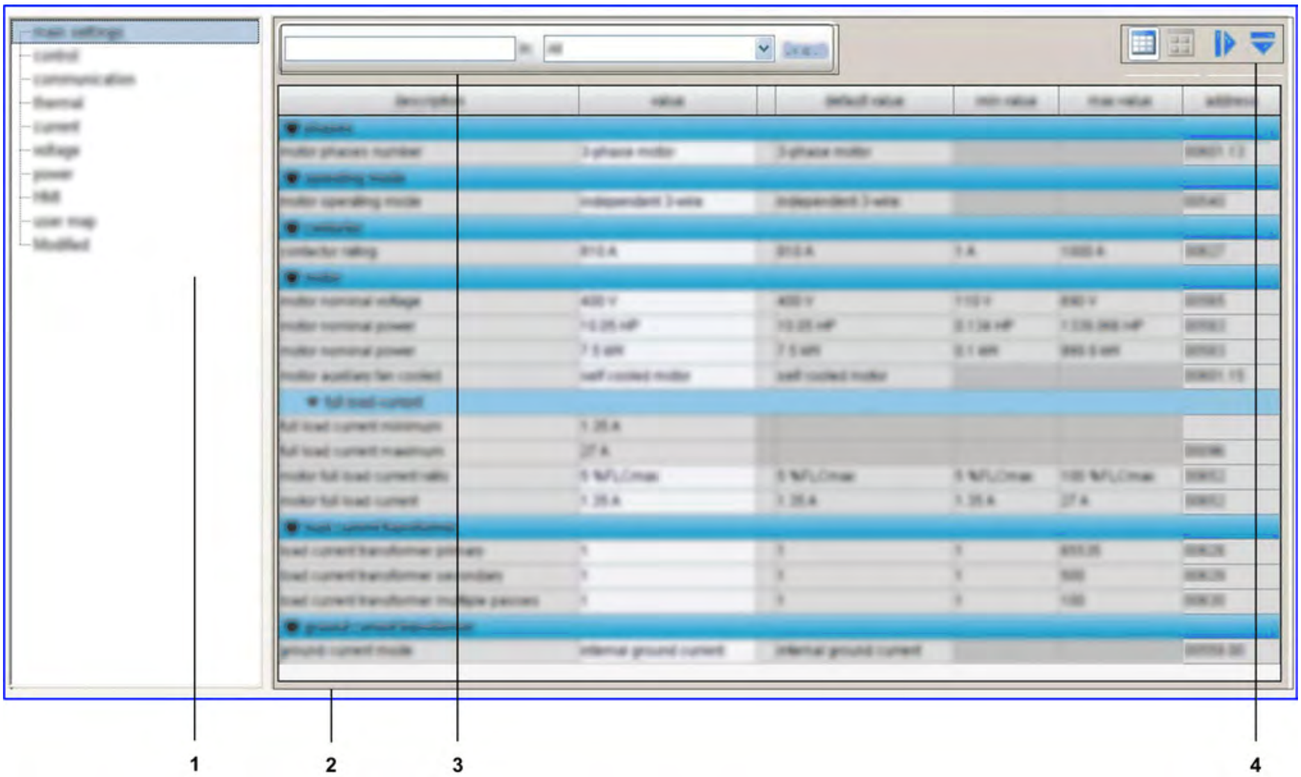
Overview

The following tabs display information in the same way.

Tab Name	Description	Basic Mode	Extended Mode
parameter list	Tabs display the LTM R controller parameters and status	X	XX
trip		XX	XX
monitoring		–	XX
diagnostic		–	XX
This topic presents the different parts of the screen and their function.			
– Not available **X** Available with restrictions **XX** Available without restrictions			

Description

This figure presents the common information in these tabs:



1 Tree view with items and subitems used to access to different tables of parameters.

2 Display area with the table of parameters.

3 Search function.

4 Display area tool bar.

Tree View

The tree view is composed of items with or without subitems. Select an item or subitem in the tree to update the display area on the right. The displayed table includes the corresponding parameters grouped in families and subfamilies.

Display Area Tool Bar

The view of the display area can be modified using the following buttons available on the top right corner of the display area:

Button	Function	Description
	Grid view	Parameters are listed by family and subfamily in a table.
	Sketch view	Parameters are presented with diagrams (charts, drawings, etc.) to explain parameters settings in a user-friendly way. Currently, TeSys T DTM does not provide such a view.
	Expand All	Expand all families and subfamilies to display all parameters.
	Collapse All	Collapse all families and subfamilies in the display area.

Display Area in Grid View

1 Column header.

2 Parameter family.

3 Parameter subfamily.

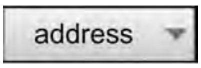
4 Parameters:

- There is one line per parameter with some of its properties displayed in the different cells of the line.
- Content of white cells can be modified, gray cells are read-only.

5 Collapse/Expand icon: to collapse or expand a parameter family or subfamily, click the arrow of the corresponding colored line.

Sorting Parameters

To sort the parameters according to the values in a column:

Step	Action	Result	Header Example
1	Click a first time on the header.	• Parameters are sorted in ascending order of the values column (alphabetically or numerically) in their respective subfamily and family. • Header appears with an arrow pointing upwards.	
2	Click a second time on the header.	• Parameters are sorted in descending order of the values in the column (alphabetically or numerically) in their respective subfamily and family. • Header appears with an arrow pointing downwards.	
3	Click a third time on the header.	• Parameters are displayed in their initial order. • Header appears according to its initial representation.	

Modifying the Order of Columns

To modify the order of columns in the display:

Step	Action
1	Click the header of the column.
2	Drag the column to the correct location.

Search Function

To find a specific text in a displayed table:

Step	Action
1	In the first field of the search bar at the top of the display area, enter the characters to search for (part of word, code, unit, etc.).
2	Select the column to search from the list. If you select the **All** option, the search is performed in all columns of the table.
3	Click **Search**: • The first matching text found is highlighted. • To search for other instances, click again the **Search** button. • If no matching text is found, the color of characters in the search field becomes red.

parameter list Tab

Overview

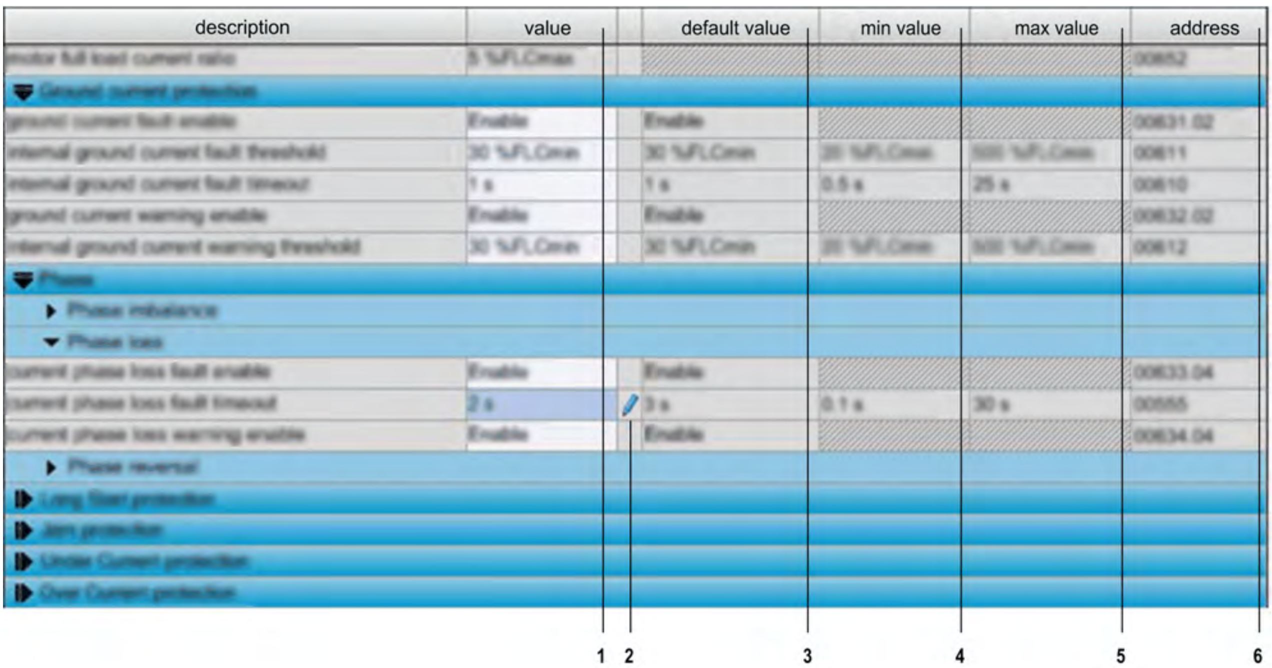
This tab is available with the basic mode but with restrictions or with the extended mode using SoMove.

The **parameter list** tab is used to set and display the LTM R controller setting parameters.

Only parameter values in the white entry fields can be modified.

Description

For a global description of the tab, refer to the tab zone description, page 36.



1 Parameter value column.

2 Modification column: a pen appears if the corresponding value is different from its factory settings.

3 Modifiable parameter factory settings column.

4 Numerical parameter minimum value column.

5 Numerical parameter maximum value column.

6 Address column: displays the parameter register and bit number when relevant.

Setting Numerical Values

There are 2 ways to set a parameter with a numerical value:

- direct entry of the numerical value
- value selection using the spin buttons

To set a numerical value by direct entry:

Step	Action
1	Select an item from the tree view.
2	Type the parameter value in the white entry field.
3	Press ENTER to validate the new parameter value entry: • If the value is between the minimum and maximum values and consistent with the resolution interval, the parameter value is set to the new value. • If the value is between the minimum and maximum values but not consistent with the resolution interval, the parameter value is rounded up to an authorized value. • If the value is not between the minimum and maximum values: ◦ If the value requested is below the minimum value, the parameter value is set to the minimum value. ◦ If the value requested is above the maximum value, the parameter value is set to the maximum value.

To set a numerical value with the spin buttons:

Step	Action
1	Select an item from the tree view.
2	Click in the white entry field of the parameter to set it with the spin buttons that are displayed on the right of the entry field.
3	Increase or decrease the value with the spin buttons. You cannot increase the value above the maximum authorized value, or decrease it below the minimum authorized value.

Editing a String

To set a string parameter:

Step	Action
1	Select an item from the tree view.
2	Type the string in the white entry field.
3	Press ENTER to validate.

Selecting Values in a List

To select a value in a list:

Step	Action
1	Select an item from the tree view.
2	Click in the white entry field of the parameter to set it with the down arrow button that is displayed on the right of the entry field.

Step	Action
3	Click the arrow button to open the drop-down selection list.
4	Select a value.
5	Press ENTER to validate the selection.

Setting User Map Addresses (For Extended Mode Only)

To set user map addresses:

Step	Action
1	Select **user map** in the tree view: • Addresses are ranked from 0 to 98 and correspond to registers 800–898. • Addresses are divided into 4 groups.
2	Enter an address value in the table: • The entered address must be in the decimal format. • Enter the address 0 to remove the address from the user map.
3	Press ENTER to validate the new address: • If the address is accepted, the address is added to the user map. • If the address is not accepted, the previous accepted address is kept in the user map.

NOTE: For more information about the user map variable, refer to the relevant section.

Setting Process Channel Mode

For LTM R Ethernet controller you can select the profile:

- E_TeSysT Fast Access
- EIOS_TeSysT

Each profile contains a limited list of registers whose values are returned directly in the variables table of the IO scanner controller:

- registers for E_TeSysT Fast Access , page 191
- registers for EIOS_TeSysT , page 192

Set the parameter **UNIT ID** to 1 in the I/O scanning configuration of the controller.

trip Tab

Overview

This tab is available with the basic mode or with the extended mode using SoMove.

The **trip** tab displays the detected trips or alarms related to the connected LTM R controller, page 56.

The data in this tab is only significant in the connected mode.

Description

For a global description of the tab, refer to the tab zone description, page 36.

This tab displays:

- the status of detected trips and alarms in the LTM R controller:
  - the trip and alarm statuses
  - the trip and alarm counters, page 67
- a history of the detected trips, page 70

Status Item in Tree View

The table in the display area shows the trips and alarms that can be detected by the LTM R controller. In the connected mode, it displays in real time the status of the trips and alarms detected by the connected LTM R controller.

The different columns provide the following information:

Column	Information
description	Name of the trip or alarm.
trip	Detected trip status: • : A red light indicates that the cause of the trip is not resolved. • : A grayed out light indicates that there is no trip. • When a trip detection is disabled, no light is displayed in the corresponding cell.
trip count	Number of detected trips since the last clear all or clear statistics action.
alarm	Detected alarm status: • : An orange light indicates that the cause of the alarm is not resolved. • : A grayed out light indicates that there is no alarm. • When a alarm detection is disabled, no light is displayed in the corresponding cell.
alarm count	Number of detected alarms since the last clear all or clear statistics action.

Trip History Item in Tree View

The LTM R controller stores the history of the 5 last detected trips. Each record contains monitoring data when the trip occurred, this helps investigation about the trip cause. Trip N-0 contains the most recent trip record, and trip N-4 contains the oldest retained trip record.

For each trip, the following information is displayed:

- the trip code and its description
- date and time of trip detection
- value of important settings when the trip occurred
- value of measurements recorded when the trip was detected, page 70

monitoring Tab

Overview

This tab is available with the extended mode using SoMove.

The **monitoring** tab is used to monitor in real time the status and measurements of the connected LTM R controller.

The data in this tab are only significant in the connected mode.

Description

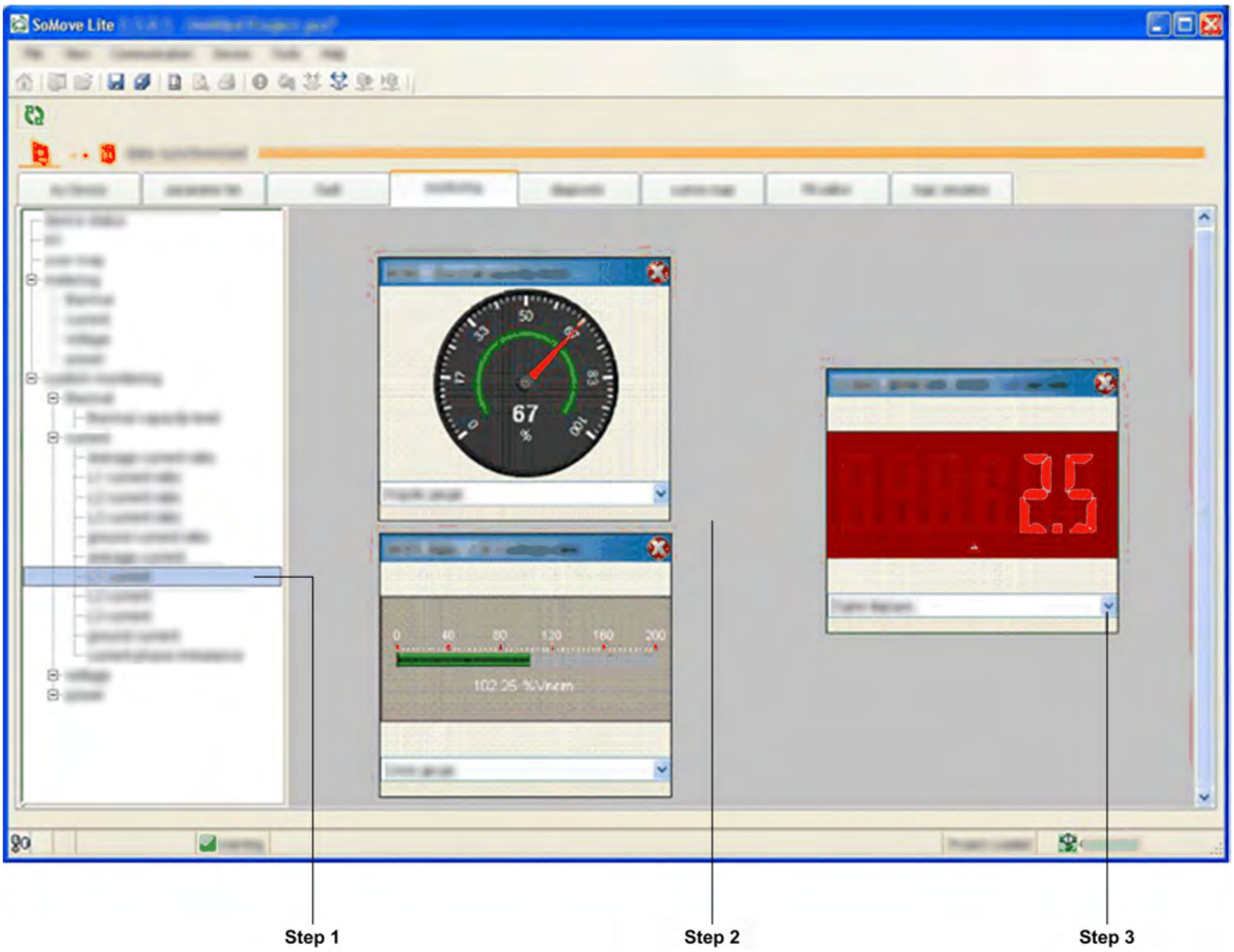
For a global description of the tab, refer to the tab zone description, page 36.

The following table lists the available tree view items in the **monitoring** tab and their functions:

Tree View Item	Description
device status	Displays general information about the LTM R controller status. This status is represented by: • values • texts • colored lights: ◦ : A red light indicates a major problem in the system. ◦ : An orange light indicates a minor problem in the system. ◦ : A green light indicates a normal operation. ◦ : A gray light indicates an inactive status.
I/O	Displays the input/output status of the LTM R controller. The status of each input and output is represented by a colored light: • : A green light indicates that the logic inputs/outputs are on. • : A gray light indicates that the logic inputs/outputs are off.
user map	Displays the values of the LTM R controller user map addresses: • Only the valid addresses are displayed (addresses different from 0). • The displayed value is the content of the related register only in the decimal format. A specific interpretation is necessary in the 2 following cases: ◦ if the register is a set of 16 bits (all the bits are merged in value) ◦ if the register is a part of a double registers (LSW or MSW, depending on endianness)
metering	Displays the LTM R controller metering values grouped by type (thermal, current, voltage, or power).
custom monitoring	Allows the user to select measures from tree list, and displays them in a widget representation. In the connected mode, the values are automatically refreshed in real time.

Custom Monitoring

You can select a number of parameters in the tree view to display the corresponding value with widgets in the display area.

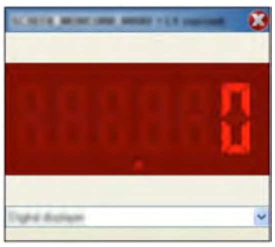


To select a parameter displayed by widgets in the **custom monitoring** display area proceed as follows:

Step	Action
1	Select the parameter to display in the tree view on the left. Multiple parameters can be selected and organized simultaneously in the display area.
2	Click the display area on the right, the value of the selected parameter is displayed by a widget at the click location. The values are automatically refreshed in real time.
3	Modify the widget type in the selection list.

Types of Widgets

Depending on the selected parameter, 3 types of widgets can be displayed:

Type	Angular Gauge	Linear Gauge	Digital Display
Widget			

diagnostic Tab

Overview

This tab is available with the extended mode using SoMove.

The **diagnostic** tab displays statistics of the connected LTM R controller.

The data in this tab is only significant in the connected mode.

Description

For a global description of this tab, refer to the tab zone description, page 36.

This table lists tree view items available in the **diagnostic** tab and their functions:

Tree View Item	Description
Eth	Monitors the Ethernet statistics of LTM R Ethernet controller , page 202.
statistics	Displays: • the LTM R controller history, page 56 • the motor history, page 71

Metering and Monitoring Functions

Overview

The LTM R controller provides measurement, metering, and monitoring in support of the current, temperature, and ground current trip protection functions. When connected to an LTM E expansion module, the LTM R controller also provides voltage and power measurement functions.

Measurement

Overview

The LTM R controller uses these measurements to perform protection, control, monitoring, and logic functions. Each measurement is detailed in this section.

The measurements can be accessed via:

- a PC running SoMove with the TeSys T DTM
- an HMI device
- a PLC via the network port

Line Currents

Description

The LTM R controller measures line currents and provides the value of each phase in amperes and as a percentage of Full Load Current (FLC).

The line currents function returns the rms value in amperes of the phase currents from the 3 CT inputs:

- L1: phase 1 current
- L2: phase 2 current
- L3: phase 3 current

The LTM R controller performs true rms calculations for line currents up to the 7th harmonic.

Single-phase current is measured from L1 and L3.

Line Current Characteristics

The line currents function has the following characteristics:

Characteristic	Value
Unit	A
Accuracy	• +/- 1 % for 8 A and 27 A models • +/- 2 % for 100 A models
Resolution	0.01 A
Refresh interval	100 ms

Line Current Ratio

The L1, L2 and L3 current ratio parameter provides the phase current as a percentage of FLC.

Line Current Ratio Formulas

The line current value for the phase is compared to the FLC parameter setting, where FLC is FLC1 or FLC2, whichever is active at that time.

Calculated Measurement	Formula
Line current ratio	100 x Ln / FLC
Where: • FLC = FLC1 or FLC2 parameter setting, whichever is active at the time • Ln = L1, L2, or L3 current value in amperes	

Line Current Ratio Characteristics

The line current ratio function has the following characteristics:

Characteristic	Value
Unit	% of FLC
Accuracy	See Line Current Characteristics, page 46
Resolution	1% FLC
Refresh interval	100 ms

Ground Current

Description

The LTM R controller measures ground currents and provides values in Amperes and as a percentage of FLCmin.

- The internal ground current (Igr∑) is calculated by the LTM R controller from the 3 line currents measured by the load current transformers. It reports 0 when the current falls below 10 % of FLCmin.
- The external ground current (Igr) is measured by the external ground current sensor connected to Z1 and Z2 terminals.

Configurable Parameters

The control channel configuration has the following configurable parameter settings:

Parameter	Setting Range	Factory Setting
Ground Current Mode	• Internal • External	Internal
Ground Current Ratio	• None • 100:1 • 200:1.5 • 1000:1 • 2000:1 • Other Ratio	None

Parameter	Setting Range	Factory Setting
Ground CT Primary	• 1…65,535	1
Ground CT Secondary	• 1…65,535	1

External Ground Current Formula

The external ground current value depends on the parameter settings:

Calculated Measurement	Formula
External ground current	(Current through Z1-Z2) x (Ground CT Primary) / (Ground CT Secondary)

Ground Current Characteristics

The ground current function has the following characteristics:

<table>
<tr><th colspan="2" rowspan="2">Characteristic</th><th colspan="2">Value</th></tr>
<tr><th>Internal Ground Current (IgrΣ)</th><th>External Ground Current (Igr)</th></tr>
<tr><td colspan="2">Unit</td><td>A</td><td>A</td></tr>
<tr><td colspan="4">Accuracy</td></tr>
<tr><td rowspan="4">LTM R 08xxx</td><td>Igr ≥ 0.3 A</td><td>+/– 10 %</td><td rowspan="12">The greater of +/– 5 % or +/– 0.01 A</td></tr>
<tr><td>0.2 A ≤ Igr ≤ 0.3 A</td><td>+/– 15 %</td></tr>
<tr><td>0.1 A ≤ Igr ≤ 0.2 A</td><td>+/– 20 %</td></tr>
<tr><td>Igr < 0.1 A</td><td>N/A(1)</td></tr>
<tr><td rowspan="4">LTM R 27xxx</td><td>Igr ≥ 0.5 A</td><td>+/– 10 %</td></tr>
<tr><td>0.3 A ≤ Igr ≤ 0.5 A</td><td>+/– 15 %</td></tr>
<tr><td>0.2 A ≤ Igr ≤ 0.3 A</td><td>+/– 20 %</td></tr>
<tr><td>Igr < 0.2 A</td><td>N/A(1)</td></tr>
<tr><td rowspan="4">LTM R 100xxx</td><td>Igr ≥ 1.0 A</td><td>+/– 10 %</td></tr>
<tr><td>0.5 A ≤ Igr ≤ 1.0 A</td><td>+/– 15 %</td></tr>
<tr><td>0.3 A ≤ Igr ≤ 0.5 A</td><td>+/– 20 %</td></tr>
<tr><td>Igr < 0.3 A</td><td>N/A(1)</td></tr>
<tr><td colspan="2">Resolution</td><td>0.01 A</td><td>0.01 A</td></tr>
<tr><td colspan="2">Refresh interval</td><td>100 ms</td><td>100 ms</td></tr>
<tr><td colspan="4">(1) For currents of this magnitude or lower, the internal ground current function should not be used. Instead, use external ground current transformers.</td></tr>
</table>

Ground Current Ratio

The Ground Current Ratio parameter provides the ground current value as a percentage of FLCmin.

Ground Current Ratio Formulas

The ground current value is compared to FLCmin.

Calculated Measurement	Formula
Ground current ratio	100 x ground current / FLCmin

Ground Current Ratio Characteristics

The ground current ratio function has the following characteristics:

Characteristic	Value
Unit	0…2,000 % of FLCmin
Accuracy	See Ground Current Characteristics, above
Resolution	0.1 % FLCmin
Refresh interval	100 ms

Average Current

Description

The LTM R controller calculates average current and provides the value for phase in amperes and as a percentage of FLC.

The average current function returns the rms value of the average current.

Average Current Formulas

The LTM R controller calculates the average current using the measured line currents. The measured values are internally summed using the following formula:

Calculated Measurement	Formula
Average current, three phase motor	Iavg = (L1 + L2 + L3) / 3
Average current, single-phase motor	Iavg = (L1 + L3) / 2

Average Current Characteristics

The average current function has the following characteristics:

Characteristic	Value
Unit	A
Accuracy	• +/- 1 % for 8 A and 27 A models • +/- 2 % for 100 A models
Resolution	0.01 A
Refresh interval	100 ms

Average Current Ratio

The Average Current Ratio parameter provides the average current value as a percentage of FLC.

Average Current Ratio Formulas

The average current value for the phase is compared to the FLC parameter setting, where FLC is FLC1 or FLC2, whichever is active at that time.

Calculated Measurement	Formula
Average current ratio	100 x Iavg / FLC
Where: • FLC = FLC1 or FLC2 parameter setting, whichever is active at the time • Iavg = average current value in amperes	

Average Current Ratio Characteristics

The average current ratio function has the following characteristics:

Characteristic	Value
Unit	% of FLC
Accuracy	See Average Current Characteristics, above
Resolution	1 % FLC
Refresh interval	100 ms

Current Phase Imbalance

Description

The current phase imbalance function measures the maximum percentage of deviation between the average current and the individual phase currents.

Formulas

The current phase imbalance measurement is based on imbalance ratio calculated from the following formulas:

Calculated Measurement	Formula
Imbalance ratio of current in phase 1 (in %)	Ii1 = (| L1 - Iavg | x 100) / Iavg
Imbalance ratio of current in phase 2 (in %)	Ii2 = (| L2 - Iavg | x 100) / Iavg
Imbalance ratio of current in phase 3 (in %)	Ii3 = (| L3 - Iavg | x 100) / Iavg
Current imbalance ratio for three phase (in %)	Iimb = Max(Ii1, Ii2, Ii3)

Characteristics

The line current imbalance function has the following characteristics:

Characteristic	Value
Unit	%
Accuracy	• +/- 1.5% for 8 A and 27 A models • +/- 3% for 100 A models
Resolution	1%
Refresh interval	100 ms

Thermal Capacity Level

Description

The thermal capacity level function uses two thermal models to calculate the number of thermal capacity used: one for copper stator and rotor windings of the motor and the other for the iron frame of the motor. The thermal model with the maximum utilized capacity is reported.

This function also estimates and displays:

- the time remaining before a thermal overload trip is triggered (see Time to Trip, page 65), and
- the time remaining until the trip condition is cleared after a thermal overload trip has been triggered (see Minimum Wait Time, page 74).

Trip Current Characteristics

The thermal capacity level function uses one of the following selected trip current characteristics (TCCs):

- definite time
- inverse thermal (factory setting)

Thermal Capacity Level Models

Both copper and iron models use the maximum measured phase current and the Motor Trip Class parameter value to generate a non-scaled thermal image. The reported thermal capacity level is calculated by scaling the thermal image to FLC.

Thermal Capacity Level Characteristics

The thermal capacity level function has the following characteristics:

Characteristic	Value
Unit	%
Accuracy	+/– 1 %
Resolution	1 %
Refresh interval	100 ms

Motor Temperature Sensor

Description

The motor temperature sensor function displays:

- The resistance value in ohms measured by a PTC or NTC resistance temperature sensor.
- The temperature value in °C or °F measured by a PT100 temperature sensor.

Refer to the product documentation for the specific temperature sensor being used. One of 4 types of temperature sensors can be used:

- PTC Binary
- PT100
- PTC Analog
- NTC Analog

Characteristics

The motor temperature sensor function has the following characteristics:

Characteristic	PT100 Temperature Sensor	Other Temperature Sensor
Unit	°C or °F, according to the value of the HMI Display Temperature Sensor Degree CF parameter	Ω
Accuracy	+/- 2 %	+/– 2 %
Resolution	1 °C or 1 °F	0.1 Ω
Refresh interval	500 ms	500 ms

Frequency

Description

The frequency function provides the value measured based on the line voltage measurements. If the frequency is unstable (+/– 2 Hz variations), the value reported is 0 until the frequency stabilizes.

If no LTM E expansion module is present, the frequency value is 0.

Characteristics

The frequency function has the following characteristics:

Characteristic	Value
Unit	Hz
Accuracy	+/– 2%
Resolution	0.1 Hz
Refresh interval	30 ms

Line-to-Line Voltages

Description

The line-to-line voltages function provides the rms value of the phase-to-phase voltage (V1 to V2, V2 to V3, and V3 to V1):

- L1-L2 voltage: phase 1 to phase 2 voltage
- L2-L3 voltage: phase 2 to phase 3 voltage
- L3-L1 voltage: phase 3 to phase 1 voltage

The expansion module performs true rms calculations for line-to-line voltage up to the 7th harmonic.

Single phase voltage is measured from L1 and L3.

Characteristics

The line-to-line voltages function has the following characteristics:

Characteristic	Value
Unit	VAC
Accuracy	+/- 1 %

Characteristic	Value
Resolution	1 VAC
Refresh interval	100 ms

Line Voltage Imbalance

Description

The line voltage imbalance function displays the maximum percentage of deviation between the average voltage and the individual line voltages.

Formulas

The line voltage imbalance calculated measurement is based on the following formulas:

Calculated Measurement	Formula
Imbalance ratio of voltage in phase 1 in %	Vi1 = 100 x | V1 - Vavg | / Vavg
Imbalance ratio of voltage in phase 2 in %	Vi2 = 100 x | V2 - Vavg | / Vavg
Imbalance ratio of voltage in phase 3 in %	Vi3 = 100 x | V3 - Vavg | / Vavg
Voltage imbalance ratio for three phase in %	Vimb = Max (Vi1, Vi2, Vi3)
Where: • V1 = L1-L2 voltage (phase 1 to phase 2 voltage) • V2 = L2-L3 voltage (phase 2 to phase 3 voltage) • V3 = L3-L1 voltage (phase 3 to phase 1 voltage) • Vavg = average voltage	

Characteristics

The line voltage imbalance function has the following characteristics:

Characteristic	Value
Unit	%
Accuracy	+/– 1.5 %
Resolution	1 %
Refresh interval	100 ms

Average Voltage

Description

The LTM R controller calculates average voltage and provides the value in volts. The average voltage function returns the rms value of the average voltage.

Formulas

The LTM R controller calculates average voltage using the measured line-to-line voltages. The measured values are internally summed using the following formula:

Calculated Measurement	Formula
Average voltage, three phase motor	Vavg = (L1-L2 voltage + L2-L3 voltage + L3-L1 voltage) / 3
Average voltage, single-phase motor	Vavg = L3-L1 voltage

Characteristics

The average voltage function has the following characteristics:

Characteristic	Value
Unit	VAC
Accuracy	+/- 1%
Resolution	1 VAC
Refresh interval	100 ms

Power Factor

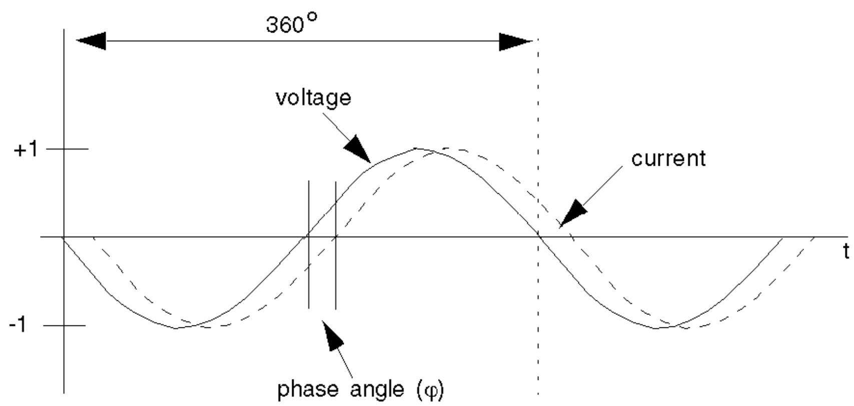
Description

The power factor function displays the phase displacement between the phase currents and phase voltages.

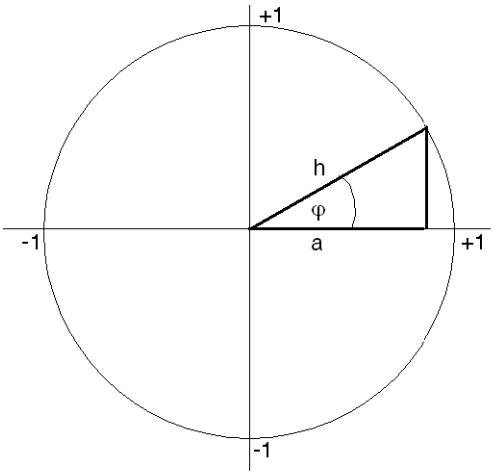
Formula

The Power Factor parameter (also called cosine phi or cos ϕ) represents the absolute value of the ratio of Active Power to Apparent Power.

The following diagram displays an example of the average rms current sinusoidal curve lagging slightly behind the average rms voltage sinusoidal curve, and the phase angle difference between the 2 curves:



After the phase angle (ϕ) is measured, the power factor can be calculated as the cosine of the phase angle (ϕ)—the ratio of side a (Active Power) over the hypotenuse h (Apparent Power):



Characteristics

The active power function has the following characteristics:

Characteristic	Value
Accuracy	+/- 10 % for cos ϕ ≥ 0.6
Resolution	0.01
Refresh interval	30 ms (typical)(1)
(1) The refresh interval depends on the frequency.	

Active Power and Reactive Power

Description

The calculation of the active power and reactive power is based on the:

- average rms phase voltage of L1, L2, L3
- average rms phase current of L1, L2, L3
- power factor
- number of phases

Formulas

Active power, also known as true power, measures average rms power. It is derived from the following formulas:

Calculated Measurement	Formula
Active power for three phase motor	√3 x Iavg x Vavg x cosϕ
Active power for single-phase motor	Iavg x Vavg x cosϕ
Where: • Iavg = Average rms current • Vavg = Average rms voltage	

The reactive power measurement is derived from the following formulas:

Calculated Measurement	Formula
Reactive power for three phase motor	$\sqrt{3}$ x Iavg x Vavg x sinϕ
Reactive power for single-phase motor	Iavg x Vavg x sinϕ
Where: • Iavg = Average rms current • Vavg = Average rms voltage	

Characteristics

The active and reactive power functions have the following characteristics:

Characteristic	Active Power	Reactive Power
Unit	kW	kVAR
Accuracy	+/- 15 %	+/- 15 %
Resolution	0.1 kW	0.1 kVAR
Refresh interval	100 ms	100 ms

Active Power Consumption and Reactive Power Consumption

Description

The active and reactive power consumption functions display the accumulated total of the active and reactive electrical power delivered, and used or consumed by the load.

Characteristics

The active and reactive power consumption functions have the following characteristics:

Characteristic	Active Power Consumption	Reactive Power Consumption
Unit	kWh	kVARh
Accuracy	+/- 15 %	+/- 15 %
Resolution	0.1 kWh	0.1 kVARh
Refresh interval	100 ms	100 ms

System and Device Monitoring Trips

Overview

The LTM R controller and the LTM E expansion module detect trips which affect the LTM R controller ability to work properly (internal controller check and check of communications, wiring, and configuration trips).

The system and device monitoring trip records can be accessed via:

- a PC running SoMove with the TeSys T DTM
- an HMI device

- a PLC via the network port

Controller Internal Trip

Description

The LTM R controller detects and records trips that are internal to the device itself. Internal trips can be either major or minor. Major and minor trips can change the state of output relays. Cycling power to the LTM R controller may clear an internal trip.

When an internal trip occurs, the Controller Internal Trip parameter is set.

Major Internal Trips

During a major trip, the LTM R controller is unable to reliably execute its own programming and can only attempt to shut itself down. During a major trip, communication with the LTM R controller is not possible. Major internal trips include:

- stack overflow trip
- stack underflow trip
- watchdog time-out
- firmware checksum trip
- CPU trip
- internal temperature trip (at 100 °C / 212 °F)
- RAM test trip

Minor Internal Trips

Minor internal trips indicate that the data being provided to the LTM R controller is unreliable and protection could be compromised. During a minor trip, the LTM R controller continues to attempt to monitor status and communications, but does not accept any start commands. During a minor trip condition, the LTM R controller continues to detect and report major trips, but not additional minor trips. Minor internal trips include:

- internal network communications detected error
- EEPROM trip
- A/D out of range detected error
- Reset button stuck
- internal temperature trip (at 85 °C / 185 °F)
- invalid configuration trip (conflicting configuration)
- detected improper logic function action (for example, attempting to write to a read-only parameter)

Controller Internal Temperature

Description

The LTM R controller monitors its Controller Internal Temperature, and reports alarm, minor trip, and major trip conditions. Trip detection cannot be disabled. Alarm detection can be enabled or disabled.

The controller retains a record of the highest attained internal temperature.

Characteristics

The Controller Internal Temperature measured values have the following characteristics:

Characteristic	Value
Unit	°C
Accuracy	+/- 4 °C (+/- 7.2 °F)
Resolution	1 °C (1.8 °F)
Refresh interval	100 ms

Parameters

The Controller Internal Temperature function includes one editable parameter:

Parameter	Setting Range	Factory Setting
Controller internal temperature alarm enable	• Enable • Disable	Enable

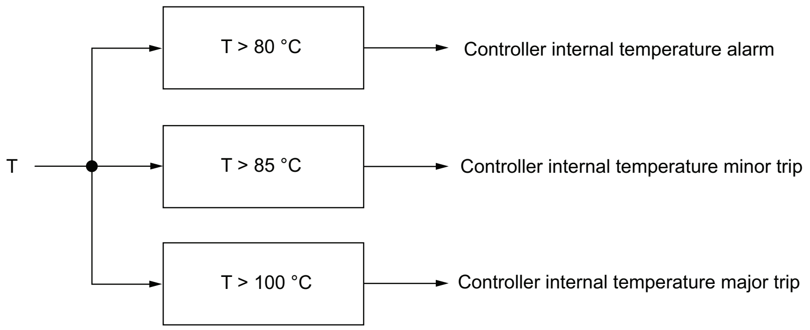
The Controller Internal Temperature function includes the following fixed alarm and trip thresholds:

Condition	Fixed Threshold Value	Sets Parameter
Internal temperature alarm	80 °C (176 °F)	Controller Internal Temperature Alarm
Internal temperature minor trip	85 °C (185 °F)	Controller Internal Trip
Internal temperature major trip	100 °C (212 °F)	

A alarm condition ceases when LTM R Controller Internal Temperature falls below 80 °C (176 °F).

Block Diagram

Controller internal temperature alarm and trip:



T Temperature

T > 80 °C (176 °F) Fixed alarm threshold

T > 85 °C (185 °F) Fixed minor trip threshold

T > 100 °C (212 °F) Fixed major trip threshold

Maximum Internal Controller Temperature

The Controller Internal Temperature Max parameter contains the highest internal temperature, expressed in °C, detected by the LTM R controller's internal temperature sensor. The LTM R controller updates this value whenever it detects an internal temperature greater than the current value.

The maximum internal temperature value is not cleared when factory settings are restored using the Clear All Command, or when statistics are reset using a Clear Statistics Command.

Control Command Detected Error Diagnostic

Description

The LTM R controller performs diagnostic tests that detect and monitor the proper functionality of control commands.

There are 4 control command diagnostic functions:

- Start Command Check
- Run Check Back
- Stop Command Check
- Stop Check Back

Parameter Settings

All 4 diagnostic functions are enabled and disabled as a group. The configurable parameter settings are:

Parameters	Setting Range	Factory Setting
Diagnostic Trip Enable	Yes/No	Yes
Diagnostic Alarm Enable	Yes/No	Yes

Start Command Check

The Start Command Check begins after a Start command, and causes the LTM R controller to monitor the main circuit to verify that current is flowing.

- The Start Command Check reports a Start Command trip or alarm if current is not detected after a delay of 1 second.
- The Start Command Check conditions ends if the motor is in Run state and the LTM R controller detects that the current is equal or more than 10% of FLCmin.

Run Check Back

The Run Check Back causes the LTM R controller to continuously monitor the main circuit to verify current is flowing.

- The Run Check Back reports a trip or alarm if average phase current is not detected for longer than 0.5 seconds without a Stop command.
- The Run Check Back ends when a Stop command executes.

Stop Command Check

The Stop Command Check begins after a Stop command, and causes the LTM R controller to monitor the main circuit and verify that no current is flowing.

- The Stop Command Check reports a trip or alarm if current is detected after a delay of 1 second.

- The Stop Command Check ends if the LTM R controller detects that the current is equal or less than 5% of FLCmin.

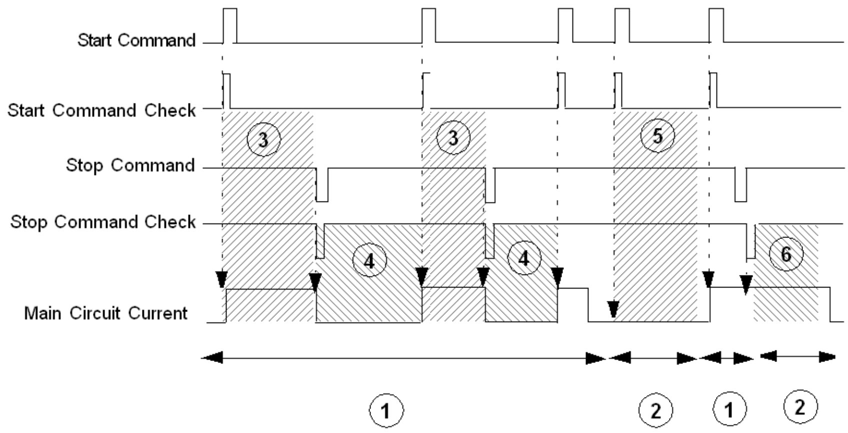
Stop Check Back

The Stop Check Back causes the LTM R controller to continuously monitor the main circuit to verify that no current is flowing.

- The Stop Check Back reports a Stop Check Back trip or alarm if average phase current is detected for longer than 0.5 seconds after a Stop command.
- The Stop Check Back condition ends when a Run command executes.

Timing Sequence

The following diagram is an example of the timing sequence for the Start Command Check and Stop Command Check:



1 Normal operation

2 Trip or alarm condition

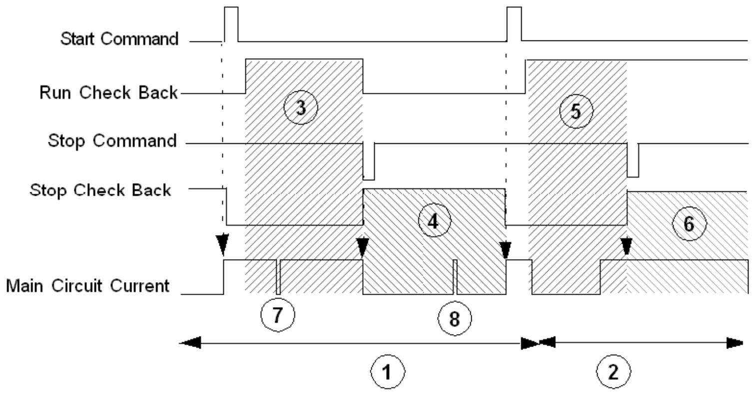
3 The LTM R controller monitors the main circuit to detect current

4 The LTM R controller monitors the main circuit to detect no current

5 The LTM R controller reports a Start Command Check trip and/or alarm if current is not detected after 1 second

6 The LTM R controller reports a Stop Command Check trip and or alarm if current is detected after 1 second

The following diagram is an example of the timing sequence for the Run Check Back and Stop Check Back:



1 Normal operation

2 Trip or alarm condition

3 After the motor enters the run state, the LTM R controller continuously monitors the main circuit to detect current until a Stop command is given or the function is disabled

4 The LTM R controller continuously monitors the main circuit to detect no current until a Start command is given or the function is disabled

5 The LTM R controller reports a Run Check Back trip and/or alarm if the current is not detected for longer than 0.5 seconds without a Stop command

6 The LTM R controller reports a Stop Check Back trip or alarm if the current is detected for longer than 0.5 seconds without a Start command

7 No current flowing for less than 0.5 seconds

8 Current flowing for less than 0.5 seconds

Wiring Trips

Description

The LTM R controller checks external wiring connections and reports a trip when it detects incorrect or conflicting external wiring. The LTM R controller can detect 4 wiring trips:

- CT Reversal Trip
- Phase Configuration Trip
- Motor Temperature Sensor Wiring Trips (short-circuit or open-circuit)

Enabling Trip Detection

Wiring diagnostics are enabled using the following parameters:

Protection	Enabling Parameters	Setting Range	Factory Setting
CT Reversal	Wiring Trip Enable	• Yes • No	Yes
Phase Configuration	Motor Phases, if set to single-phase	• Single-phase • three phase	three phase
Motor Temperature Sensor Wiring	Motor Temperature Sensor Type, if set to a sensor type, and not to **None**	• None • PTC binary • PT100 • PTC analog • NTC analog	None

CT Reversal Trip

When individual external load CTs are used, they must all be installed in the same direction. The LTM R controller checks the CT wiring and reports a trip if it detects one of the current transformers is wired backwards when compared to the others.

This function can be enabled and disabled.

Phase Configuration Trip

The LTM R controller checks all 3 motor phases for On Level current, then checks the Motor Phases parameter setting. The LTM R controller reports a trip if it detects current in phase 2 if the LTM R controller is configured for single-phase operation.

This function is enabled when the LTM R controller is configured for single-phase operation. It has no configurable parameters.

Motor Temperature Sensor Trips

When the LTM R controller is configured for motor temperature sensor protection, the LTM R controller provides short-circuit and open-circuit detection for the temperature sensing element.

The LTM R controller signals a trip when calculated resistance at the T1 and T2 terminals:

- falls below the fixed short-circuit detection threshold, or
- exceeds the fixed open-circuit detection threshold.

The trip must be reset according to the configured Reset Mode: manual, automatic, or remote.

Short-circuit and open-circuit detection thresholds have no trip time delay. There are no alarms associated with the short-circuit and the open-circuit detection.

Short-circuit and open-circuit detection of the motor temperature sensing element is available for all operating states.

This protection is enabled when a temperature sensor is employed and configured, and cannot be disabled.

The motor temperature sensor function has the following characteristics:

Characteristic	Value
Unit	Ω
Normal operating range	15…6500 W
Accuracy	at 15 Ω: +/- 10 % at 6500 Ω: +/- 5 %

Characteristic	Value
Resolution	0.1 Ω
Refresh interval	100 ms

The fixed thresholds for the open-circuit and short-circuit detection functions are:

Detection Function		Fixed Results For PTC Binary, or PT100, or PTC/NTC Analog	Accuracy
Short-circuit detection	threshold	15 Ω	+/– 10 %
	re-closing	20 Ω	+/– 10 %
Open-circuit detection	threshold	6500 Ω	+/– 5 %
	re-closing	6000 Ω	+/– 5 %

Configuration Checksum

Description

The LTM R controller calculates a checksum of parameters based on all configuration registers. The EEPROM trip code (64) is reported.

Communication Loss

Description

The LTM R controller monitors communication through:

- the network port
- the HMI port

Network Port Parameter Settings

The LTM R controller monitors network communication creates both a trip and a alarm report when the network communications are lost.

On LTM R Version...	The communication loss...
• LTMR••C•• • LTMR••D•• • LTMR••P••	Is detected as part of the protocol management, without specific adjustable parameters.
• LTMR••M••	Is detected if no communication exchanges occurred for a time period equal to, or longer than, the network port comm loss timeout.
• LTMR••E••	Is detected if no communication exchanges occurred with the Primary IP for a time period equal to, or longer than, the network port communication loss timeout.

The network port communications have the following configurable settings:

Parameter	Setting Range	Factory Setting
Network port trip enable	Enable/Disable	Enable
Network port alarm enable	Enable/Disable	Enable
Network port comm loss timeout (Modbus, EtherNet/IP and Modbus/TCP only)	0...99.99 s In increments of 0.01 s	2 s

Parameter	Setting Range	Factory Setting
Network port fallback setting(1)	• Hold • Run • O.1, O.2 off • O.1, O.2 on • O.1 off • O.2 off	O.1, O.2 off
Primary IP address (EtherNet/IP and Modbus/TCP only)	0.0.0.0 to 255.255.255.255	0.0.0.0
(1) The operating mode affects the configurable parameters for the network port fallback settings.		

HMI Port Parameter Settings

The LTM R controller monitors HMI port communications and reports both a alarm and a trip if no valid communication has been received by the HMI port for longer than 7 seconds.

The HMI port communication has the following fixed and configurable settings:

Parameter	Setting Range	Factory Setting
HMI port trip enable	Enable/Disable	Enable
HMI port alarm enable	Enable/Disable	Enable
HMI port fallback setting(1)	• Hold • Run • O.1, O.2 off • O.1, O.2 on • O.1 off • O.2 off	O.1, O.2 off
(1) The operating mode affects the configurable parameters for the HMI port fallback settings.		

Fallback Condition

When the communication between the LTM R controller and either the network or the HMI is lost, the LTM R controller is in a fallback condition. When the communication recovers, the fallback condition is no longer applied by the LTM R controller.

The behavior of logic outputs O.1 and O.2 when the LTM R controller is in fallback condition is determined by:

- The operating mode (see Operating Modes, page 147).
- The Network Port Fallback Setting and HMI Port Fallback Setting parameters.

Fallback setting selection can include:

Port Fallback Setting	Description
Hold (O.1, O.2)	Directs the LTM R controller to hold the state of logic outputs O.1 and O.2 as of the time of the communication loss.
Run	Directs the LTM R controller to perform a Run command for a 2-step control sequence on the communication loss.
O.1, O.2 Off	Directs the LTM R controller to turn off both logic outputs O.1 and O.2 following a communication loss.
O.1, O.2 On	Directs the LTM R controller to turn on both logic outputs O.1 and O.2 following a communication loss.
O.1 On	Directs the LTM R controller to turn on only logic output O.1 following a communication loss.
O.2 On	Directs the LTM R controller to turn on only logic output O.2 following a communication loss.

The following table indicates which fallback options are available for each operating mode:

Port Fallback Setting	Operating Mode					
	Overload	Independent	Reverser	2-step	2-speed	Custom
Hold (O.1, O.2)	Yes	Yes	Yes	Yes	Yes	Yes
Run	No	No	No	Yes	No	No
O.1, O.2 Off	Yes	Yes	Yes	Yes	Yes	Yes
O.1, O.2 On	Yes	Yes	No	No	No	Yes
O.1 On	Yes	Yes	Yes	No	Yes	Yes
O.2 On	Yes	Yes	Yes	No	Yes	Yes

NOTE: When you select a network or HMI fallback setting, your selection must identify an active control source.

Time to Trip

Description

When a thermal overload condition exists, the LTM R controller reports the time to trip before the trip occurs in the Time To Trip parameter.

When the LTM R controller is not in a thermal overload condition, to avoid the appearance of being in a trip state, the LTM R controller reports the time to trip as 9999.

If the motor has an auxiliary fan and the Motor Aux Fan Cooled parameter has been set, the cooling period is 4 times shorter.

Characteristics

The time to trip function has the following characteristics:

Characteristic	Value
Unit	s
Accuracy	+/– 10 %
Resolution	1 s
Refresh interval	100 ms

LTM R Configuration Trip

Description

The LTM R controller checks the Load CT parameters set in configuration mode.

An LTM R configuration trip is detected when the Load CT Primary, Load CT Secondary, and Load CT Multiple Passes parameters are not consistent, and generates a System and Device Monitoring Trip. The trip condition is cleared once the parameters are correct. The LTM R controller remains in configuration mode as long as the parameters are not consistent.

LTM E Configuration Trip and Alarm

Description

The LTM R controller checks the presence of the LTM E expansion module. Its absence generates a System and Device Monitoring Trip.

LTM E Configuration Trip

LTM E configuration trip:

- If LTM E based protection trips are enabled but no LTM E expansion module is present, this will cause an LTM E configuration trip.
- It does not have any delay setting.
- The trip condition clears when no protection trip requiring an LTM E is enabled, or when the LTM R has been power-cycled with an appropriate LTM E being present.

LTM E Configuration Alarm

LTM E configuration alarm:

- If LTM E based protection alarms are enabled but no LTM E expansion module is present, this will cause an LTM E configuration alarm.
- The alarm clears when no protection alarm requiring an LTM E is enabled, or when the LTM R has been power-cycled with an appropriate LTM E being present.

External Trip

Description

The LTM R controller has an external trip feature, which detects if an error happened on an external system linked to it.

An external trip is triggered by setting a bit in the custom logic command register 1 (see table below). This external trip sets the controller into a trip state based on different parameters in the system.

An external trip can be reset only by clearing the external trip bit in the register.

External Trip Parameter Settings

Parameter	Description
Custom logic external trip command	The value is written
External system trip	Reads Custom logic external trip command parameter
Trip code	Number is 16: External trip set by program customized with custom logic editor

Trip and Alarm Counters

Overview

The LTM R controller counts and records the number of trips and alarms that occur. In addition, it counts the number of auto-reset attempts. This information can be accessed to assist with system performance and maintenance.

Trip and alarm counters can be accessed via:

- a PC running SoMove with the TeSys T DTM
- an HMI device
- a PLC via the network port

Introducing Trip and Alarm Counters

Detecting Alarms

If a alarm detection function is enabled, the LTM R controller detects a alarm immediately when the monitored value rises above, or falls below, a threshold setting.

Detecting Trips

Before the LTM R controller detects a trip, certain preconditions must exist. These conditions can include

- the trip detecting function must be enabled,
- a monitored value (for example, current, voltage, or thermal resistance) must rise above, or fall below, a threshold setting,
- the monitored value must remain above or below the threshold setting for a specified time duration.

Counters

When a trip occurs, the LTM R controller increments at least 2 counters:

- a counter for the specific trip detecting function, and
- a counter for all trips.

When a alarm occurs, the LTM R controller increments a single counter for all alarms. However, when the LTM R controller detects a thermal overload alarm, it also increments the thermal overload alarms counter.

A counter contains a value from 0 to 65,535 and increments by a value of 1 when a trip, alarm, or reset event occurs. A counter stops incrementing when it reaches a value of 65,535.

When a trip is automatically reset, the LTM R controller increments only the auto-resets counter. Counters are saved on power loss.

Clearing Counters

All trip and alarm counters are reset to 0 by executing the Clear Statistics Command or Clear All Command.

All Trips Counter

Description

The Trips Count parameter contains the number of trips that have occurred since the Clear All Statistics Command last executed.

The Trips Count parameter increments by a value of 1 when the LTM R controller detects any trip.

All Alarms Counter

Description

The Alarms Count parameter contains the number of alarms that have occurred since the Clear All Statistics Command last executed.

The Alarms Count parameter increments by a value of 1 when the LTM R controller detects any alarm.

Auto-Reset Counter

Description

The Auto-Reset Count parameter contains the number of times the LTM R controller attempted, but unsuccessful, to auto-reset a trip. This parameter is used for the 3 auto-reset trip groups.

If an auto-reset attempt is successful (defined as the same trip not recurring within 60 s), this counter is reset to zero. If a trip is reset either manually or remotely, the counter is not incremented.

For information on trip management, see Trip Management and Clear Commands, page 169.

Protection Trips and Alarms Counters

Protection Trip Counts

Protection trip counters include:

- Current Phase Imbalance Trips Count
- Current Phase Loss Trips Count
- Current Phase Reversal Trips Count
- Ground Current Trips Count
- Jam Trips Count
- Long Start Trips Count
- Motor Temp Sensor Trips Count
- Over Power Factor Trips Count
- Overcurrent Trips Count
- Overpower Trips Count
- Overvoltage Trips Count
- Thermal Overload Trips Count
- Under Power Factor Trips Count

- Undercurrent Trips Count
- Underpower Trips Count
- Undervoltage Trips Count
- Voltage Phase Imbalance Trips Count
- Voltage Phase Loss Trips Count
- Voltage Phase Reversal Trips Count

Protection Alarm Counts

The Thermal Overload Alarms Count parameter contains the total number of alarms for the thermal overload protection function.

When any alarm occurs, including a thermal overload alarm, the LTM R controller increments the Alarms Count parameter.

Control Command Detected Errors Counter

Description

A Diagnostic Trip occurs when the LTM R controller detects any of the following control command errors:

- Start Command Check detected errors
- Stop Command Check detected errors
- Stop Check Back detected errors
- Run Check Back detected errors

For information on these control command functions, see Control Command Detected Error Diagnostic , page 59.

Wiring Trips Counter

Description

The Wiring Trips Count parameter contains the total number of the following wiring trips that have occurred since the Clear Statistics Command last executed:

- Wiring Trip, which is triggered by a:
  - CT Reversal Trip
  - Phase Configuration Trip
  - Motor Temperature Sensor Wiring Trip
- Voltage Phase Reversal Trip
- Current Phase Reversal Trip

The LTM R controller increments the Wiring Trips Count parameter by a value of 1 each time any one of the above 3 trips occurs. For information on connection errors and related trips, see Wiring Trips, page 61.

Communication Loss Counters

Description

Trips detected for the following communication functions:

Counter	Contains
HMI Port Trips Count	The number of times communications via the HMI port was lost.
Network Port Internal Trips Count	The number of internal trips experienced by the network module, reported by the network module to the LTM R controller.
Network Port Config Trips Count	The number of major trips experienced by the network module, exclusive of network module internal trips, reported by the network module to the LTM R controller.
Network Port Trips Count	The number of times communications via the network port was lost.

Internal Trip Counters

Description

Trips detected for the following internal trips:

Counter	Contains
Controller Internal Trips Count	The number of major and minor internal trips. For information on internal trips, see Controller Internal Trip, page 57.
Internal Port Trips Count	The number of LTM R controller internal communication trips, plus the number of unsuccessful attempts to identify the network communication module.

Trip History

Trip History

The LTM R controller stores a history of LTM R controller data that was recorded at the time of the last 5 detected trips. Trip n-0 contains the most recent trip record, and trip n-4 contains the oldest retained trip record.

Each trip record includes:

- Trip Code
- Date and Time
- Value of Settings
  - Motor Full Load Current Ratio (% of FLCmax)
- Value of Measurements
  - Thermal Capacity Level
  - Average Current Ratio
  - L1, L2, L3 Current Ratio
  - Ground Current Ratio
  - Full Load Current Max
  - Current Phase Imbalance
  - Voltage Phase Imbalance
  - Power Factor
  - Frequency
  - Motor Temp Sensor
  - Average Voltage
  - L3-L1 Voltage, L1-L2 Voltage, L2-L3 Voltage
  - Active Power

Motor History

Overview

The LTM R controller tracks and saves motor operating statistics.

Motor statistics can be accessed using:

- a PC running SoMove with the TeSys T DTM
- an HMI device
- a PLC via the network port.

Motor Starts Counters

Description

The LTM R controller tracks motor starts and records the data as a statistic that can be retrieved for operational analysis. The following statistics are tracked:

- Motor Starts Count
- Motor LO1 Closings Count (logic output O.1 starts)
- Motor LO2 Closings Count (logic output O.2 starts)

The Clear Statistics Command resets the Motor Starts Count parameter to 0.

NOTE: The Motor LO1 Closings Count and Motor LO2 Closings Count parameters cannot be reset to 0, because these parameters together indicate the usage of the relay outputs over time.

Motor Starts Per Hour Counter

Description

The LTM R controller tracks the number of motor starts during the past hour and records this figure in the Motor Starts Per Hour Count parameter.

The LTM R controller sums start in 5 minute intervals with an accuracy of 1 interval (+0/– 5 minutes), which means that the parameter will contain the total number of starts within either the previous 60 minutes or the previous 55 minutes.

This function is used as a maintenance function to avoid thermal strain on the motor.

Characteristics

The motor starts per hour function has the following characteristics:

Characteristic	Value
Accuracy	5 minutes (+ 0/– 5 minutes)
Resolution	5 minutes
Refresh interval	100 ms

Load Sheddings Counter

Description

The Load Sheddings Count parameter contains the number of times the load sheddings protection function has been activated since the last Clear Statistics Command.

For information on the Load Sheddings protection function, see Load Shedding, page 123.

Auto Restart Counters

Description

There are 3 types of counting statistics:

- Auto restart immediate count
- Auto restart delayed count
- Auto restart manual count

For information on the Auto restart protection function, see Automatic Restart, page 125.

Motor Last Start Current Ratio

Description

The LTM R controller measures the maximum current level reached during the last start of the motor and reports the value in the Motor Last Start Current Ratio parameter for analysis of the system for maintenance purposes.

This value may also be used to help configure the long start threshold setting in the long start protection function.

The value is not stored in the non-volatile memory: it is lost at a power cycle.

Characteristics

The motor last start current ratio function has the following characteristics:

Characteristic	Value
Unit	% of FLC
Accuracy	• +/- 1 % for 8 A and 27 A models • +/- 2 % for 100 A models
Resolution	1 % FLC
Refresh interval	100 ms

Motor Last Start Duration

Description

The LTM R controller tracks the duration of the last motor start and reports the value in the Motor Last Start Duration parameter for analysis of the system for maintenance purposes.

This value may also be useful in setting the long start delay timeout used in the long start and definite trip overload protection functions.

The value is not stored in the non-volatile memory: it is lost at a power cycle.

Characteristics

The motor last start duration function has the following characteristics:

Characteristic	Value
Unit	s
Accuracy	+/– 1 %
Resolution	1 s
Refresh interval	1 s

Operating Time

Description

The LTM R controller tracks motor operating time and records the value in the Operating Time parameter. Use this information to help schedule motor maintenance, such as lubrication, inspection, and replacement.

System Operating Status

Overview

The LTM R controller monitors the motor operating state and the minimum time to wait to restart the motor.

The Motor states can be accessed via:

- a PC running SoMove with the TeSys T DTM
- an HMI device
- a PLC via the network port

Motor State

Description

The LTM R controller tracks the motor state and reports the following states by setting the corresponding boolean parameters:

Motor state	Parameter
Run	Motor Running
Ready	System Ready
Start	Motor Starting

Minimum Wait Time

Description

The LTM R controller tracks the time remaining to restart the motor according to one of the following events:

- automatic reset, page 173
- thermal overload, page 78
- rapid cycle lockout, page 93
- load shedding, page 123
- automatic restart, page 125
- transition time.

If more than one timer is active, the parameter displays the maximum timer, which is the minimum wait for the trip response or the control function to reset.

NOTE: Even with an LTM R powered off, time is tracked down for at least 30 mn.

Characteristics

The Minimum Wait Time function has the following characteristics:

Characteristic	Value
Unit	s
Accuracy	+/– 1 %
Resolution	1 s
Refresh interval	1 s

Motor Protection Functions

Overview

This chapter describes the motor protection functions provided by the LTM R controller.

Motor Protection Functions Introduction

Overview

This section introduces you to the motor protection functions provided by the LTM R controller, including protection parameters and characteristics.

Definitions

Defined Functions and Data

The LTM R controller monitors current, ground-current and motor temperature sensor parameters. When the LTM R controller is connected to an expansion module, it also monitors voltage and power parameters. The LTM R controller uses these parameters in protection functions to detect trip and alarm conditions. The LTM R controller's response to trip and alarm conditions is fixed for the predefined operating modes. Logic output O.4 activates on a trip, and logic output O.3 activates on a alarm. For more information about predefined operating modes, see Operating Modes, page 147.

You can configure these motor protection functions to detect the existence of undesirable operating conditions that, if not resolved, can cause motor and equipment damage.

All motor protection functions include trip detection, and most protection functions also include alarm detection.

Customized Functions and Data

In addition to using the protection functions and parameters included in a predefined operating mode, you can use the Custom Logic Editor in the TeSys T DTM to create a new, customized operating mode. To create a custom operating mode, select any predefined operating mode, then edit its code to meet the needs of your application.

Using the Custom Logic Editor, you can create a customized operating mode by:

- modifying the LTM R controller's responses to protection trips or alarms
- adding new functions, based on either predefined or newly created parameters

Trips

A trip is a serious undesirable operating condition. Trip-related parameters can be configured for most protection functions.

The response of the LTM R controller to a trip include the following:

- output O.4 contacts:
  - contact 95-96 is open
  - contact 97-98 is closed
- trip status bits are set in a trip parameter
- a text message is displayed in an HMI screen (if an HMI is attached)
- a trip status indicator is displayed in the TeSys T DTM, if connected

The LTM R controller counts and records the number of trips for each protection function.

After a trip has occurred, merely resolving the underlying condition does not clear the trip. To clear the trip, the LTM R controller must be reset. See Trip Management - Introduction, page 169.

Alarms

A alarm is a less-serious, though still undesirable, operating condition. A alarm indicates corrective action may be required to help prevent a problem condition from occurring. If left unresolved, a alarm may lead to a trip condition. Alarm-related parameters can be configured for most protection functions.

The response of the LTM R controller to a alarm include the following:

- output O.3 is closed
- alarm status bits are set in a alarm parameter
- a text message is displayed in an HMI screen (if attached)
- a alarm status indicator is displayed in the TeSys T DTM

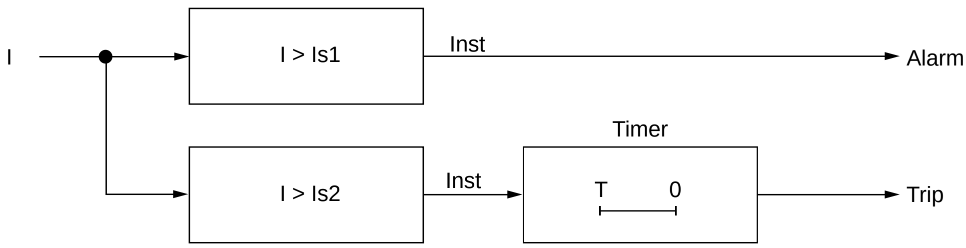
  NOTE: For some protection functions, alarm detection shares the same threshold as trip detection. For other protection functions, alarm detection has a separate alarm threshold.

The LTM R controller clears the alarm whenever the measured value no longer exceeds the alarm threshold—plus or minus a 5 % hysteresis band.

Motor Protection Characteristics

Operation

The following diagram describes the operation of a typical motor protection function. This diagram, and the following diagrams, are expressed in terms of current. However, the same principles apply to voltage.



I Measurement of the monitored parameter

Is1 Alarm threshold setting

Is2 Trip threshold setting

T Trip timeout setting

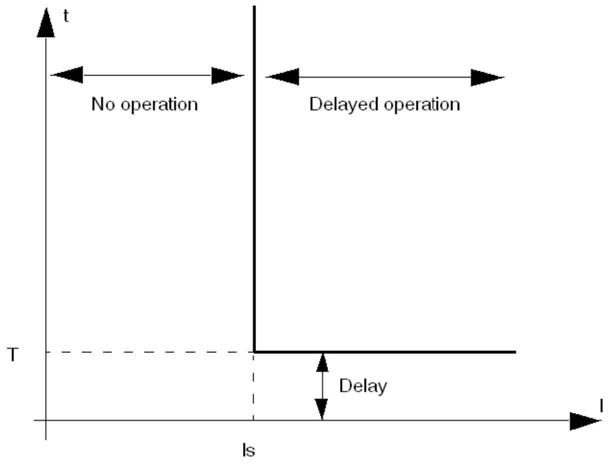
Inst Instantaneous alarm/trip detection

Settings

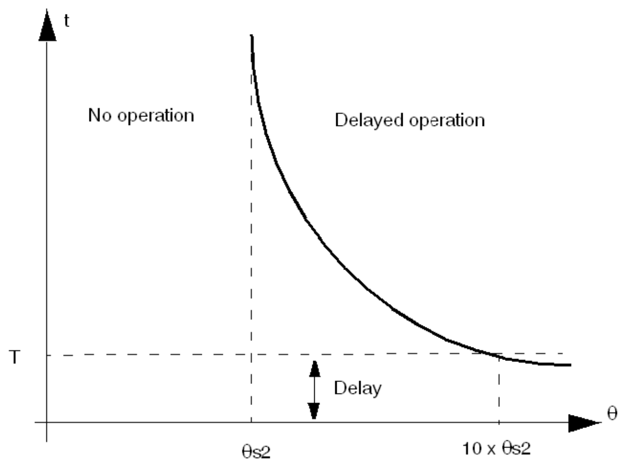
Some protection functions include configurable settings, including:

- Trip threshold: A limit setting for the monitored parameter that triggers a protection function trip.
- Alarm threshold: A limit setting for the monitored parameter that triggers a protection function alarm.
- Trip timeout: A time delay that must expire before the protection function trip is triggered. The behavior of a timeout depends on its trip current characteristic profile.
- Trip curve characteristic (TCC): The LTM R controller includes a definite trip characteristic for all protection functions, except the Thermal Overload Inverse Thermal protection function, which has both an inverse trip and definite trip curve characteristic, as described below.

Definite TCC: The duration of the trip timeout remains a constant regardless of changes in the value of the measured quantity (current), as described in the following diagram:



Inverse TCC: The duration of the time delay varies inversely with the value of the measured quantity (here, thermal capacity). As the measured quantity increases, the potential for harm also increases, thereby causing the duration of the time delay to decrease, as described in the following diagram:

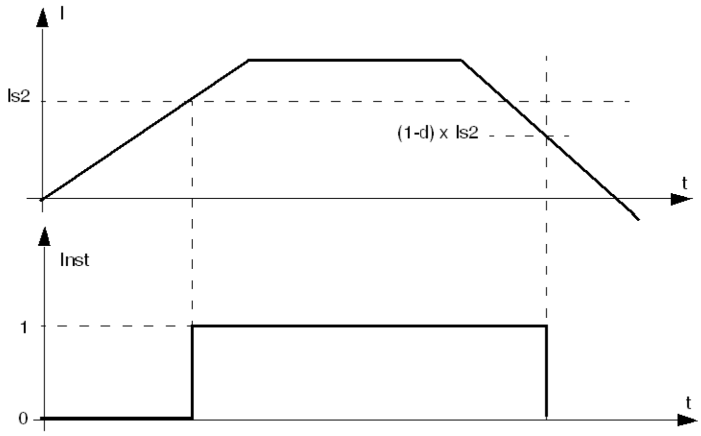


Hysteresis

To improve stability, motor protection functions apply a hysteresis value that is added to or subtracted from limit threshold settings before a trip or alarm response is reset. The hysteresis value is calculated as a percentage, typically 5%, of the limit threshold and is

- subtracted from the threshold value for upper limit thresholds,
- added to the threshold value for lower limit thresholds.

The following diagram describes the logic result of measurement processing (Inst) when hysteresis is applied to an upper limit threshold:



d Hysteresis percentage

Thermal Motor Protection Functions

Overview

This section describes the thermal motor protection functions of the LTM R controller.

Thermal Overload

Overview

The LTM R controller can be configured to provide thermal protection, by selecting one of the following settings:

- Inverse Thermal, page 79 (factory setting)
- Definite Time, page 83

Each setting represents a Trip Curve Characteristic. The LTM R controller stores the selected setting in its Thermal Overload Mode parameter. Only one setting can be activated at a time. See the topics that immediately follow, for information on the operation and configuration of each setting.

Parameter Settings

The Thermal Overload function has the following configurable parameter settings, which apply to every trip current characteristic:

Parameters	Setting Range	Factory Setting
Mode	• Inverse thermal • Definite time	Inverse thermal
Trip enable	Enable/Disable	Enable
Alarm enable	Enable/Disable	Enable
Motor auxiliary fan cooled	Enable/Disable	Disable

Thermal Overload - Inverse Thermal

Description

When you set the Thermal Overload Mode parameter to **Inverse Thermal** and select a motor trip class, the LTM R controller monitors the motor's utilized thermal capacity and signals

- a alarm when utilized thermal capacity exceeds a configured alarm threshold,
- a trip when utilized thermal capacity is greater than 100 %.

⚠ CAUTION

RISK OF MOTOR OVERHEATING

The Motor Trip Class parameter must be set to the thermal heating characteristics of the motor. Refer to the motor manufacturer's instructions before setting this parameter.

Failure to follow these instructions can result in injury or equipment damage.

There is no time delay for the thermal overload alarm.

The LTM R controller calculates the Thermal Capacity Level in all operating states. When power to the LTM R controller is lost, the LTM R controller retains the last measurements of the motor's thermal state for a period of 30 minutes, allowing it to estimate the motor's thermal state when power is re-applied.

Trip and alarm monitoring can be separately enabled and disabled.

- The thermal overload alarm is cleared by the LTM R controller when the utilized thermal capacity falls 5 % below the alarm threshold.
- The thermal overload trip can be reset by the user when the utilized thermal capacity falls below the trip reset threshold and after the trip reset timeout is elapsed.

Reset for Emergency Restart

You can use the Clear Thermal Capacity Level Command, issued from the PLC or an HMI, to re-start an overloaded motor in an emergency situation. This command resets the thermal capacity utilization value to 0 and bypasses the cooling period required by the thermal model before the motor can be restarted.

This command also resets the Rapid Cycle Lockout Timeout to allow an immediate restart without lock.

The Clear All Command does not perform a Clear Thermal Capacity Level.

⚠ WARNING

LOSS OF MOTOR PROTECTION

Clearing the thermal capacity level inhibits thermal protection and can cause equipment overheating and fire. Continued operation with inhibited thermal protection should be limited to applications where immediate restart is vital.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

The Clear Thermal Capacity Level Command will not reset the trip response. Instead

- Only an action external to the LTM R controller (for example, a reduction in the motor load) can clear the trip condition,

- Only a reset command, from the valid reset means configured in the Trip Reset Mode parameter, will reset the trip response.

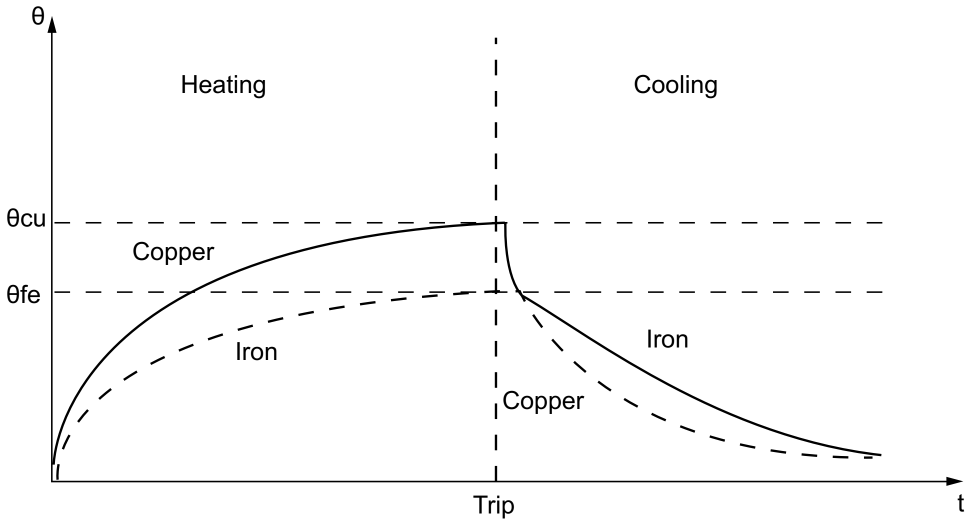
⚠ WARNING
UNINTENDED EQUIPMENT OPERATION
A reset command may re-start the motor if the LTM R controller is used in a 2-wire control circuit.
Equipment operation must conform to local and national safety regulations and codes.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

Operation

The thermal overload inverse thermal protection function is based on a thermal model of the motor that combines 2 thermal images:

- a copper-based image representing the thermal state of the stator and rotor windings, and
- an iron-based image representing the thermal state of the motor frame.

Using measured current and the input motor trip class setting, the LTM R controller considers only the highest thermal state, iron or copper, when calculating thermal capacity utilized by the motor, as described below:



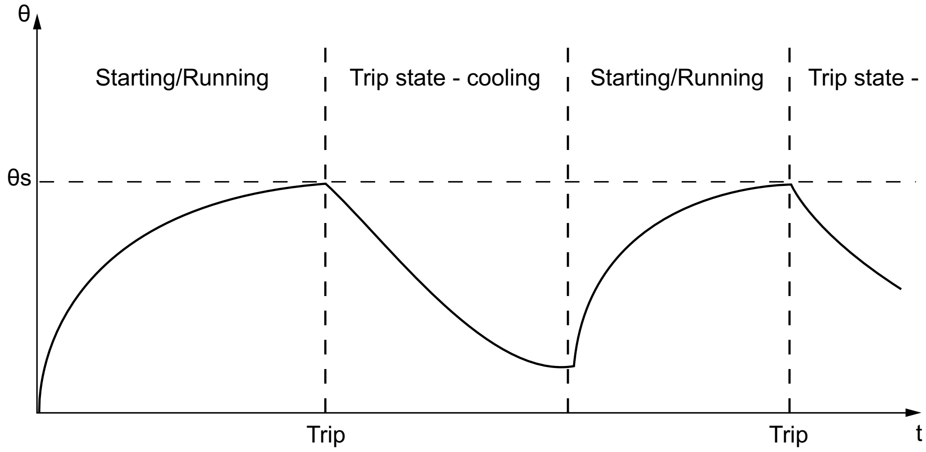
θ Thermal value

θfe Iron tripping threshold

θcu Copper tripping threshold

t Time

When inverse thermal trip mode is selected, the Thermal Capacity Level parameter, indicating utilized thermal capacity due to load current, is incremented during both start and run states. When the LTM R controller detects that the thermal capacity level (θ) exceeds the trip threshold (θ s), it triggers a thermal overload trip, as described below:



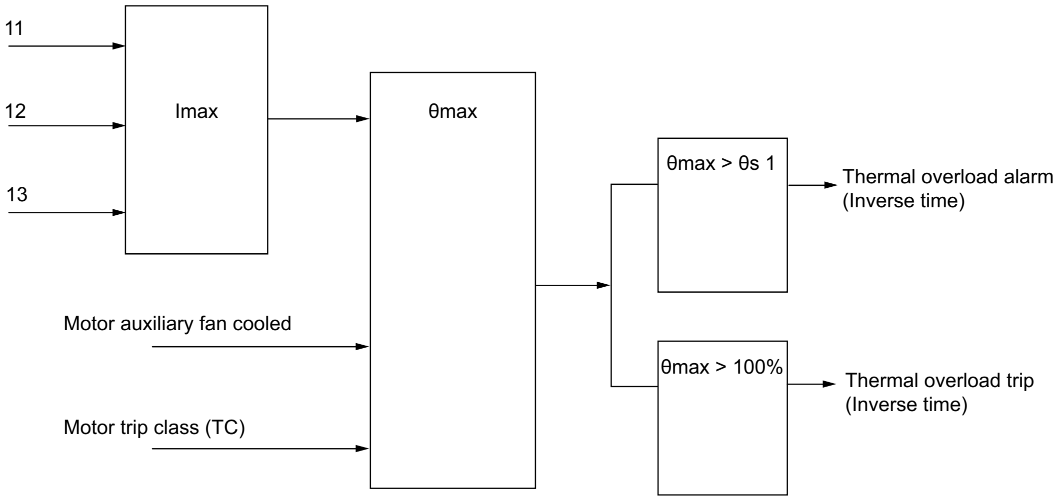
Functional Characteristics

The Thermal Overload inverse thermal functions include the following features:

- 1 motor trip class setting:
  - Motor Trip Class
- 4 configurable thresholds:
  - Motor Full Load Current Ratio (FLC1)
  - Motor High Speed Full Load Current Ratio (FLC2)
  - Thermal Overload Alarm Threshold
  - Thermal Overload Trip Reset Threshold
- 1 time delay:
  - Trip Reset Timeout
- 2 function outputs:
  - Thermal Overload Alarm
  - Thermal Overload Trip
- 2 counting statistics:
  - Thermal Overload Trips Count
  - Thermal Overload Alarms Count
- 1 setting for an external auxiliary motor cooling fan:
  - Motor Aux Fan Cooled
- 1 measure of utilized thermal capacity:
  - Thermal Capacity Level

NOTE: For LTM R controllers configured for 2-speed predefined operating mode, 2 trip thresholds are used: FLC1 and FLC2.

Block Diagram



Imax Maximum current

θmax Thermal capacity level

θs1 Thermal overload alarm threshold

Parameter Settings

The thermal overload inverse thermal functions have the following configurable parameter settings:

Parameters	Setting Range	Factory Setting
FLC1, FLC2	• 0.4...8.0 A in increments of 0.08 A for LTMR08 • 1.35...27.0 A in increments of 0.27 A for LTMR27 • 5...100 A in increments of 1 A for LTMR100	• 0.4 A for LTMR08 • 1.35 A for LTMR27 • 5 A for LTMR100
Alarm threshold	10...100 % of thermal capacity	85 % of thermal capacity
Motor trip class	5...30 in increments of 5	5
Trip reset timeout	50...999 in 1 s increments	120 s
Trip reset threshold	35...95 % of thermal capacity	75 % of thermal capacity

The thermal overload inverse thermal functions have the following non-configurable parameter settings:

Parameter	Fixed Setting
Thermal overload trip threshold	100 % of thermal capacity

Technical Characteristics

The thermal overload inverse thermal functions have the following characteristics:

Characteristics	Value
Hysteresis	–5 % of thermal overload alarm threshold
Trip time accuracy	+/– 0.1 s

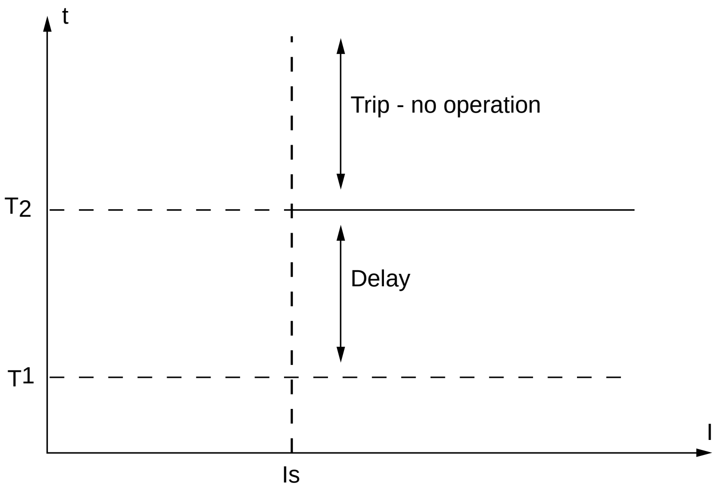
Thermal Overload - Definite Time

Description

When you set the Thermal Overload Mode parameter to **Definite Time**, the LTM R controller signals:

- a alarm when measured maximum phase current exceeds a configurable threshold (OC1 or OC2).
- a trip when the maximum phase current continuously exceeds the same threshold (OC1 or OC2) for a set time delay.

The thermal overload definite time trip includes a time delay of constant magnitude, following a start command, before the protection is active and a trip timeout duration, as described below:



Is Trip and alarm threshold (OC1 or OC2)

T1 Start command

T2 Elapsed time delay

There is no time delay for the thermal overload definite time alarm.

Trip and alarm monitoring can be separately enabled and disabled.

The definite time protection function is disabled following a start by a delay defined by the Long Start Trip Timeout setting. The LTM R controller, when configured for overload predefined operating mode, uses the change in state from off to on level current to begin the Start state. This delay allows the motor to draw current on startup required to overcome the inertia of the motor at rest.

> **NOTE:** Configuration of this protection function requires configuration of the Long Start protection function, including the Long Start Trip Timeout parameter.

Functional Characteristics

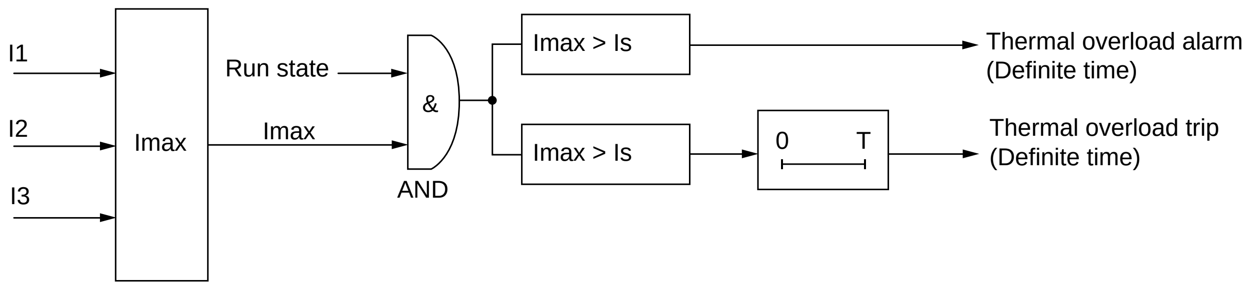
The thermal overload definite time function includes the following features:

- 2 configurable threshold settings; one setting (OC1) is used for single speed motors, both settings are required for 2-speed motors:
  - OC1(Motor Full Load Current Ratio) or
  - OC2 (Motor High Speed Full Load Current Ratio)
- 1 time delay:
  - Overcurrent Time (O-Time, set by the Thermal Overload Trip Definite Timeout parameter)

- 2 function outputs:
  - Thermal Overload Alarm
  - Thermal Overload Trip
- 2 counting statistics:
  - Thermal Overload Trips Count
  - Thermal Overload Alarms Count

Block Diagram

Thermal overload alarm and trip:



I1 Phase 1 current

I2 Phase 2 current

I3 Phase 3 current

Is Trip and alarm threshold (OC1 or OC2)

T Trip timeout

Parameter Settings

The definite time thermal overload function has the following configurable parameter settings:

Parameters	Setting Range	Factory Setting
Trip threshold: • Motor full load current ratio (OC1) - or - • Motor high speed full load current ratio (OC2)	5...100 % of FLCmax, in 1 % increments. Note: OC1 and OC2 settings can be set directly (in Amperes) in the **Settings** menu of an HMI, or in the **Parameters** tab of the TeSys T DTM.	5 % FLCmax
Thermal overload trip definite timeout (O-time or over-current time)	1...300 s in 1 s increments	10 s
Thermal overload alarm threshold	20...800 % of OC in 1 % increments	80 % of OC
Long start trip timeout(1) (D-time)	1...200 s in 1 s increments	10 s
(1) The definite time thermal overload function requires the simultaneous use of the Long start motor protection function, both of which employ the Long start trip timeout setting.		

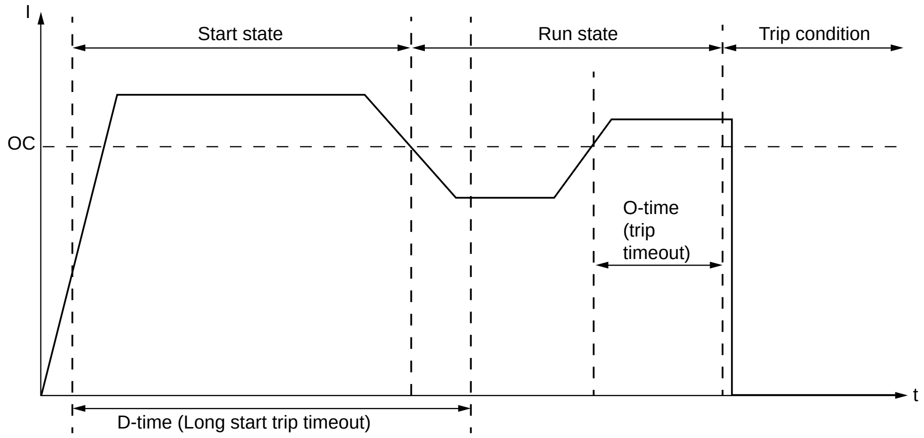
Technical Characteristics

The definite time thermal overload function has the following characteristics:

Characteristics	Value
Hysteresis	–5 % of alarm and trip thresholds
Trip time accuracy	+/– 0.1 s

Example

The following diagram describes a definite time thermal overload trip:



OC Trip threshold (OC1 or OC2)

Motor Temperature Sensor

Overview

The LTM R controller has 2 terminals—T1 and T2—that can be connected to a motor temperature sensing element to provide protection for motor windings by detecting high temperature conditions that could lead to damage or degradation.

These protections are activated when the Motor Temp Sensor Type parameter is set to one of the following settings:

- PTC Binary, page 86
- PT100, page 87
- PTC Analog, page 89
- NTC Analog, page 91

Only one of these motor protection sensing elements can be enabled at a time.

> **NOTE:** Motor temperature sensor protection is based in ohms. PTC Binary protection thresholds are pre-set to IEC standards and are non-configurable. PTC Analog and NTC Analog protection functions may require that you scale the resistance value to the corresponding threshold level in degrees, based on the properties of the selected sensing element.

When a sensor type is changed, the LTM R controller's motor temperature sensing configuration settings revert to their factory settings. If a sensor type is replaced with another sensor of the same type, the setting values are retained.

Parameter Settings

The motor temperature sensor function has the following configurable parameter settings, which apply to the selected motor temp sensor type:

Parameters	Setting Range	Factory Setting
Sensor type	• None • PTC Binary • PT100 • PTC Analog • NTC Analog	None
Trip enable	Enable/Disable	Disable
Alarm enable	Enable/Disable	Disable

Motor Temperature Sensor - PTC Binary

Description

The PTC Binary motor temperature sensing function is enabled when the Motor Temp Sensor Type parameter is set to **PTC Binary** and the LTM R controller is connected to a binary positive temperature coefficient thermistor embedded in the motor.

The LTM R controller monitors the state of the temperature sensing element and signals:

- a motor temperature sensor alarm when the measured resistance exceeds a fixed threshold.
- a motor temperature sensor trip when the measured resistance exceeds the same fixed threshold.

The trip and alarm conditions continue until measured resistance falls below a separate fixed motor temperature sensor re-closing threshold.

Motor temperature sensing trip thresholds are factory pre-set and are not configurable. Trip monitoring can be enabled or disabled.

The function is available for all operating states.

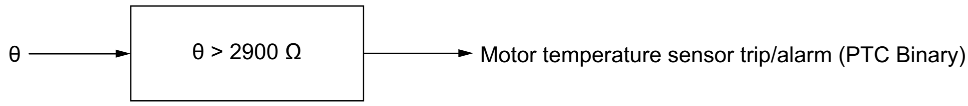
Functional Characteristics

The PTC Binary motor temperature sensor function includes the following features:

- 2 function output:
  - Motor Temp Sensor Alarm
  - Motor Temp Sensor Trip
- 1 counting statistic:
  - Motor Temp Sensor Trips Count

Block Diagram

Motor temperature sensor trip/alarm:



θ Temperature sensing element resistance

Parameter Settings

The PTC binary motor temperature sensor function has the following non-configurable parameter settings:

Parameter	Fixed settings	Accuracy
Trip/Alarm threshold	2900 Ω	+/– 2 %
Trip/Alarm re-closing threshold	1575 Ω	+/– 2 %

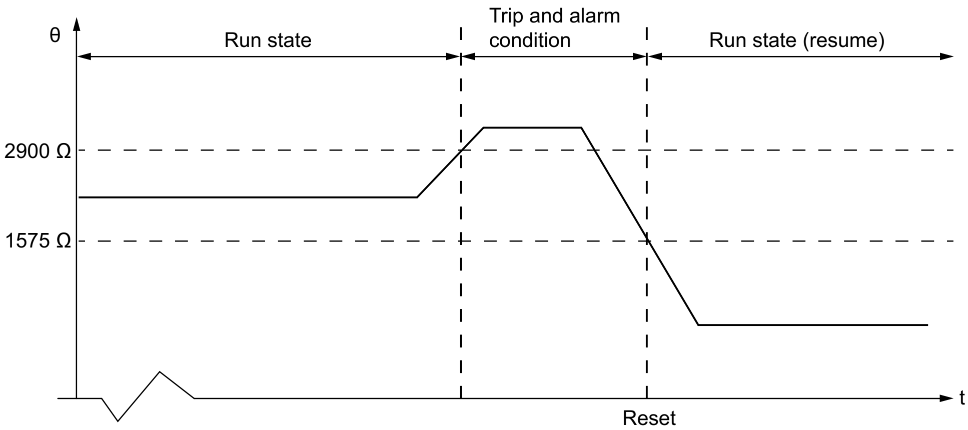
Technical Characteristics

The PTC binary motor temperature sensor function has the following characteristics:

Characteristic	Value
Detection time	0.5...0.6 s
Detection time accuracy	+/– 0.1 s

Example

The following diagram describes the occurrence of a PTC binary motor temp sensor trip with an automatic reset:



2900 Ω Trip threshold

1575 Ω Trip re-closing threshold

Reset This marks the time after which a reset can be executed. A start command is required before run state can be resumed. In this example, auto-reset has been enabled.

Motor Temperature Sensor - PT100

Description

The PT100 motor temperature sensing function is enabled when the Motor Temperature Sensor Type parameter is set to **PT100** and the LTM R controller is connected to a PT100 sensor embedded in the motor.

The LTM R controller monitors the state of the temperature sensing element and signals:

- a motor temperature sensor alarm when the measured temperature exceeds a configurable alarm threshold.

- a motor temperature sensor trip when the measured temperature exceeds a separately set trip threshold.

The LTM R directly measures the temperature with a PT100 sensor. The temperature measured by the PT100 sensor, either in °C (factory setting) or in °F, is displayed on the HMI or the TeSys T DTM, according to the Motor Temperature Sensor Display Degree CF parameter:

The trip or alarm condition continues until the measured temperature falls below 95 % of the trip or alarm threshold.

There is a fixed detection time of 0.5 s to 0.6 s to the motor temperature sensor trip or alarm.

Trip and alarm monitoring can be separately enabled and disabled.

The function is available for all operating states.

NOTE:

The temperature is derived from the following equation: **T = 2.6042 * R - 260.42**,

where **R** = resistance (Ω).

NOTE: To connect a 3-wire PT100 sensor to an LTM R controller, simply do not wire the compensation pin of the 3-wire PT100 sensor.

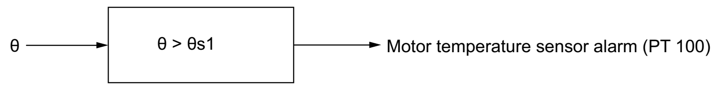
Functional Characteristics

The PT100 motor temperature sensor function includes the following features:

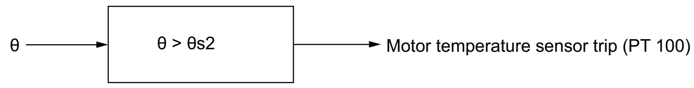
- 2 configurable thresholds:
  - Motor Temperature Sensor Alarm Threshold Degree
  - Motor Temperature Sensor Trip Threshold Degree
- 2 function outputs:
  - Motor Temperature Sensor Alarm
  - Motor Temperature Sensor Trip
- 1 counting statistic:
  - Motor Temperature Sensor Trips Count
- 1 display configuration:
  - Motor Temperature Sensor Display Degree CF

Block Diagram

Motor temperature sensor alarm:



Motor temperature sensor trip:



θ Temperature measured by the PT100 sensor

θs1 Motor temperature sensor alarm threshold

θs2 Motor temperature sensor trip threshold

Parameter Settings

The PT100 motor temperature sensor function has the following configurable parameter settings:

Parameters	Setting Range	Factory Setting
Trip threshold degree	0...200 °C in 1 °C increments	0 °C
Alarm threshold degree	0...200 °C in 1 °C increments	0 °C
Motor temperature sensor display degree CF	°C (0) °F (1)	°C

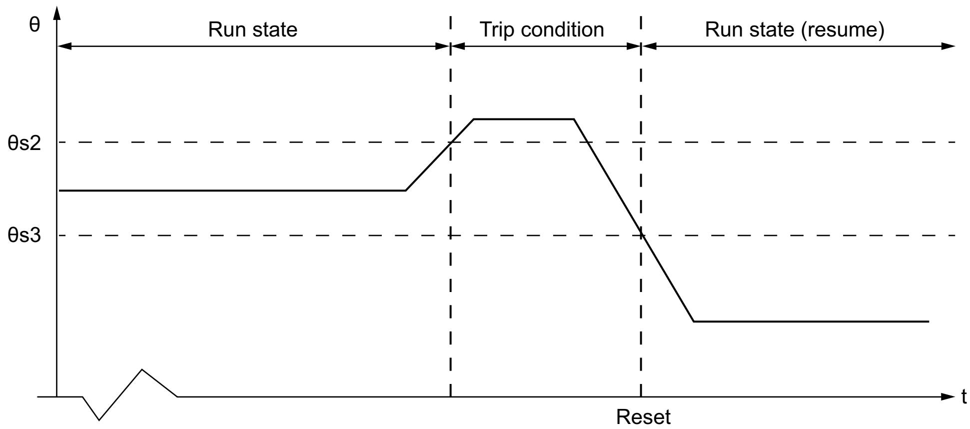
Technical Characteristics

The PT100 motor temperature sensor function has the following characteristics:

Characteristic	Value
Hysteresis	–5 % of Alarm threshold and Trip threshold
Detection time	0.5...0.6 s
Trip time accuracy	+/–0.1 s

Example

The following diagram describes a Motor temperature sensor PT100 trip with automatic reset and an active Run command:



θs2 Trip threshold

θs3 Trip re-closing threshold (95% of trip threshold)

Motor Temperature Sensor - PTC Analog

Description

The PTC Analog motor temperature sensing function is enabled when the Motor Temp Sensor Type parameter is set to **PTC Analog** and the LTM R controller is connected to an analog PTC thermistor embedded in the motor.

The LTM R controller monitors the state of the temperature sensing element and signals:

- a motor temperature sensor alarm when the measured resistance exceeds a configurable alarm threshold.

- a motor temperature sensor trip when the measured resistance exceeds a separately set trip threshold.

The trip or alarm condition continues until the measured resistance falls below 95 % of the trip or alarm threshold.

Trip and alarm monitoring can be separately enabled and disabled.

The function is available for all operating states.

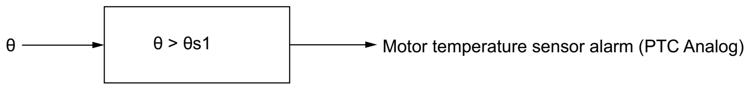
Functional Characteristics

The PTC Analog motor temperature sensor function includes the following features:

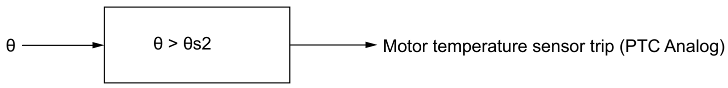
- 2 configurable thresholds:
  - Motor Temp Sensor Alarm Threshold
  - Motor Temp Sensor Trip Threshold
- 2 function outputs:
  - Motor Temp Sensor Alarm
  - Motor Temp Sensor Trip
- 1 counting statistic:
  - Motor Temp Sensor Trips Count

Block Diagram

Motor temperature sensor alarm:



Motor temperature sensor trip:



θ Temperature sensing element resistance

θs1 Motor temperature sensor alarm threshold

θs2 Motor temperature sensor trip threshold

Parameter Settings

The PTC analog motor temperature sensor function has the following configurable parameter settings:

Parameters	Setting Range	Factory Setting
Trip threshold	20...6500 Ω in 0.1 Ω increments	20 Ω
Alarm threshold	20...6500 Ω in 0.1 Ω increments	20 Ω

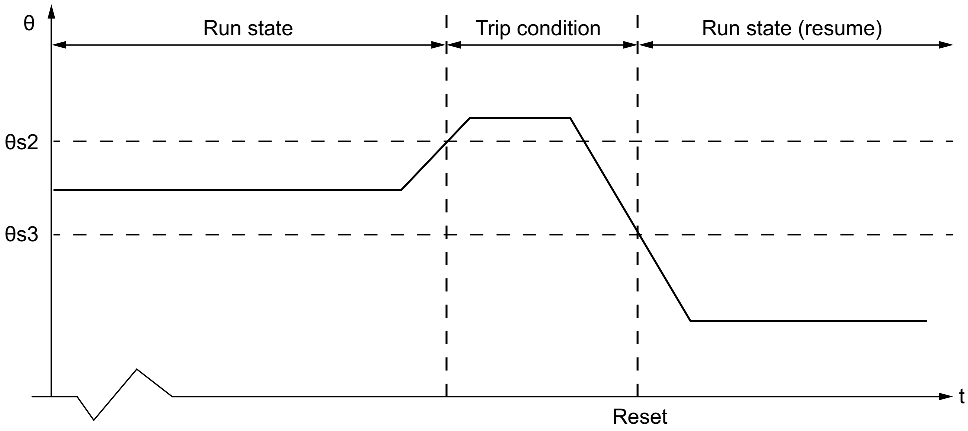
Technical Characteristics

The PTC analog motor temperature sensor function has the following characteristics:

Characteristic	Value
Hysteresis	–5 % of Alarm threshold and Trip threshold
Detection time	0.5...0.6 s
Detection time accuracy	+/–0.1 s

Example

The following diagram describes a Motor temperature sensor PTC analog trip with automatic reset and an active Run command:



θs2 Trip threshold

θs3 Trip re-closing threshold (95% of trip threshold)

Motor Temperature Sensor - NTC Analog

Description

The NTC Analog motor temperature sensing function is enabled when the Motor Temp Sensor Type parameter is set to **NTC Analog** and the LTM R controller is connected to an analog NTC thermistor embedded in the motor.

The LTM R controller monitors the state of the temperature sensing element and signals:

- a motor temperature sensor alarm when the measured resistance falls below a configurable alarm threshold.
- a motor temperature sensor trip when the measured resistance falls below a separately set trip threshold.

The trip or alarm condition continues until the measured resistance exceeds 105 % of the trip or alarm threshold.

Trip and alarm monitoring can be separately enabled and disabled.

The function is available for all operating states.

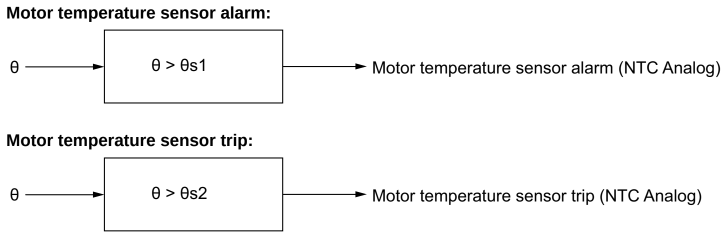
Functional Characteristics

The NTC Analog motor temperature sensor function includes the following features:

- 2 configurable thresholds:
  - Alarm Threshold
  - Trip Threshold

- 2 function outputs:
  - Motor Temp Sensor Alarm
  - Motor Temp Sensor Trip
- 1 counting statistic:
  - Motor Temp Sensor Trips Count

Block Diagram



θ Temperature sensing element resistance

θs1 Motor temperature sensor alarm threshold

θs2 Motor temperature sensor trip threshold

Parameter Settings

The NTC analog motor temperature sensor function has the following configurable parameter settings:

Parameters	Setting Range	Factory Setting
Trip threshold	20...6500 Ω in 0.1 Ω increments	20 Ω
Alarm threshold	20...6500 Ω in 0.1 Ω increments	20 Ω

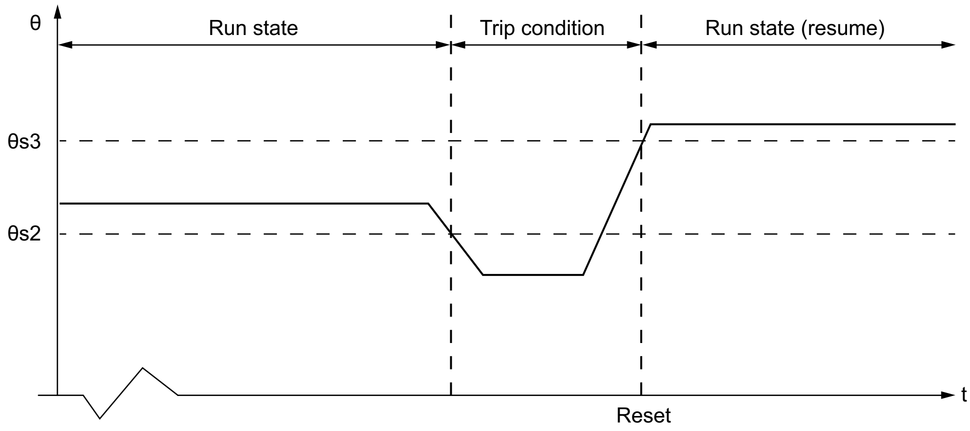
Technical Characteristics

The NTC analog motor temperature sensor function has the following characteristics:

Characteristics	Value
Hysteresis	+ 5 % of Alarm threshold and Trip thresholds
Detection time	0.5...0.6 s
Detection time accuracy	+/– 0.1 s

Example

The following diagram describes a Motor temperature sensor NTC analog trip with automatic reset:



θr2 Trip threshold

θr3 Trip re-closing threshold (105% of trip threshold)

Rapid Cycle Lockout

Description

The rapid cycle lockout function helps prevent potential harm to the motor caused by repetitive, successive inrush currents resulting from too little time between starts.

The rapid cycle lockout function provides a configurable timer, which begins its count when the LTM R controller detects On Level Current–defined as 20 % of FLC. At the same time the Rapid Cycle Lockout bit is set.

If the LTM R controller detects a Run command before the rapid cycle lockout has elapsed, the:

- Rapid Cycle Lockout bit remains set
- LTM R controller ignores the Run command. It helps prevent the motor from restarting
- HMI device (if attached) displays "WAIT"
- LTM R controller Alarm LED flashes red 5 times per second, indicating the LTM R controller has disabled motor outputs thereby helping prevent an undesirable condition caused by starting the motor
- LTM R controller monitors the wait time–if more than 1 timer is active, the LTM R controller reports the minimum wait time before the longest timer elapses

On power loss, the LTM R controller helps preserve the state of the lockout timer in non-volatile memory. When the LTM R controller next powers up, the timer restarts its count and again ignores Run commands until the timer completes the timeout.

Setting the Rapid Cycle Lockout Timeout parameter to 0 disables this function.

The Rapid Cycle Lockout Timeout setting can be edited when the LTM R controller is in its normal operating state. If an edit is made while the timer is counting, the edit is effective when the timer finishes counting.

This function has no alarm and no trip.

> **NOTE:** The Rapid Cycle Lockout function is not active when the overload operating mode is selected.

Functional Characteristics

The rapid cycle lockout function includes the following parameters:

- 1 time delay:
  - Rapid Cycle Lockout Timeout
- 1 status bit:
  - Rapid Cycle Lockout

In addition, the Rapid Cycle Lockout function:

- disables motor outputs
- causes the LTM R Alarm LED to flash 5 times per second

Parameter Settings

The rapid cycle lockout function has the following parameters:

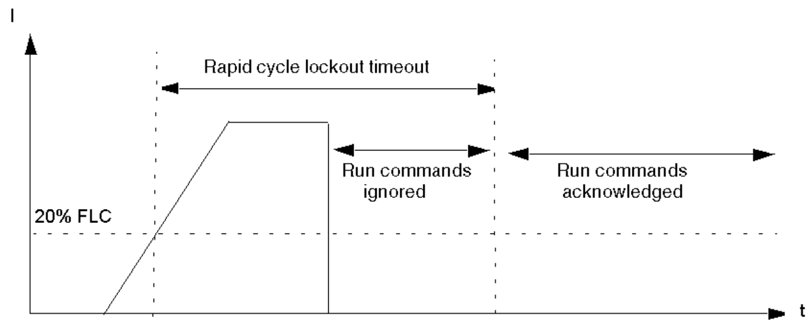
Parameters	Setting Range	Factory Setting
Rapid cycle lockout timeout	0...9999 s in increments of 1 s	0 s

Technical Characteristics

The rapid cycle lockout function has the following characteristics:

Characteristics	Value
Trip time accuracy	+/– 0.1 s or +/– 5%

Example



Current Motor Protection Functions

Overview

This section describes the current motor protection functions of the LTM R controller.

Current Phase Imbalance

Description

The current phase imbalance function signals:

- a alarm when the current in any phase differs by more than a set percentage from the average current in all 3 phases.
- a trip when the current in any phase differs by more than a separately set percentage from the average current in all 3 phases for a set period of time.

⚠CAUTION

RISK OF MOTOR OVERHEATING

The Current Phase Imbalance Trip Threshold must be properly set to help protect the wiring and motor equipment from harm caused by motor overheating.

- The setting you input must conform to national and local safety regulations and codes.
- Refer to the motor manufacturer’s instructions before setting this parameter.

Failure to follow these instructions can result in injury or equipment damage.

NOTE: Use this function to detect and guard against smaller current phase imbalances. For larger imbalances, in excess of 80 % of the average current in all 3 phases, use the current phase loss motor protection function.

This function has 2 adjustable trip time delays:

- one applies to current imbalances occurring while the motor is in start state, and
- one applies to current imbalances occurring after startup while the motor is in run state

Both timers begin if the imbalance is detected in start state.

The function identifies the phase causing a current imbalance. If the maximum deviation from the 3 phase current average is the same for 2 phases, the function identifies both phases.

Trip and alarm monitoring can be separately enabled and disabled.

The function applies only to 3-phase motors.

Functional Characteristics

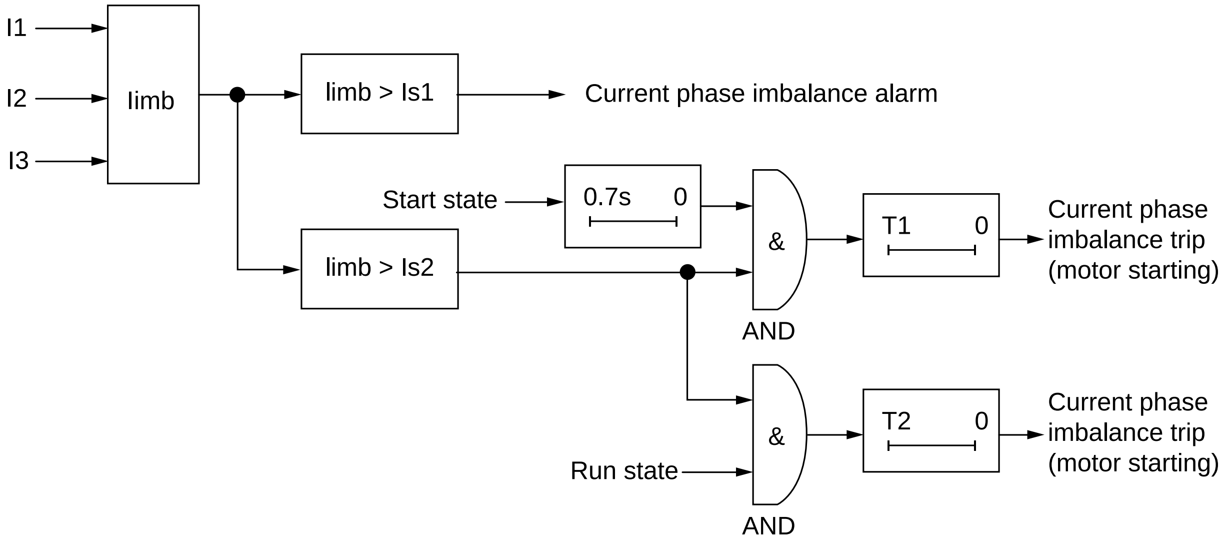
The current phase imbalance function includes the following features:

- 2 thresholds:
  - Alarm Threshold
  - Trip Threshold
- 2 trip time delays:
  - Trip Timeout Starting
  - Trip Timeout Running
- 2 function outputs:
  - Current Phase Imbalance Alarm
  - Current Phase Imbalance Trip
- 1 counting statistic:
  - Current Phase Imbalance Trips Count

- 3 indicators identifying the phase or phases with the highest current imbalance:
  - L1 Current Highest Imbalance
  - L2 Current Highest Imbalance
  - L3 Current Highest Imbalance

Block Diagram

Current phase imbalance alarm and trip:



I1 Phase 1 current

I2 Phase 2 current

I3 Phase 3 current

Iimb Current imbalance ratio for 3-phase

Is1 Alarm threshold

Is2 Trip threshold

T1 Trip timeout starting

T2 Trip timeout running

Parameter Settings

The current phase imbalance function has the following parameters:

Parameters	Setting Range	Factory Setting
Trip enable	Enable/Disable	Enable
Trip timeout starting	0.2...20 s in 0.1 s increments	0.7 s
Trip timeout running	0.2...20 s in 0.1 s increments	5 s
Trip threshold	10...70 % of the calculated imbalance in 1% increments	10 %
Alarm enable	Enable/Disable	Disable
Alarm threshold	10...70 % of the calculated imbalance in 1% increments	10 %

NOTE: A time of 0.7 second is added to the Trip timeout starting parameter to avoid nuisance tripping during the start phase.

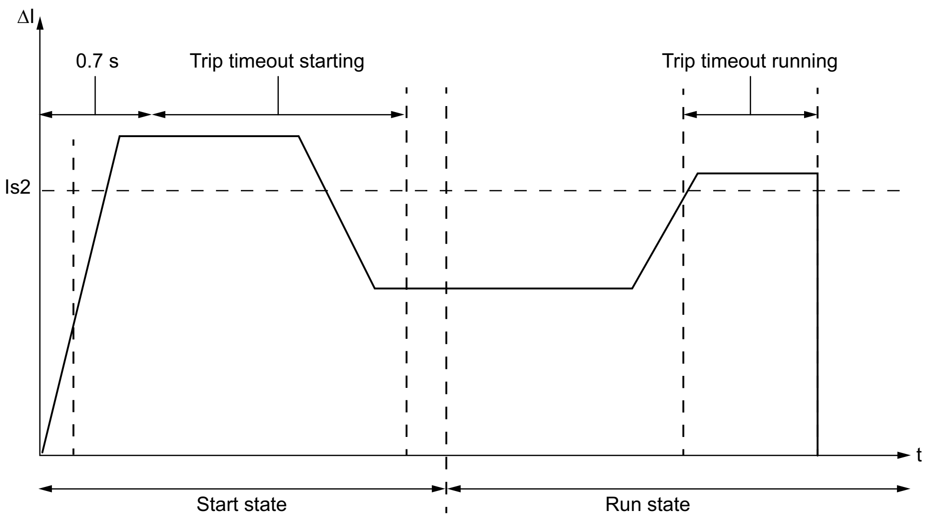
Technical Characteristics

The current phase imbalance function has the following characteristics:

Characteristics	Value
Hysteresis	–5 % of trip or alarm threshold
Trip time accuracy	+/–0.1 s or +/–5 %

Example

The following diagram describes the detection of a current phase imbalance occurring during run state.



ΔI Percentage difference between current in any phase and the 3 phase current average

Is2 Trip threshold

Current Phase Loss

Description

The current phase loss function signals:

- a alarm when the current in any phase differs by more than 80 % from the average current in all 3 phases.
- a trip when the current in any phase differs by more than 80 % from the average current in all 3 phases for a set period of time.

  NOTE: Use this function to detect and guard against large current phase imbalances, in excess of 80 % of the average current in all 3 phases. For smaller current imbalances, use the current phase imbalance motor protection function.

This function has a single adjustable trip time delay, which is applied when the motor is in start state or run state.

The function identifies the phase experiencing a current loss. If the maximum deviation from the 3 phase current average is the same for 2 phases, the function identifies both phases.

Trip and alarm monitoring can be separately enabled and disabled.

The function applies only to 3-phase motors.

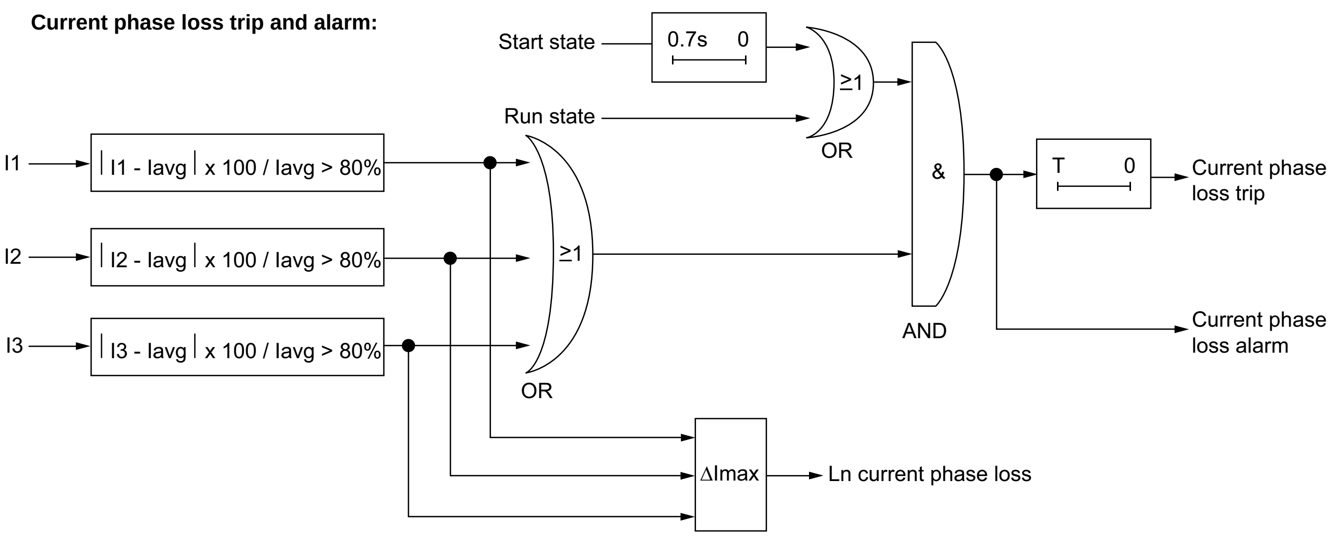
Functional Characteristics

The current phase loss function includes the following features:

- 1 fixed trip and alarm threshold equal to 80 % of the 3 phase average current.
- 1 trip time delay:
  - Current Phase Loss Timeout
- 2 function outputs:
  - Current Phase Loss Alarm
  - Current Phase Loss Trip
- 1 counting statistic:
  - Current Phase Loss Trips Count
- 3 indicators identifying the phase or phases experiencing the current loss:
  - L1 Current loss
  - L2 Current loss
  - L3 Current loss

Block Diagram

Current phase loss trip and alarm:



I1 Phase 1 current

I2 Phase 2 current

I3 Phase 3 current

Ln Line current number or numbers with the greatest deviation from Iavg

Iavg 3 phase current average

T Trip timeout

Parameter Settings

The current phase loss function has the following configurable parameters:

Parameters	Setting Range	Factory Setting
Trip enable	Enable/Disable	Enable
Timeout	0.1...30 s in 0.1 s increments	3 s
Alarm enable	Enable/Disable	Enable

NOTE: A time of 0.7 second is added to the Trip timeout parameter to avoid nuisance tripping during the start phase.

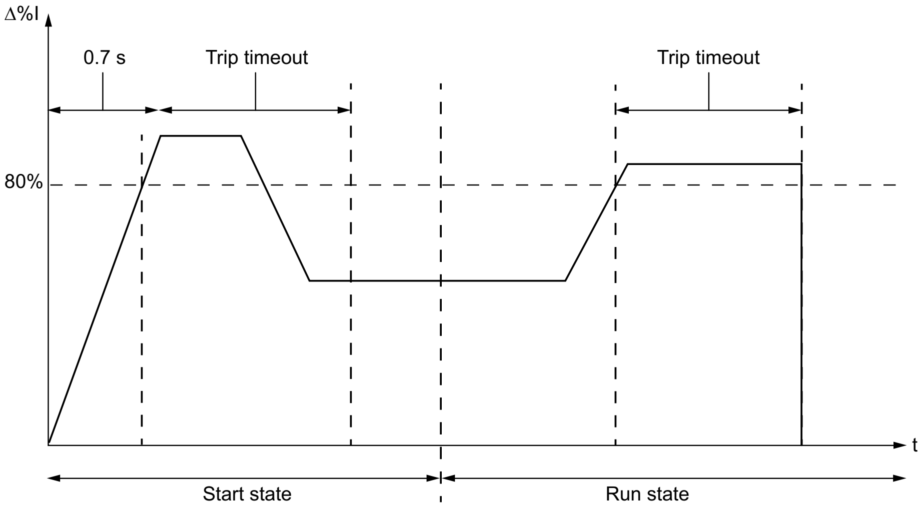
Technical Characteristics

The current phase loss function has the following characteristics:

Characteristics	Value
Hysteresis	75 % of the 3 phase average current
Trip time accuracy	+/–0.1 s or +/–5 %

Example

The following diagram describes the occurrence of a current phase loss trip of a motor in run state.



Δ%I Percentage difference between current in any phase and the 3 phase current average

Current Phase Reversal

Description

The current phase reversal function signals a trip when it detects that the current phases of a 3-phase motor are out of sequence with the Motor Phases Sequence parameter, ABC or ACB.

NOTE: When the LTM R controller is connected to an expansion module, phase reversal protection is based on voltage phase sequence before the motor starts, and on current phase sequence after the motor starts.

This function:

- is active when the motor is in start state or run state
- applies only to 3-phase motors
- has no alarm and no timer.

This function can be enabled or disabled.

Functional Characteristics

The current phase reversal function adds to one counting statistic, Wiring Trips Count.

Parameter Settings

The current phase reversal function has the following configurable parameters:

Parameters	Setting Range	Factory Setting
Trip enable	Enable/Disable	Disable
Phase sequence	• A-B-C • A-C-B	A-B-C

Technical Characteristics

The current phase reversal function has the following characteristics:

Characteristic	Value
Trip time at motor startup	within 0.2 s of motor startup
Trip time accuracy	+/–0.1 s or +/–5%

Long Start

Description

The long start function detects a locked or stalled rotor in start state and signals a trip when current continuously exceeds a separately set threshold for the same period of time.

Each predefined operating mode has its own current profile, representing a successful start cycle for the motor. The LTM R controller detects a long start trip condition whenever the actual current profile, occurring after a start command, varies from the expected profile.

Trip monitoring can be separately enabled and disabled.

This function has no alarm.

Start Cycle

The configurable parameters for the Long Start protection function, Long Start Trip Threshold and Long Start Trip Timeout, are used by the LTM R controller in defining and detecting the motor's start cycle. See Start Cycle, page 144.

Functional Characteristics

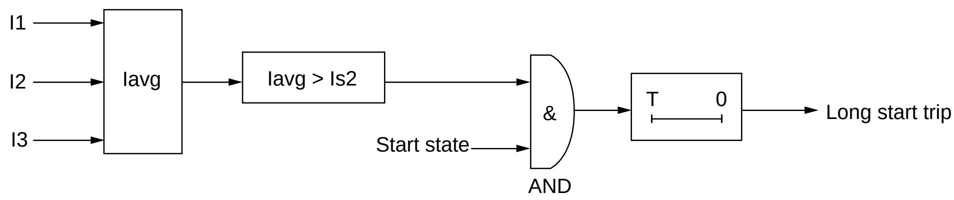
The long start function includes the following features:

- 1 threshold:
  - Trip Threshold
- 1 trip time delay:
  - Trip Timeout

- 1 function outputs:
  - Long Start Trip
- 1 counting statistic:
  - Long Start Trips Count

Block Diagram

Long start trip:



I1 Phase 1 current

I2 Phase 2 current

I3 Phase 3 current

Is2 Trip threshold

T Trip timeout

Parameter Settings

The long start function has the following parameters:

Parameters	Setting Range	Factory Setting
Trip enable	Enable/Disable	Enable
Trip timeout	1...200 s in 1 s increments	10 s
Trip threshold	100...800 % of FLC	100 % of FLC

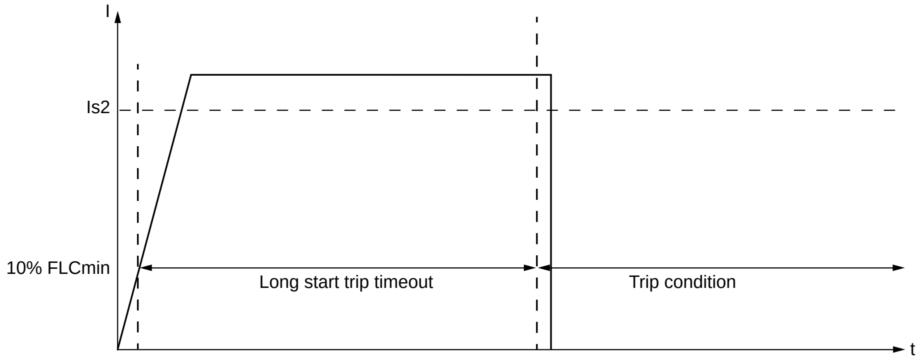
Technical Characteristics

The long start function has the following characteristics:

Characteristic	Value
Hysteresis	–5 % of Trip threshold
Trip time accuracy	+/– 0.1 s or +/– 5 %

Example

The following diagram describes the occurrence of a single threshold cross long start trip:



Is2 Long start trip threshold

Jam

Description

The jam function detects a locked rotor during run state and signals:

- a alarm when current in any phase exceeds a set threshold, after the motor has reached run state.
- a trip when current in any phase continuously exceeds a separately set threshold for a specified period of time, after the motor has reached run state.

The jam function is triggered when the motor is jammed during run state and stops, or is suddenly overloaded and draws excessive current.

Trip and alarm monitoring can be separately enabled and disabled.

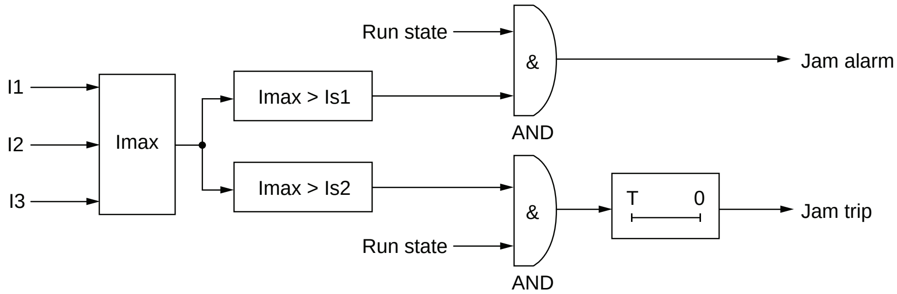
Functional Characteristics

The jam function includes the following features:

- 2 thresholds:
  - Alarm Threshold
  - Trip Threshold
- 1 trip time delay:
  - Trip Timeout
- 2 function outputs:
  - Jam Alarm
  - Jam Trip
- 1 counting statistic:
  - Jam Trips Count

Block Diagram

Jam alarm and trip:



I1 Phase 1 current

I2 Phase 2 current

I3 Phase 3 current

Is1 Alarm threshold

Is2 Trip threshold

T Trip timeout

Parameter Settings

The jam function has the following parameters:

Parameters	Setting Range	Factory Setting
Trip enable	Enable/Disable	Enable
Trip timeout	1...30 s in 1 s increments	5 s
Trip threshold	100...800 % of FLC in 1 % increments	200 % of FLC
Alarm enable	Enable/Disable	Disable
Alarm threshold	100...800 % of FLC in 1 % increments	200 % of FLC

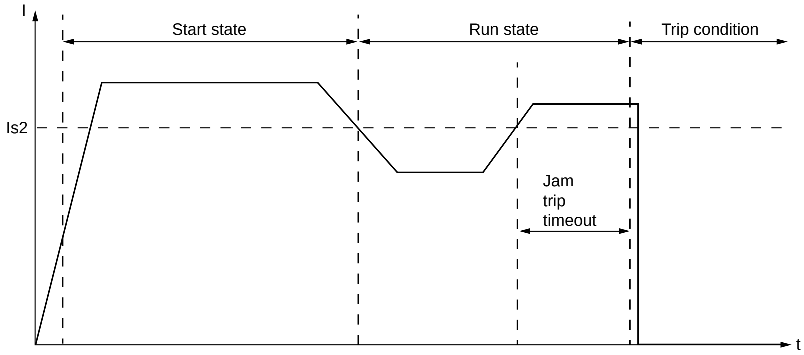
Technical Characteristics

The jam function has the following characteristics:

Characteristics	Value
Hysteresis	–5 % of Trip threshold or Alarm threshold
Trip time accuracy	+/–0.1 s or +/– 5 %

Example

The following diagram describes the occurrence of a jam trip.



Is2 Jam trip threshold

Undercurrent

Description

The undercurrent function signals:

- a alarm when the 3-phase Average Current falls below a set threshold, after the motor has reached run state.
- a trip when the 3-phase Average Current falls and remains below a separately set threshold for a set period of time, after the motor has reached run state.

The undercurrent function is triggered when the motor current falls below a defined level for the driven load, for example, if a drive belt or shaft has broken, allowing the motor to run free rather than under load. This function has a single trip time delay. Trip and alarm monitoring can be separately enabled and disabled.

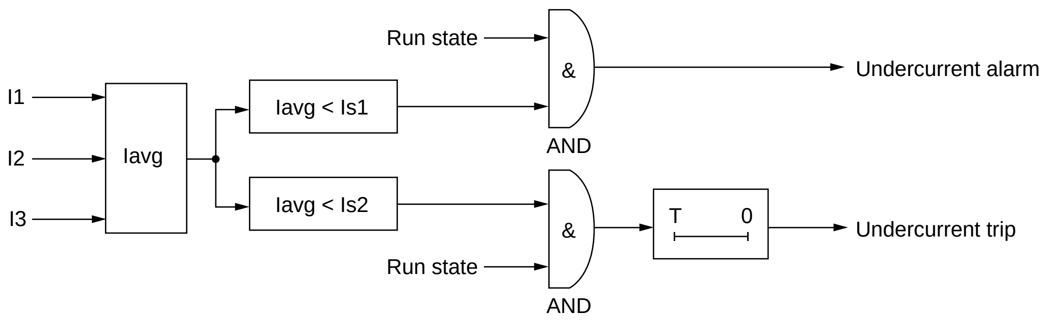
Functional Characteristics

The undercurrent function includes the following features:

- 2 thresholds:
  - Alarm Threshold
  - Trip Threshold
- 1 trip time delay:
  - Trip Timeout
- 2 function outputs:
  - Undercurrent Alarm
  - Undercurrent Trip
- 1 counting statistic:
  - Undercurrent Trips Count

Block Diagram

Undercurrent alarm and trip:



Iavg Average current

Is1 Alarm threshold

Is2 Trip threshold

T Trip timer delay

Parameter Settings

The undercurrent function has the following parameters:

Parameters	Setting Range	Factory Setting
Trip enable	Enable/Disable	Disable
Trip timeout	1...200 s in 1 s increments	1 s
Trip threshold	30...100 % of FLC in 1 % increments	50 % of FLC
Alarm enable	Enable/Disable	Disable
Alarm threshold	30...100 % of FLC in 1 % increments	50 % of FLC

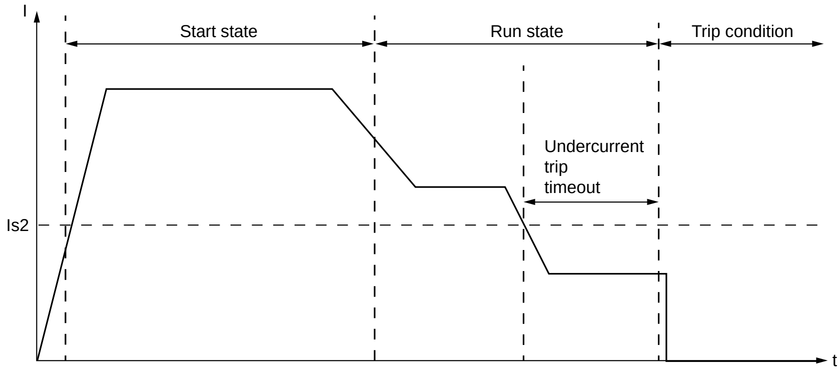
Technical Characteristics

The undercurrent function has the following characteristics:

Characteristics	Value
Hysteresis	–5 % of Trip threshold or Alarm threshold
Trip time accuracy	+/– 0.1 s or +/- 5 %

Example

The following diagram describes the occurrence of an undercurrent trip.



Is2 Undercurrent trip threshold

Overcurrent

Description

The overcurrent function signals:

- a alarm when current in a phase exceeds a set threshold, after the motor has reached run state.
- a trip when current in a phase continuously exceeds a separately set threshold for a set period of time, after the motor has reached run state.

The overcurrent function can be triggered when the equipment is overloaded or a process condition is detected causing current to increase beyond the set threshold. This function has a single trip time delay. Trip and alarm monitoring can be separately enabled and disabled.

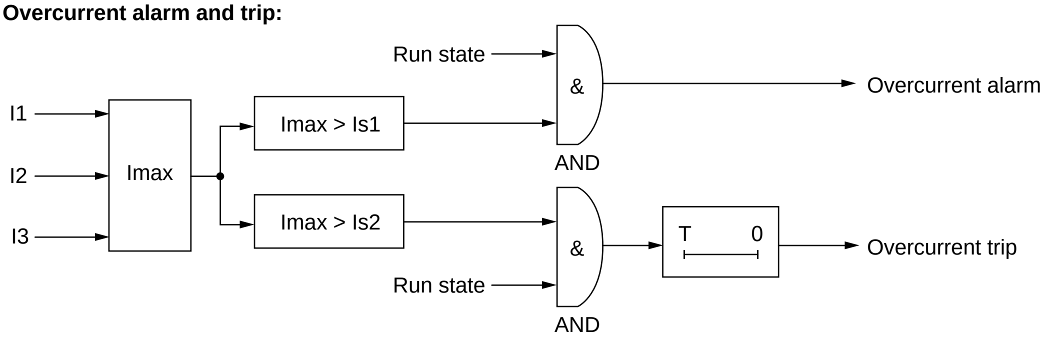
Functional Characteristics

The overcurrent function includes the following features:

- 2 thresholds:
  - Alarm Threshold
  - Trip Threshold
- 1 trip time delay:
  - Trip Timeout
- 2 function outputs:
  - Overcurrent Alarm
  - Overcurrent Trip
- 1 counting statistic:
  - Overcurrent Trips Count

Block Diagram

Overcurrent alarm and trip:



I1 Phase 1 current

I2 Phase 2 current

I3 Phase 3 current

Is1 Alarm threshold

Is2 Trip threshold

T Trip timeout

Parameter Settings

The overcurrent function has the following parameters:

Parameters	Setting Range	Factory Setting
Trip enable	Enable/Disable	Disable
Trip timeout	1...250 s in 1 s increments	10 s
Trip threshold	30...800 % of FLC in 1 % increments	200 % of FLC
Alarm enable	Enable/Disable	Disable
Alarm threshold	30...800 % of FLC in 1 % increments	200 % of FLC

Technical Characteristics

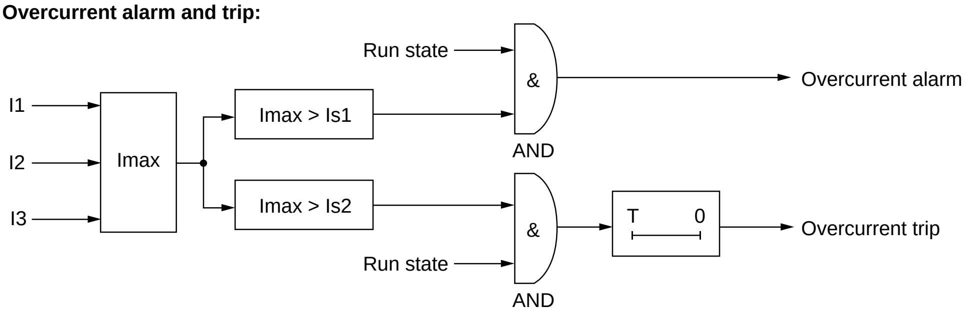
The overcurrent function has the following characteristics:

Characteristics	Value
Hysteresis	–5 % of Trip threshold or Alarm threshold
Trip time accuracy	+/– 0.1 s or +/– 5%

Example

The following diagram describes the occurrence of an overcurrent trip.

Overcurrent alarm and trip:



Is2 Overcurrent trip threshold

Ground Current

Overview

The LTM R controller can be configured to detect ground current:

- internally, by summing the 3-phase current signals from the secondary of the internal current transformers, page 108.
- externally, by measuring the current delivered by the secondary of an external ground current sensor, page 111.

Use the Ground Current Mode parameter to select either internal or external ground current trip protection. Only one of these ground current mode settings can be activated at a time.

Parameter Settings

The ground current protection function has the following configurable parameter settings, which apply to both internal and external ground current protection:

Parameters	Setting Range	Factory Setting
Ground current mode	• Internal • External	Internal
Trip enable	Enable/Disable	Enable
Alarm enable	Enable/Disable	Enable
Ground trip disabled while starting	Enable/Disable	Enable

Internal Ground Current

Description

The internal ground current function is enabled when the Ground Current Mode parameter is set to **Internal** and disabled when set to **External**.

⚠⚠DANGER

IMPROPER TRIP DETECTION

Internal ground current function will not protect people from harm caused by ground current.

Ground current trip thresholds must be set to protect the motor and related equipment.

Ground current trip settings must conform to national and local safety regulations and codes.

Failure to follow these instructions will result in death or serious injury.

The internal ground current function sums the current readings from the secondary of the internal current transformers and signals:

- a alarm when the summed current exceeds a set threshold.
- a trip when the summed current continuously exceeds a separately set threshold for a set period of time.

The internal ground current function has a single trip time delay.

The internal ground current function can be enabled when the motor is in ready state, start state, or run state. This function can be configured so that it is disabled during start state, and enabled only during ready state and run state.

Trip and alarm monitoring can be separately enabled and disabled.

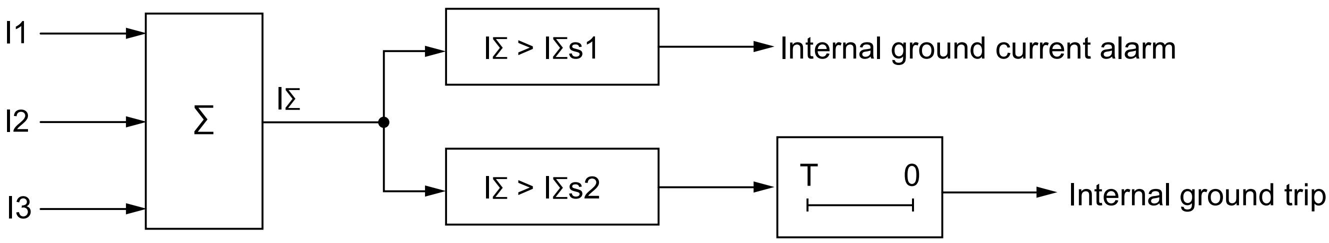
Functional Characteristics

The internal ground current function includes the following features:

- 1 measure of ground current in amperes:
  - Ground Current
- 1 measure of ground current as a % of FLCmin:
  - Ground Current Ratio
- 2 thresholds:
  - Alarm Threshold
  - Trip Threshold
- 1 trip time delay:
  - Trip Timeout
- 2 function outputs:
  - Internal Ground Current Alarm
  - Internal Ground Current Trip
- 1 counting statistic:
  - Ground Current Trips Count

Block Diagram

Internal ground current alarm and trip:



I1 Phase 1 current

I2 Phase 2 current

I3 Phase 3 current

IΣ Summed current

IΣs1 Alarm threshold

IΣs2 Trip threshold

T Trip timeout

Parameter Settings

The internal ground current function has the following parameters:

Parameters	Setting Range	Factory Setting
Internal ground current trip timeout	0.5...25 s in 0.1 s increments	1 s
Internal ground current trip threshold	50...500 % of FLCmin in 1 % increments	50 % of FLCmin
Internal ground current alarm threshold	50...500 % of FLCmin in 1 % increments	50 % of FLCmin

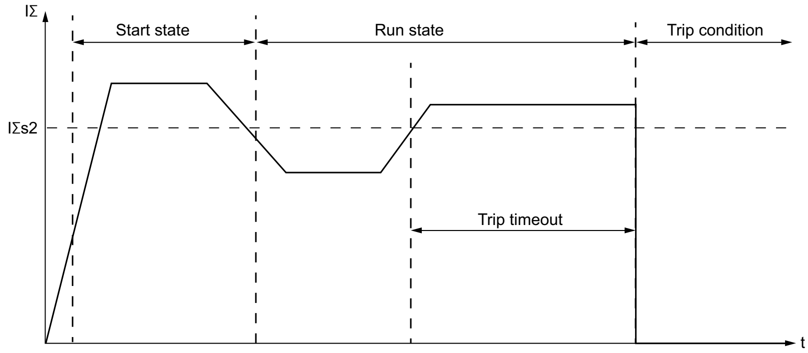
Technical Characteristics

The internal ground current function has the following characteristics:

Characteristics	Value
Hysteresis	–5 % of Trip threshold or Alarm threshold
Trip time accuracy	+/– 0.1 s or +/–5 %

Example

The following diagram describes the occurrence of an internal ground current trip occurring during run state.



IΣs2 internal ground current trip threshold

External Ground Current

Description

The external ground current function is enabled when:

- the Ground Current Mode parameter is set to **External**, and
- a current transformation ratio is set.

When Ground Current Mode is set to **Internal**, the external ground current function is disabled.

DANGER

IMPROPER TRIP DETECTION

External ground current function will not protect people from harm caused by ground current.

Ground current trip thresholds must be set to protect the motor and related equipment.

Ground current trip settings must conform to national and local safety regulations and codes.

Failure to follow these instructions will result in death or serious injury.

The LTM R controller has 2 terminals—Z1 and Z2—that can be connected to an external ground current sensor. The external ground current function measures ground current delivered by the secondary of the external current transformer and signals:

- a alarm when the delivered current exceeds a set threshold.
- a trip when the delivered current continuously exceeds a separately set threshold for a set period of time.

The external ground current function has a single trip time delay.

The external ground current function can be enabled when the motor is in ready state, start state, or run state. This function can be configured so that it is disabled only during start state, and enabled during ready state and run state.

Trip and alarm monitoring can be separately enabled and disabled.

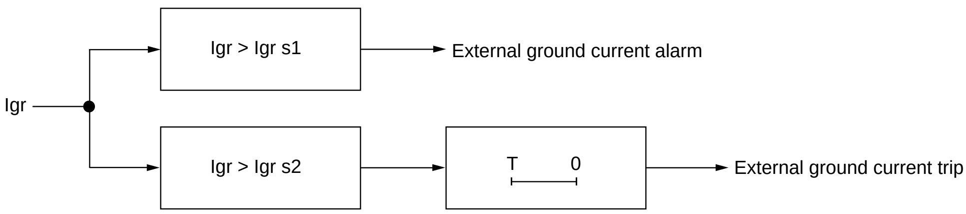
Functional Characteristics

The external ground current function includes the following features:

- 1 measure of ground current in amperes:
  - Ground Current
- 2 thresholds:
  - Alarm Threshold
  - Trip Threshold
- 1 trip time delay:
  - Trip Timeout
- 2 function outputs:
  - External Ground Current Alarm
  - External Ground Current Trip
- 1 counting statistic:
  - Ground Current Trips Count

Block Diagram

External ground current alarm and trip:



Igr Ground current from external ground CT

Igr s1 Alarm threshold

Igr s2 Trip threshold

T Trip timeout

Parameter Settings

The external ground current function has the following parameters:

Parameters	Setting Range	Factory Setting
External ground current trip timeout	0.1...25 s in 0.01 s increments	0.5 s
External ground current trip threshold	0.02...20 A in 0.01 A increments	1 A
External ground current alarm threshold	0.02...20 A in 0.01 A increments	1 A

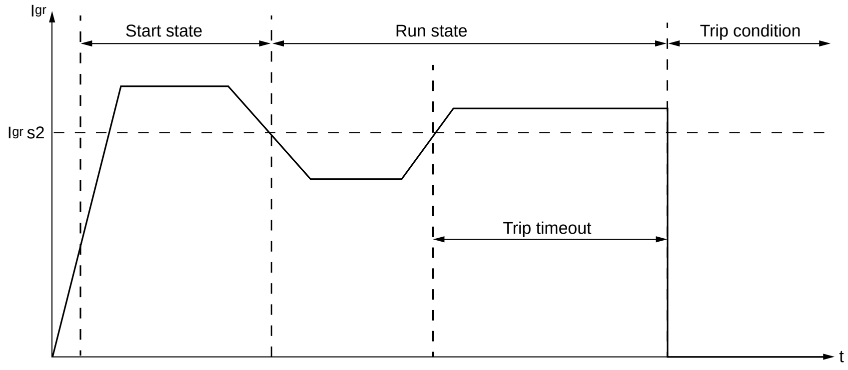
Technical Characteristics

The external ground current function has the following characteristics:

Characteristics	Value
Hysteresis	–5 % of Trip threshold or Alarm threshold
Trip time accuracy	+/– 0.1 s or +/–5 %

Example

The following diagram describes the occurrence of an external ground current trip occurring during run state.



Igr s2 External ground current trip threshold

Voltage Motor Protection Functions

Overview

This section describes the voltage motor protection functions provided by the LTM R controller.

Voltage Phase Imbalance

Description

The voltage phase imbalance function signals:

- a alarm when the voltage in any composed phase differs by more than a set percentage from the average voltage in all 3 phases
- a trip when the voltage in any composed phase differs by more than a separately set percentage from the average voltage in all 3 phases for a set period of time

  NOTE: A composed phase is the combined measure of 2 phases: L1 + L2, L2 + L3, or L3 + L1.

This function:

- is active when the LTM R controller is connected to an expansion module
- is active when the average voltage is between 50 % and 120 % of the nominal voltage
- is available when the motor is in ready state, start state and run state
- applies only to 3-phase motors

This function has 2 adjustable trip time delays:

- one applies to voltage imbalances occurring while the motor is in start state, and
- one applies to voltage imbalances occurring while the motor is in run state, or when the long start time duration expires

Both timers begin if the imbalance is detected in start state.

NOTE: Use this function to detect and guard against smaller voltage phase imbalances. For larger imbalances, in excess of 40 % of the average voltage in all 3 phases, use the voltage phase loss motor protection function.

Trip and alarm monitoring can be separately enabled and disabled.

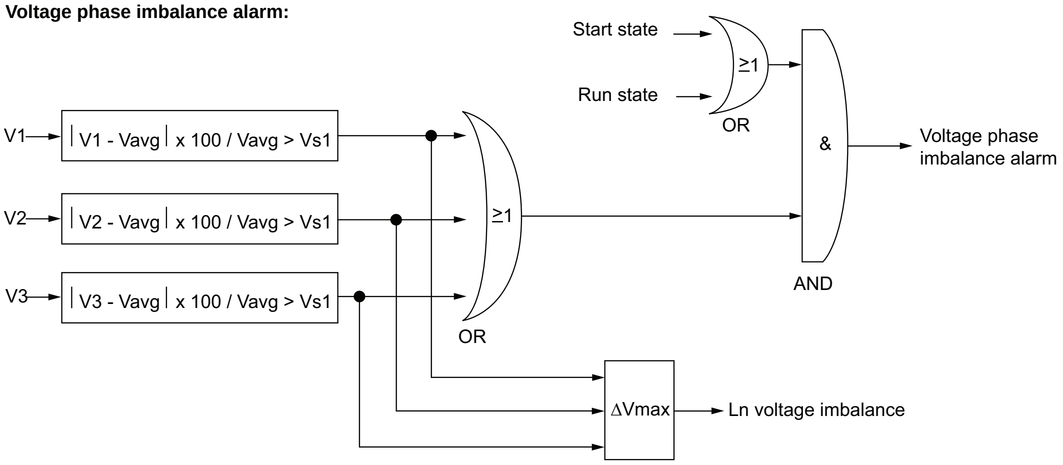
Functional Characteristics

The voltage phase imbalance function includes the following features:

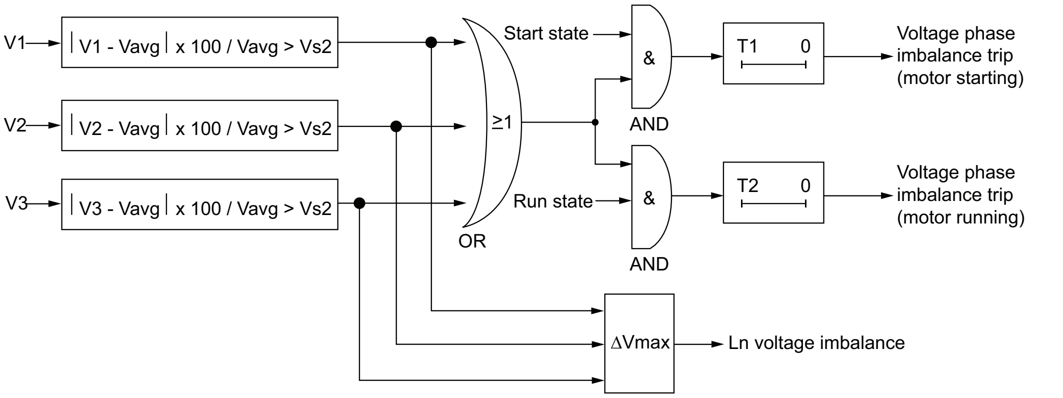
- 2 thresholds:
  - Alarm Threshold
  - Trip Threshold
- 2 trip time delays:
  - Trip Timeout Starting
  - Trip Timeout Running
- 2 function outputs:
  - Voltage Phase Imbalance Alarm
  - Voltage Phase Imbalance Trip
- 1 counting statistic:
  - Voltage Phase Imbalance Trips Count
- 3 indicators identifying the phase with the highest voltage imbalance:
  - L1-L2 Highest Imbalance
  - L2-L3 Highest Imbalance
  - L3-L1 Highest Imbalance

Block Diagram

Voltage phase imbalance alarm:



Voltage phase imbalance trip:



V1 L1-L2 voltage

V2 L2-L3 voltage

V3 L3-L1 voltage

Ln Line number or numbers with greatest deviation from Vavg

Vs1 Alarm threshold

Vs2 Trip threshold

Vavg 3 phase voltage average

T1 Trip timeout starting

T2 Trip timeout running

Parameter Settings

The voltage phase imbalance function has the following parameters:

Parameters	Setting Range	Factory Setting
Trip enable	Enable/Disable	Disable
Trip timeout starting	0.2...20 s in 0.1 s increments	0.7 s
Trip timeout running	0.2...20 s in 0.1 s increments	2 s
Trip threshold	3...15 % of the calculated imbalance in 1 % increments	10 %
Alarm enable	Enable/Disable	Disable
Alarm threshold	3...15 % of the calculated imbalance in 1 % increments	10 %

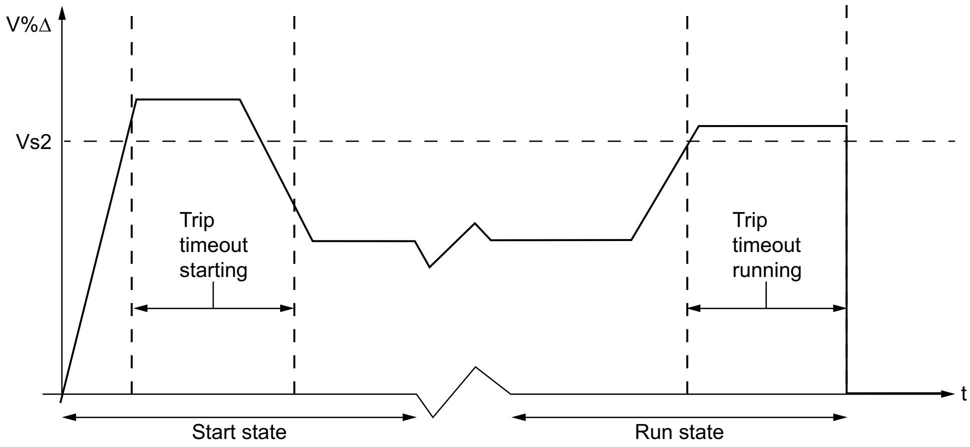
Technical Characteristics

The voltage phase imbalance function has the following characteristics:

Characteristics	Value
Hysteresis	–5 % of Trip threshold or Alarm threshold
Trip time accuracy	+/– 0.1 s or +/– 5 %

Example

The following diagram describes the occurrence of a voltage phase imbalance:



V%Δ Percentage difference between voltage in any phase and the 3 phase average voltage

Vs2 Trip threshold

Voltage Phase Loss

Description

The voltage phase loss function is based on the Voltage Phase Imbalance function and signals:

- a alarm when the voltage in any phase differs by more than a 38 % from the average voltage in all 3 phases.
- a trip when the voltage in any phase differs by more than 38 % from the average voltage in all 3 phases for a set period of time.

This function:

- is active when the LTM R controller is connected to an expansion module
- is active when the average voltage is between 50 % and 120 % of the nominal voltage
- is available when the motor is in ready state, start state or run state
- applies only to 3-phase motors

This function has a single adjustable trip time delay.

> **NOTE:** Use this function to detect and guard against large voltage phase imbalances, in excess of 40 % of the average voltage in all 3 phases. For smaller voltage imbalances, use the voltage phase imbalance motor protection function.

The function identifies the phase experiencing a voltage loss. If the maximum deviation from the 3 phase voltage average is the same for 2 phases, the function identifies both phases.

Trip and alarm monitoring can be separately enabled and disabled.

Functional Characteristics

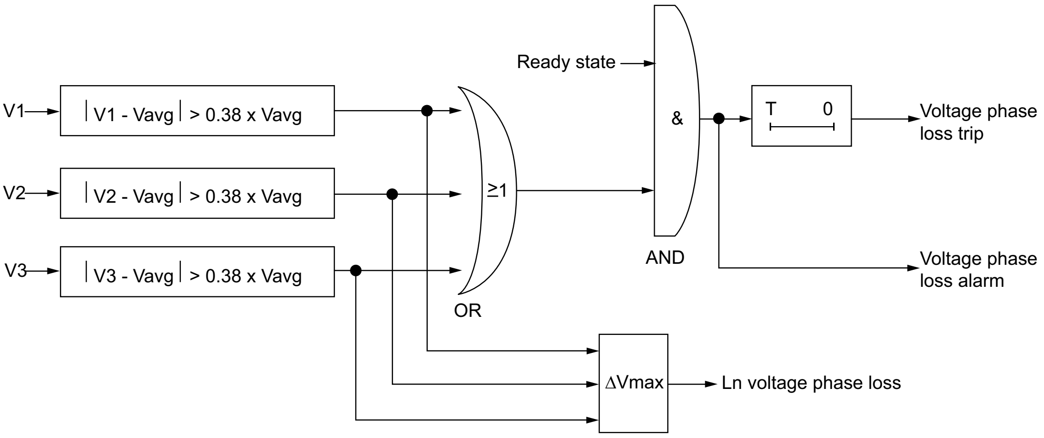
The voltage phase loss function includes the following features:

- A fixed trip and alarm threshold equal to 38 % of the 3 phase average voltage.
- A single, adjustable trip time delay:
  - Voltage Phase Loss Timeout

- 2 function outputs:
  - Voltage Phase Loss Alarm
  - Voltage Phase Loss Trip
- 1 counting statistic:
  - Voltage Phase Loss Trips Count
- 3 indicators identifying the phase experiencing the voltage loss:
  - L1-L2 Voltage loss
  - L2-L3 Voltage loss
  - L3-L1 Voltage loss

Block Diagram

Voltage phase loss trip and alarm:



V1 L1-L2 voltage

V2 L2-L3 voltage

V3 L3-L1 voltage

Ln Line voltage number or numbers with the greatest deviation from Vavg

Vavg 3 phase average voltage

T Trip timeout

Parameter Settings

The voltage phase loss function has the following configurable parameters:

Parameters	Setting Range	Factory Setting
Trip enable	Enable/Disable	Enable
Trip timeout	0.1...30 s in 0.1 s increments	3 s
Alarm enable	Enable/Disable	Enable

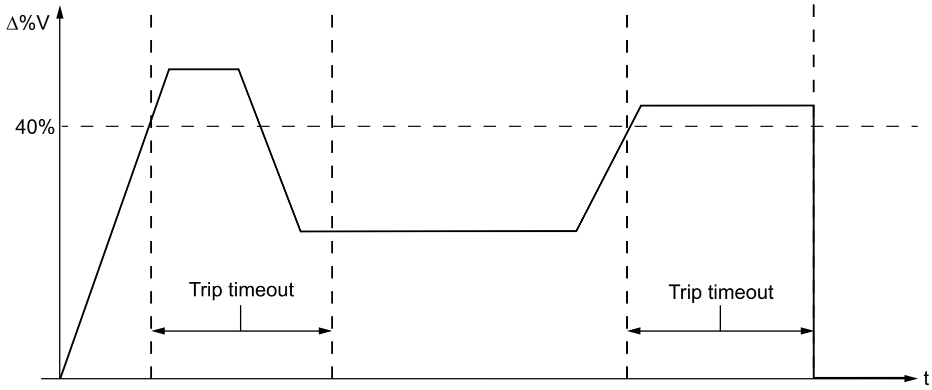
Technical Characteristics

The voltage phase loss function has the following characteristics:

Characteristics	Value
Hysteresis	45 % of the 3 phase average voltage
Trip time accuracy	+/– 0.1 s or +/– 5%

Example

The following diagram describes the occurrence of a voltage phase loss trip of a motor in run state:



ΔV% Percentage difference between voltage in any phase and the 3 phase average voltage

Voltage Phase Reversal

Description

The voltage phase reversal function signals a trip when it detects that the voltage phases of a 3-phase motor are out of sequence, usually indicating a wiring trip. Use the Motor Phases Sequence parameter to configure the direction, ABC or ACB, in which the motor will turn.

This function:

- is available when the LTM R controller is connected to an expansion module
- is active when the average voltage is between 50 % and 120 % of the nominal voltage
- is available when the motor is in ready state, start state and run state
- applies only to 3-phase motors
- has no alarm and no timer

This function can be enabled or disabled.

Functional Characteristics

The voltage phase reversal function adds one counting statistic, Wiring Trips Count.

Parameter Settings

The voltage phase reversal function has the following configurable parameters:

Parameters	Setting Range	Factory Setting
Trip enable	Enable/Disable	Disable
Motor phases sequence	• A-B-C • A-C-B	A-B-C

Technical Characteristics

The voltage phase reversal function has the following characteristics:

Characteristics	Value
Trip time	within 0.2 s
Trip time accuracy	+/– 0.1 s

Undervoltage

Description

The undervoltage function signals:

- a alarm when voltage in a phase falls below a set threshold.
- a trip when voltage in a phase falls and remains below a separately set threshold for a set period of time.

This function has a single trip time delay. Both the trip and alarm thresholds are defined as a percentage of the Motor Nominal Voltage (Vnom) parameter setting.

The undervoltage function is available only in ready state and run state, when the LTM R controller is connected to an expansion module.

Trip and alarm monitoring can be separately enabled and disabled.

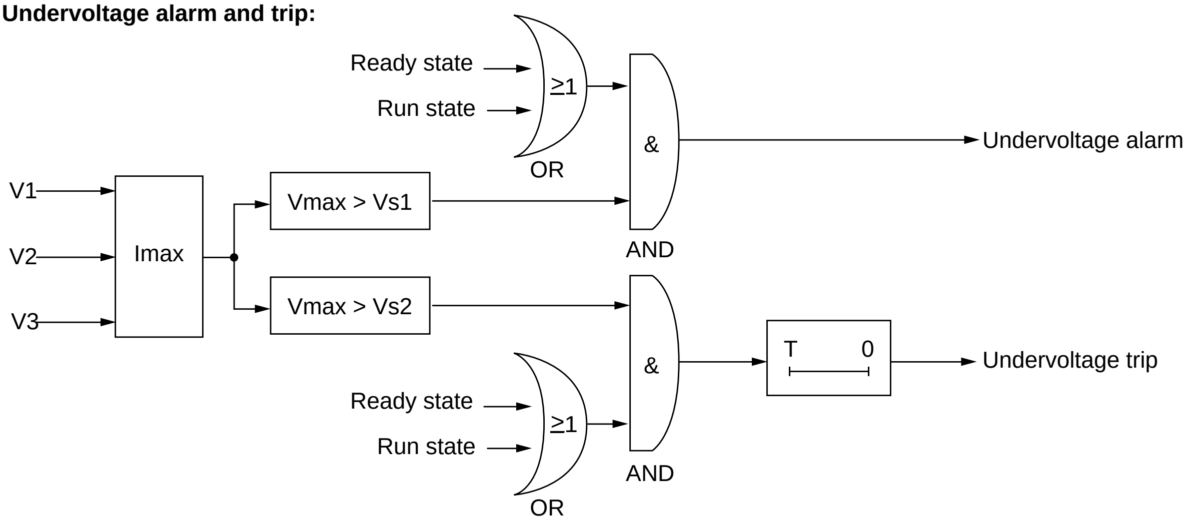
Functional Characteristics

The undervoltage function includes the following features:

- 2 thresholds:
  - Alarm Threshold
  - Trip Threshold
- 1 trip time delay:
  - Trip Timeout
- 2 function outputs:
  - Undervoltage Alarm
  - Undervoltage Trip
- 1 counting statistic:
  - Undervoltage Trips Count

Block Diagram

Undervoltage alarm and trip:



V1 L1-L2 voltage

V2 L2-L3 voltage

V3 L3-L1 voltage

Vs1 Alarm threshold

Vs2 Trip threshold

T Trip timeout

Parameter Settings

The undervoltage function has the following parameters:

Parameters	Setting Range	Factory Setting
Trip enable	Enable/Disable	Disable
Trip timeout	0.2...25 s in 0.1 s increments	3 s
Trip threshold	70...99 % of Motor nominal voltage in 1 % increments	85 %
Alarm enable	Enable/Disable	Disable
Alarm threshold	70...99 % of Motor nominal voltage in 1 % increments	85 %

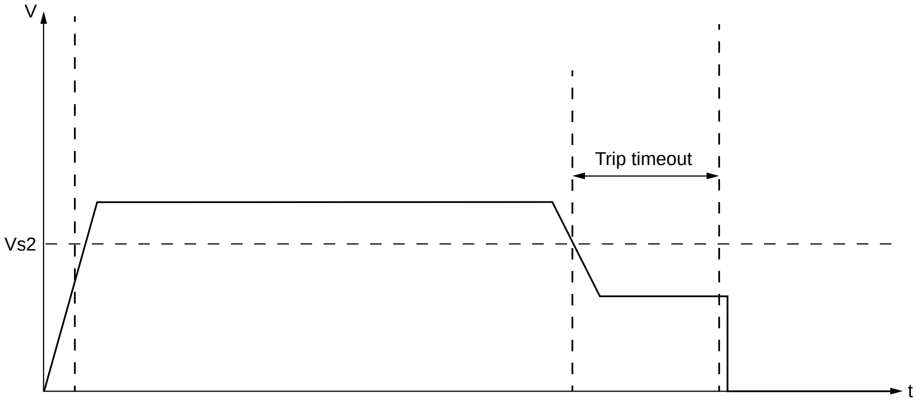
Technical Characteristics

The undervoltage function has the following characteristics:

Characteristics	Value
Hysteresis	-5 % of Trip threshold or Alarm threshold
Trip time accuracy	+/– 0.1 s or +/– 5 %

Example

The following diagram describes the occurrence of a undervoltage trip.



Vs2 Undervoltage trip threshold

Overvoltage

Description

The overvoltage function signals:

- a alarm when voltage in a phase exceeds a set threshold.
- a trip when voltage in a phase continuously exceeds a separately set threshold for a specified period of time.

This function has a single trip time delay. Both the trip and alarm thresholds are defined as a percentage of the Motor Nominal Voltage (Vnom) parameter setting.

The overvoltage function is available in ready state and run state, when the LTM R controller is connected to an expansion module.

Trip and alarm monitoring can be separately enabled and disabled.

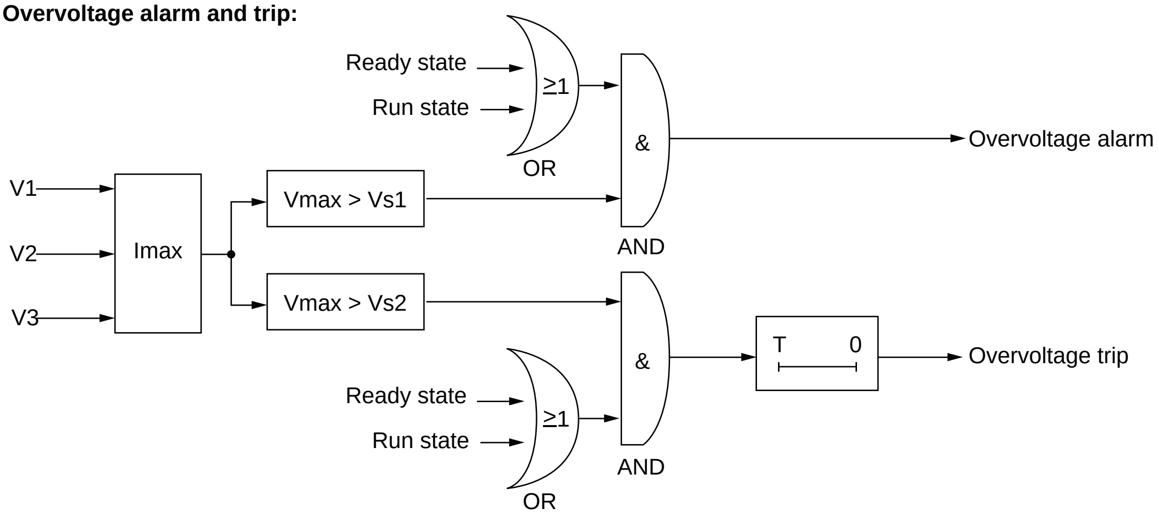
Functional Characteristics

The overvoltage function includes the following features:

- 2 thresholds:
  - Alarm Threshold
  - Trip Threshold
- 1 trip time delay:
  - Trip Timeout
- 2 function outputs:
  - Overvoltage Alarm
  - Overvoltage Trip
- 1 counting statistic:
  - Overvoltage Trips Count

Block Diagram

Overvoltage alarm and trip:



V1 L1-L2 voltage

V2 L2-L3 voltage

V3 L3-L1 voltage

Vs1 Alarm threshold

Vs2 Trip threshold

T Trip timeout

Parameter Settings

The overvoltage function has the following parameters:

Parameters	**Setting Range**	**Factory Setting**
Trip enable	Enable/Disable	Disable
Trip timeout	0.2...25 s in 0.1 s increments	3 s
Trip threshold	101...115 % of Motor nominal voltage in 1 % increments	110 %
Alarm enable	Enable/Disable	Disable
Alarm threshold	101...115 % of Motor nominal voltage in 1 % increments	110 %

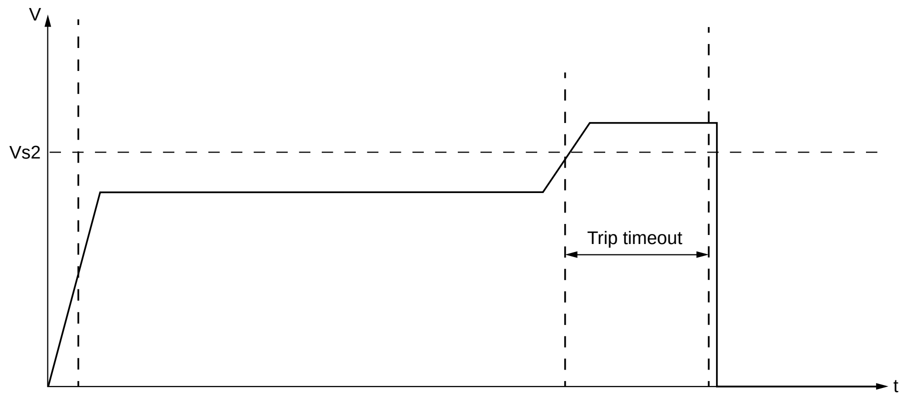
Technical Characteristics

The overvoltage function has the following characteristics:

Characteristics	**Value**
Hysteresis	–5 % of Trip threshold or Alarm threshold
Trip time accuracy	+/–0.1 s or +/– 5%

Example

The following diagram describes the occurrence of an overvoltage trip.



Vs2 Overvoltage trip threshold

Voltage Dip Management

Overview

When a voltage dip is detected, the LTM R can perform 2 different functions to shed and reconnect automatically the load:

- Load shedding, page 123
- Automatic restart, page 125

Selection is done via the Voltage dip mode parameter:

If Voltage dip mode is...	Then...
0	nothing happens
1	load shedding function is enabled
2	automatic restart function is enabled

Load Shedding and Automatic Restart functions exclude each other.

Load Shedding

Description

The LTM R controller provides load shedding, which you can use to deactivate non-critical loads if voltage level is substantially reduced. For example, use load shedding when power is transferred from a main utility supply to a backup generator system, where the backup generator system can supply power only to a limited number of critical loads.

The LTM R only monitors load shedding when Load Shedding is selected.

With the load shedding function enabled, the LTM R controller monitors the average phase voltage and:

- reports a load shedding condition and stops the motor when voltage falls below a configurable Voltage dip threshold and stays below the threshold for the duration of a configurable load shedding timer,
- clears the load shedding condition when voltage rises above a configurable Voltage dip restart threshold and remains above the threshold for the duration of a configurable Load shedding restart timer.

When the LTM R controller clears the load shedding condition:

- in 2-wire (maintained) configuration, it issues a Run command to re-start the motor,
- in 3-wire (impulse) configuration, it does not automatically re-start the motor.

In Overload motor operating mode, load shedding conditions do not affect O.1 and O.2 operating states.

In Independent motor operating mode, load shedding conditions do not affect O.2 state.

If your application includes another device that externally provides load shedding, the LTM R controller's load shedding function should not be enabled.

All voltage dip thresholds and timers can be adjusted when the LTM R controller is in its normal operating state. When a load shedding timer is counting at the time it is adjusted, the new duration time does not become effective until the timer expires.

This function is available only when your application includes an LTM E expansion module.

Functional Characteristics

The load shedding function includes the following features:

- 2 thresholds:
  - Voltage Dip Threshold
  - Voltage Dip Restart Threshold
- 2 time delays:
  - Load Shedding Timeout
  - Voltage Dip Restart Timeout
- 1 status flag
  - Load Shedding
- 1 counting statistic:
  - Load Sheddings Count

In addition, the load shedding function:

- disables logic outputs O.1 and O.2
- causes the alarm LED to flash 5 times per second

Parameter Settings

The load shedding function has the following parameters:

Parameters	Setting Range	Factory Setting
Voltage dip mode	0 = None 1 = Load shedding 2 = Auto restart	0 = None
Load shedding timeout	1...9999 s in increments of 1 s	10 s
Voltage dip threshold	50...115 % of Motor nominal voltage	70 %
Voltage dip restart timeout	1...9999 s in increments of 1 s	2 s
Voltage dip restart threshold	65...115 % of Motor nominal voltage	90 %

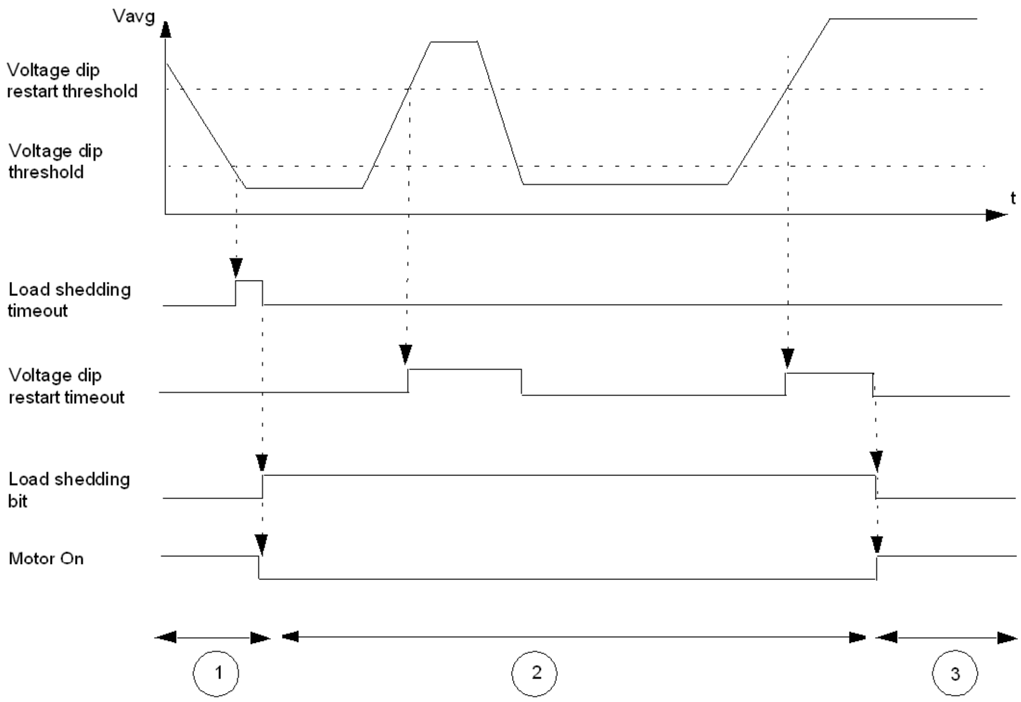
Technical Characteristics

The load shedding function has the following characteristics:

Characteristics	Value
Trip time accuracy	+/– 0.1 s or +/– 5%

Timing Sequence

The following diagram is an example of the timing sequence for the load shedding function, for a 2-wire configuration with automatic restart:



1 Motor running

2 Load shed; motor stopped

3 Load shed cleared; motor auto-restart (2-wire operation)

Automatic Restart

Description

The LTM R controller provides automatic restart.

With the automatic restart function enabled, the LTM R controller monitors the instantaneous phase voltage and detects voltage dip conditions. The voltage dip detection shares some parameters with the Load shedding function.

3 restart sequences are managed by the function according to the duration of the voltage dip:

- Immediate restart: the motor restarts automatically.
- Delayed restart: the motor restarts automatically after a timeout.
- Manual restart: the motor restarts manually. A Run command is necessary.

All automatic restart timers can be adjusted when the LTM R controller is in its normal operating state. When an automatic restart timer is counting at the time it is adjusted, the new duration time does not become effective until the timer expires.

This function is available only when your application includes an LTM E expansion module.

Functional Characteristics

The automatic restart function includes the following features:

- 3 time delays:
  - Auto Restart Immediate Timeout
  - Auto Restart Delayed Timeout
  - Voltage Dip Restart Timeout
- 5 status flags:
  - Voltage Dip Detection: the LTM R is in a dip condition
  - Voltage Dip Occurred: a dip has been detected in the last 4.5 seconds
  - Auto Restart Immediate Condition
  - Auto Restart Delayed Condition
  - Auto Restart Manual Condition
- 3 counting statistics:
  - Auto Restart Immediate Count
  - Auto Restart Delayed Count
  - Auto Restart Manual Count

Parameter Settings

The automatic restart function has the following parameters:

Parameters	Setting Range	Factory Setting
Voltage dip mode	0 = None 1 = Load shedding 2 = Auto restart	0 = None
Voltage dip threshold	50...115 % of Motor nominal voltage	65 %
Voltage dip restart threshold	65...115 % of Motor nominal voltage	90 %
Auto restart immediate timeout	0...0.4 s in increments of 0. 1 s	0.2 s
Auto restart delayed timeout	• 0...300 s: timeout setting in increments of 1 s • 301 s: timeout infinite	4 s
Voltage dip restart timeout	0...9999 s in increments of 1 s	2 s

Technical Characteristics

The automatic restart function has the following characteristics:

Characteristics	Value
Timing accuracy	+/– 0.1 s or +/– 5%

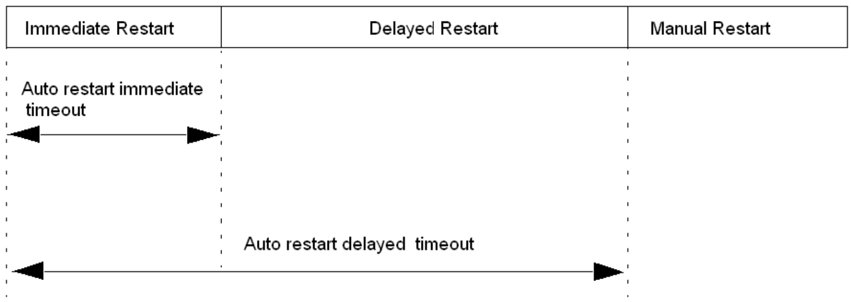
Automatic Restart Behavior

The automatic restart behavior is characterized by the voltage dip duration, that is the number of time passed from the voltage loss until the voltage restoration.

The 2 possible settings are:

- immediate restart timeout,
- delayed restart timeout (with delay defined by Restart Delay Time).

The following diagram shows the automatic restart phases:



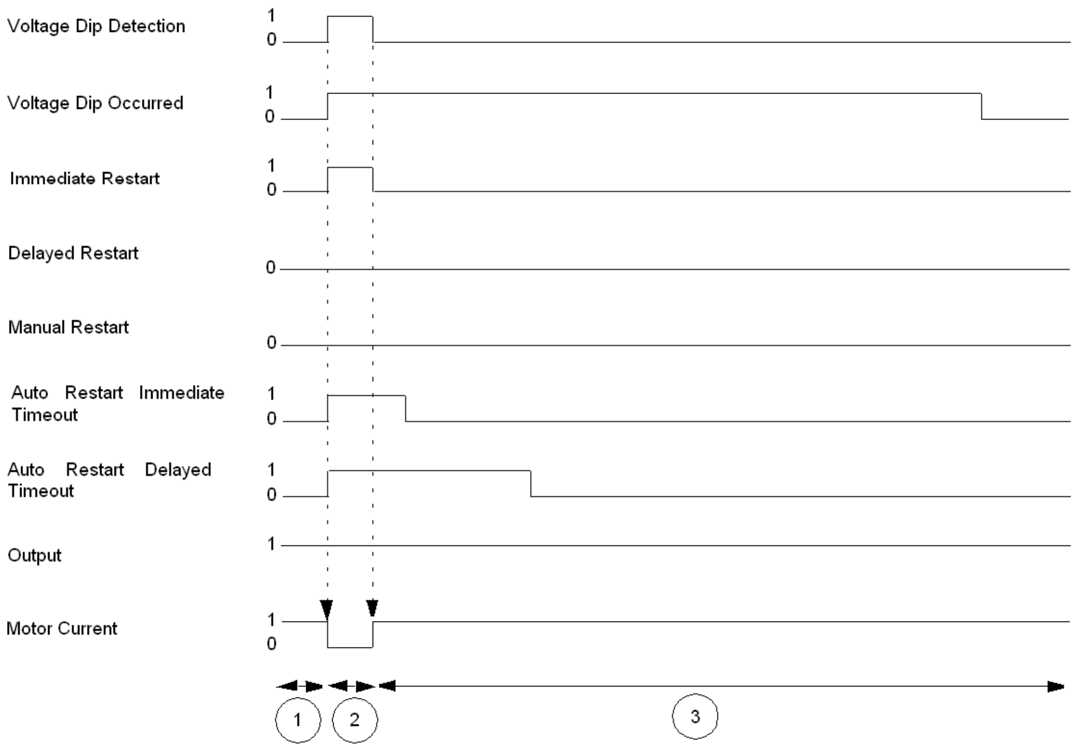
If the voltage dip duration is less than the immediate restart timeout and if the voltage dip is the second one occurring within 1 second, then the motor will require a delayed restart.

When a delayed restart is active (the delay timer is running):

- the timer is paused for the duration of the dip if a voltage dip occurs,
- the delayed restart is canceled if a start or stop command occurs.

Timing Sequence - Immediate Restart

The following diagram is an example of the timing sequence when an immediate restart occurs:



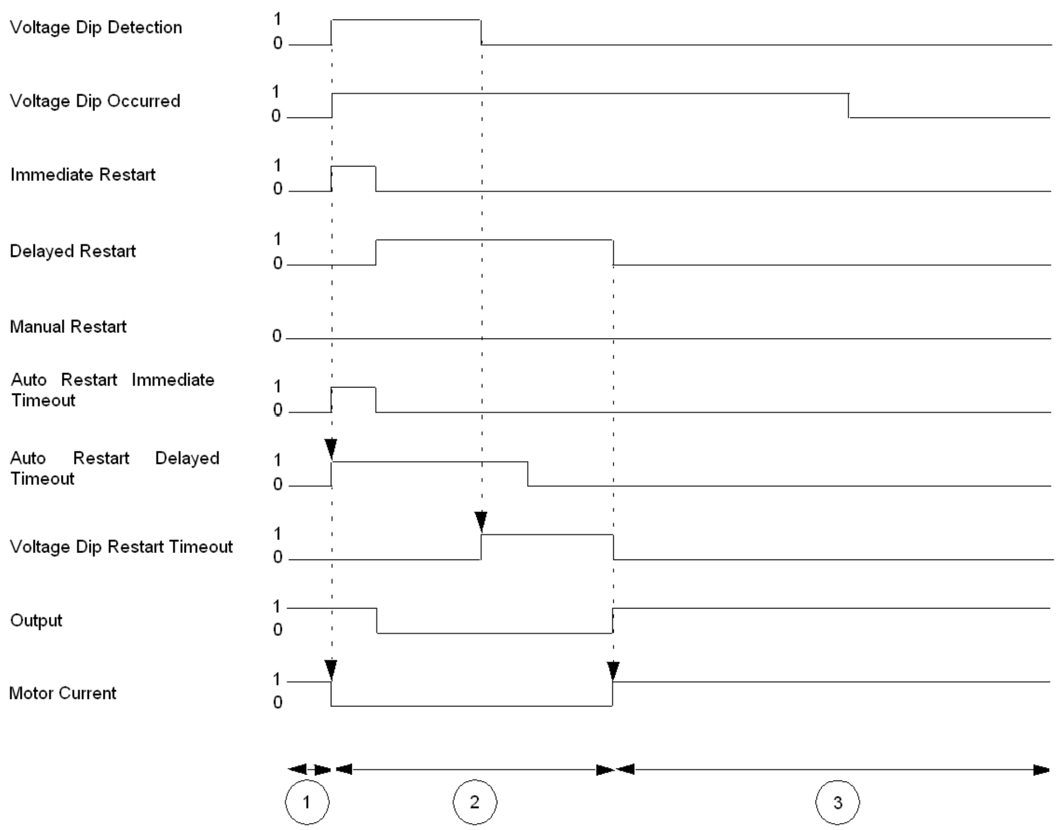
1 Motor running

2 Voltage dip detected, motor stopped

3 Voltage dip cleared, motor automatic restart

Timing Sequence - Delayed Restart

The following diagram is an example of the timing sequence when a delayed restart occurs:



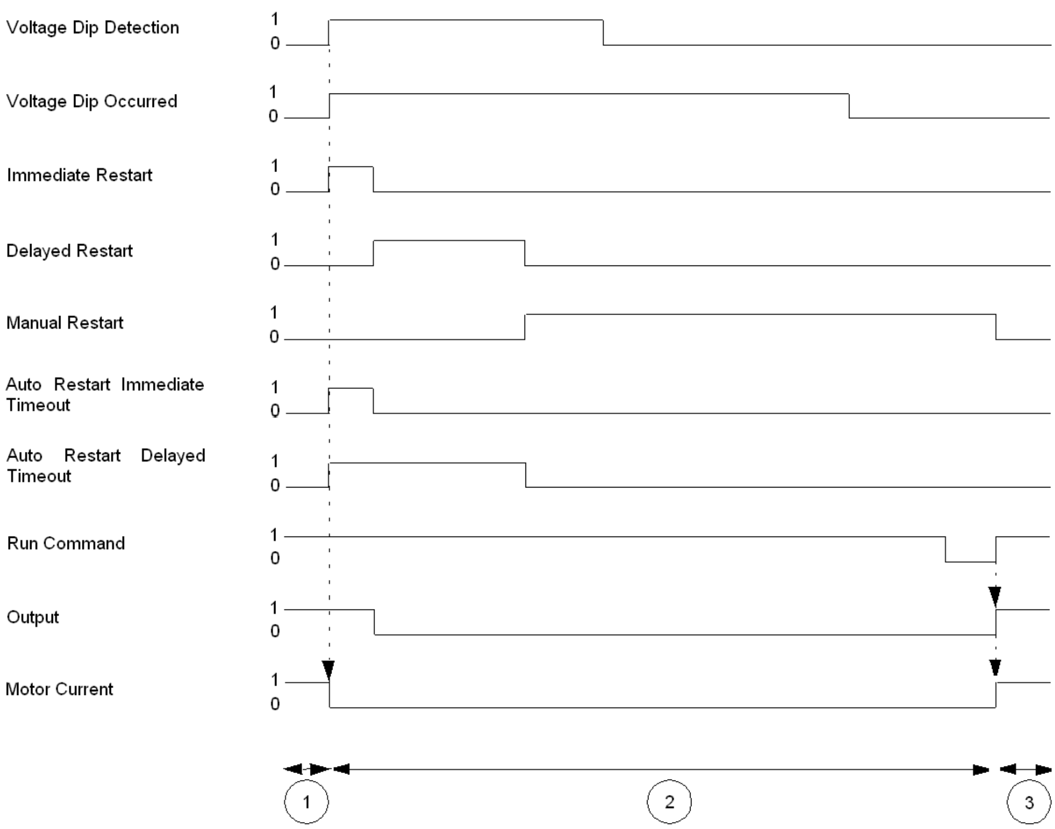
1 Motor running

2 Voltage dip detected, motor stopped

3 Voltage dip cleared, motor automatic restart

Timing Sequence - Manual Restart

The following diagram is an example of the timing sequence when a manual restart occurs:



1 Motor running

2 Voltage dip detected, motor stopped

3 Voltage dip cleared, motor automatic restart

Power Motor Protection Functions

Overview

This section describes the power motor protection functions provided by the LTM R controller.

Underpower

Description

The underpower function signals:

- a alarm when the value of active power falls below a set threshold.
- a trip when the value of active power falls and remains below a separately set threshold for a set period of time.

This function has a single trip time delay. Both the trip and alarm thresholds are defined as a percentage of the Motor Nominal Power parameter setting (Pnom).

The underpower function is available only in run state, when the LTM R controller is connected to an expansion module.

Trip and alarm monitoring can be separately enabled and disabled.

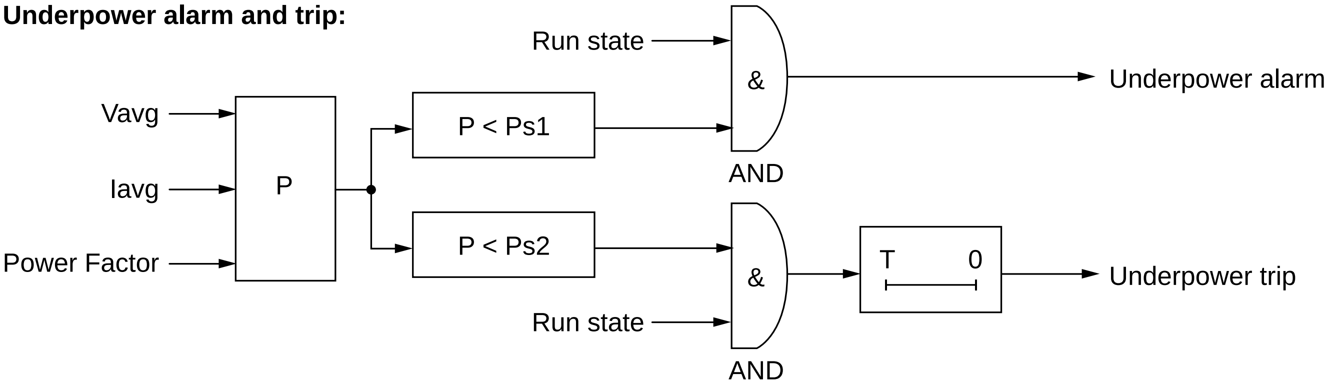
Functional Characteristics

The underpower function includes the following features:

- 2 thresholds:
  - Underpower Alarm Threshold
  - Underpower Trip Threshold
- 1 trip time delay:
  - Underpower Trip Timeout
- 2 function outputs:
  - Underpower Alarm
  - Underpower Trip
- 1 counting statistic:
  - Underpower Trips Count

Block Diagram

Underpower alarm and trip:



Vavg Average rms voltage

Iavg Average rms current

P Power

Ps1 Alarm threshold

Ps2 Trip threshold

T Trip timeout

Parameter Settings

The underpower function has the following parameters:

Parameters	Setting Range	Factory Setting
Trip enable	Enable/Disable	Disable
Trip timeout	1...100 s in 1 s increments	60 s
Trip threshold	20...800 % of Motor nominal power in 1 % increments	20 %
Alarm enable	Enable/Disable	Disable
Alarm threshold	20...800 % of Motor nominal power in 1 % increments	30 %

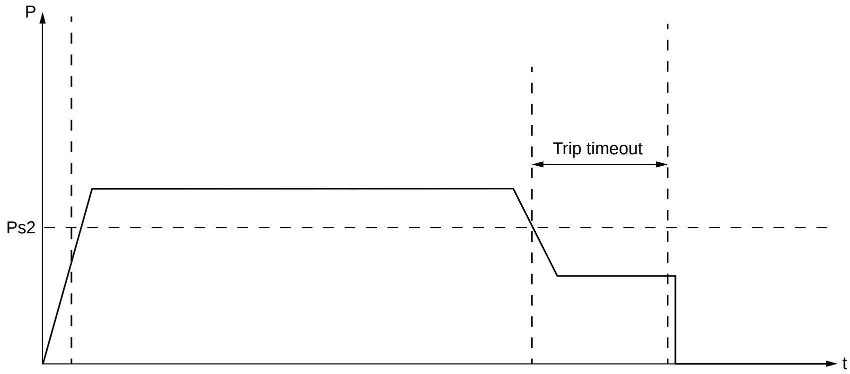
Technical Characteristics

The underpower function has the following characteristics:

Characteristics	Value
Hysteresis	–5 % of Trip threshold or Alarm threshold
Accuracy	+/– 5%

Example

The following diagram describes the occurrence of an underpower trip.



Ps2 Underpower trip threshold

Overpower

Description

The overpower function signals:

- a alarm when the value of active power exceeds a set threshold.
- a trip when the value of active power exceeds a separately set threshold and remains above that threshold for a set period of time.

This function has a single trip time delay. Both the trip and alarm thresholds are defined as a percentage of the Motor Nominal Power parameter setting (Pnom).

The overpower function is available only in run state, when the LTM R controller is connected to an expansion module.

Trip and alarm monitoring can be separately enabled and disabled.

Functional Characteristics

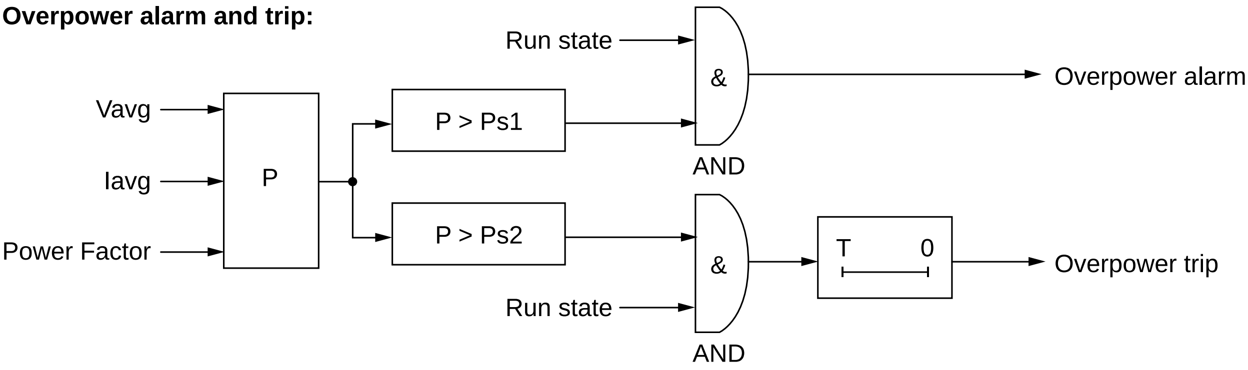
The overpower function includes the following features:

- 2 thresholds:
  - Overpower Alarm Threshold
  - Overpower Trip Threshold
- 1 trip time delay:
  - Overpower Trip Timeout
- 2 function outputs:
  - Overpower Alarm
  - Overpower Trip

- 1 counting statistic:
  - Overpower Trips Count

Block Diagram

Overpower alarm and trip:



Vavg Average rms voltage

Iavg Average rms current

P Power

Ps1 Alarm threshold

Ps2 Trip threshold

T Trip timeout

Parameter Settings

The overpower function has the following parameters:

Parameters	Setting Range	Factory Setting
Trip enable	Enable/Disable	Disable
Trip timeout	1...100 s in 1 s increments	60 s
Trip threshold	20...800 % of Motor nominal power in 1 % increments	150 %
Alarm enable	Enable/Disable	Disable
Alarm threshold	20...800 % of Motor nominal power in 1 % increments	150 %

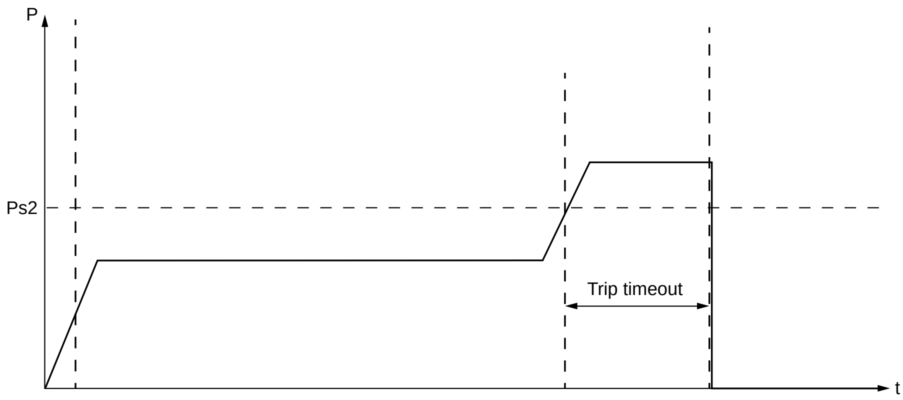
Technical Characteristics

The overpower function has the following characteristics:

Characteristics	Value
Hysteresis	–5 % of Trip threshold or Alarm threshold
Accuracy	+/– 5 %

Example

The following diagram describes the occurrence of an overpower trip.



Ps2 Overpower trip threshold

Under Power Factor

Description

The under power factor protection function monitors the value of the power factor and signals:

- a alarm when the value of the power factor falls below a set threshold.
- a trip when the value of the power factor falls below a separately set threshold and remains below that threshold for a set period of time.

This function has a single trip time delay.

The under power factor protection function is available only in run state, when the LTM R controller is connected to an expansion module.

Trip and alarm monitoring can be separately enabled and disabled.

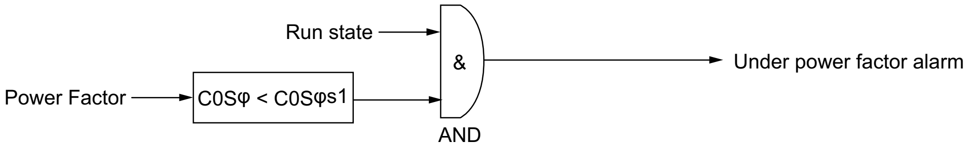
Functional Characteristics

The under power factor function includes the following features:

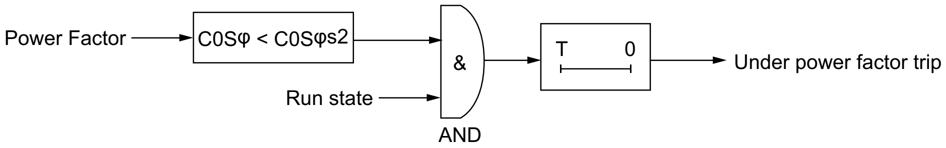
- 2 thresholds:
  - Under Power Factor Alarm Threshold
  - Under Power Factor Trip Threshold
- 1 trip time delay:
  - Under Power Factor Trip Timeout
- 2 function outputs:
  - Under Power Factor Alarm
  - Under Power Factor Trip
- 1 counting statistic:
  - Under Power Factor Trips Count

Block Diagram

Under power factor alarm:



Under power factor trip:



cosϕs1 Under power factor alarm threshold

cosϕs2 Under power factor trip threshold

T Under power factor trip timeout

Parameter Settings

The under power factor function has the following parameters:

Parameters	Setting Range	Factory Setting
Trip enable	Enable/Disable	Disable
Trip timeout	1...25 s in 0.1 s increments	10 s
Trip threshold	0...1 x Power factor in 0.01 increments	0.60
Alarm enable	Enable/Disable	Disable
Alarm threshold	0...1 x Power factor in 0.01 increments	0.60

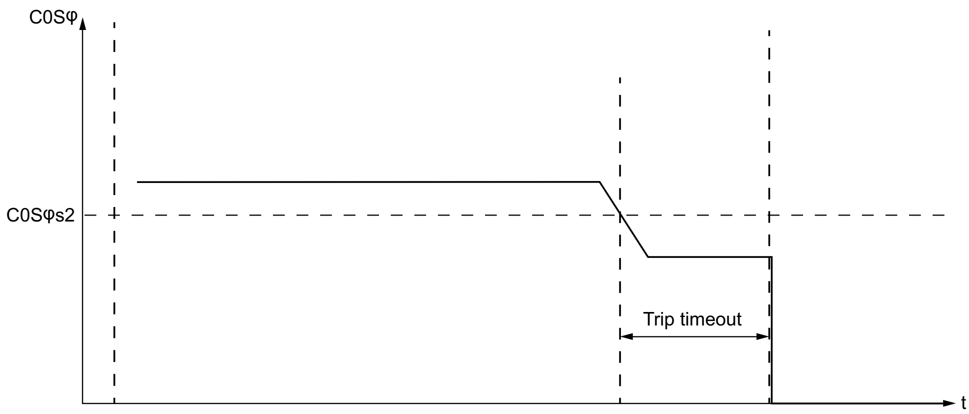
Technical Characteristics

The under power factor function has the following characteristics:

Characteristics	Value
Hysteresis	–5 % of Trip threshold or Alarm threshold
Accuracy	+/–3° or +/– 10 % (for cos ϕ ≥ 0.6)
Trip time accuracy	+/– 0.1 s or +/– 5 %

Example

The following diagram describes the occurrence of an under power factor trip.



cosϕs2 Under power factor trip threshold

Over Power Factor

Description

The over power factor protection function monitors the value of the power factor and signals:

- a alarm when the value of the power factor exceeds a set threshold.
- a trip when the value of the power factor exceeds a separately set threshold and remains above that threshold for a set period of time.

This function has a single trip time delay.

The over power factor protection function is available only in run state, when the LTM R controller is connected to an expansion module.

Trip and alarm monitoring can be separately enabled and disabled.

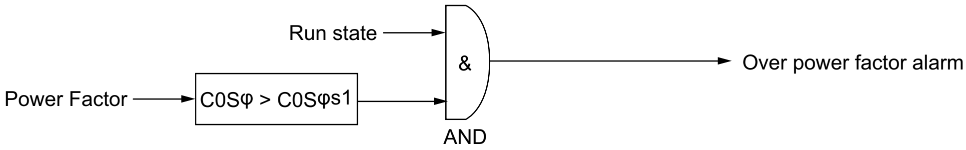
Functional Characteristics

The over power factor function includes the following features:

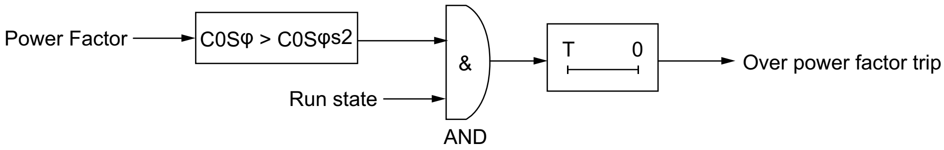
- 2 thresholds:
  - Over Power Factor Alarm Threshold
  - Over Power Factor Trip Threshold
- 1 trip time delay:
  - Over Power Factor Trip Timeout
- 2 function outputs:
  - Over Power Factor Alarm
  - Over Power Factor Trip
- 1 counting statistic:
  - Over Power Factor Trips Count

Block Diagram

Over power factor alarm:



Over power factor trip:



cosϕs1 Over power factor alarm threshold

cosϕs2 Over power factor trip threshold

T Over power factor trip timeout

Parameter Settings

The over power factor function has the following parameters:

Parameters	Setting Range	Factory Setting
Trip enable	Enable/Disable	Disable
Trip timeout	1...25 s in 0.1 s increments	10 s
Trip threshold	0...1 x Power factor in 0.01 increments	0.90
Alarm enable	Enable/Disable	Disable
Alarm threshold	0...1 x Power factor in 0.01 increments	0.90

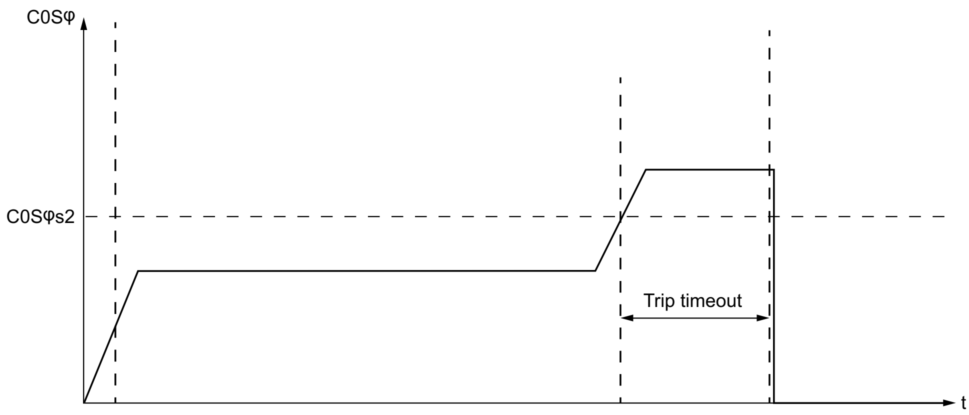
Technical Characteristics

The over power factor function has the following characteristics:

Characteristics	Value
Hysteresis	–5 % of Trip threshold or Alarm threshold
Accuracy	+/– 3° or +/– 10 % (for cos ϕ ≥ 0.6)
Trip time accuracy	+/–0.1 s or +/– 5 %

Example

The following diagram describes the occurrence of an over power factor trip.



cosϕs2 Over power factor trip threshold

Motor Control Functions

Overview

The topics in this chapter describe the LTM R controller's operating states which determine the operating modes, and the trip reset mode (manual, remote, automatic).

This chapter also introduces custom operating mode, which you can use to customize a predefined control program.

Control Channels and Operating States

Overview

This section describes:

- how to configure control of the LTM R controller outputs, and
- the LTM R controller's operating states, including:
  - how the LTM R controller transitions between operating states during startup, and
  - the motor protection functions provided by the LTM R controller in each operating state

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

The application of this product requires expertise in the design and programming of control systems. Only persons with such expertise should be allowed to program, install, alter and apply this product. Follow all local and national safety codes and standards.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Control Channels

Overview

The LTM R can be configured for 1 control channel out of 3:

- Terminal strip: Input devices wired to the input terminals on the front face of the LTM R controller.
- HMI: An HMI device connected to the LTM R controller's HMI port.
- Network: A network PLC connected to the controller network port.

Control Channel Selection

You can easily select between 2 control channels, assigning one channel to be the local control source and the second channel to be the remote control source.

The possible channel assignments are:

Control Channel	Local	Remote
Terminal strip (factory setting)	Yes	Only with an LTM CU present
HMI	Yes	Only with an LTM CU present
Network	No	Yes

In local control, the control channel selection (Terminal strip or HMI) is determined by setting the Control local channel setting in the Control setting register.

In remote control, the control channel selection is always Network, unless an LTM CU is present. In this case, the control channel selection is determined by setting the Control remote channel setting in the Control setting register.

If an LTM CU is present, the logic input I.6 and the local/remote button on the LTM CU are used together to select between local and remote control source:

Logic Input I.6	LTM CU Local/Remote Status	Active Control Source
Inactive	-	Local
Active	Local	Local
	Remote (or not present)	Remote

NOTE:

- The Network control channel is always considered as 2-wire control, regardless of the operating mode selected.
- In 3-wire mode, Stop commands can be disabled in the Control setting register.
- In 2-wire mode, Stop commands given by the non-controlling channel shall always be ignored.
- Run commands from a channel other than the selected control channel shall be ignored.

For a predefined operating mode, only one control source may be enabled to direct the outputs. You can use the custom logic editor to add one or more additional control sources.

Terminal Strip

In Terminal Strip control, the LTM R controller commands its outputs according to the state of its inputs. This is the control channel factory setting when logic input I.6 is inactive.

The following conditions apply to Terminal Strip control channel:

- Any terminal inputs assigned to start and stop commands control the outputs according to the motor operating mode.
- HMI and network start commands are ignored.

When using LTM CU, the parameter Stop Terminal Strip Disable is set in the Control Setting register.

HMI

In HMI control, the LTM R controller commands its outputs in response to start and stop commands received from an HMI device connected to the HMI port.

The following conditions apply to HMI control channel:

- Any HMI start and stop commands control the outputs according to the motor operating mode.
- Network start commands and terminal strip start commands are ignored.

When using LTM CU, the parameter Stop HMI Disable is set in the Control Setting register.

Network

In Network control, a remote PLC sends commands to the LTM R controller through the network communication port.

The following conditions apply to Network control channel:

- Any network start and stop commands control the outputs according to the motor operating mode.
- The HMI unit can read (but not write) the LTM R controller parameters.

Control Transfer Mode

Select the Control Transfer Mode parameter to enable bumpless transfer when changing the control channel; clear this parameter to enable bump transfer. The configuration setting for this parameter determines the behavior of logic outputs O.1 and O.2, as follows:

Control Transfer Mode Setting	LTM R Controller Behavior When Changing Control Channel
Bump	Logic outputs O.1 and O.2 open (if closed) or remain open (if already open) until the next valid signal occurs. The motor stops. Note: In overload predefined operating mode, logic outputs O.1 and O.2 are user-defined and therefore may not be affected by a Bump transfer.
Bumpless	Logic outputs O.1 and O.2 are not affected and remain in their original position until the next valid signal occurs. The motor does not stop.

When you start the motor in Remote control mode with the PLC, the LTM R controller changes to Local control mode (I.6=1 to I.6=0) and the status of the motor changes depending on the control transfer mode, as follows:

If the LTM R controller configuration is...	Then the control mode changes from Remote to Local and the motor…
3-Wire Bumpless	keeps running
2-Wire Bumpless	keeps running if the logic inputs I.1 or I.2 are activated
3-Wire Bump	stops
2-Wire Bump	

When the LTM R controller changes from Local to Remote control mode (I.6=0 to I.6=1), the status of the motor in Local control mode, whether running or stopped, remains unchanged. The control transfer mode selected does not affect the status of the motor as the LTM R controller only takes account of the last control command (logic outputs O.1 or O.2) sent by the PLC.

⚠ CAUTION

FAILURE TO STOP AND RISK OF UNINTENDED OPERATION

LTM R controller operation cannot be stopped from the terminals when control channel is changed to Terminal Strip control channel if the LTM R controller is:

- operating in Overload operating mode- and -
- configured in Bumpless- and -
- operated over a network using Network control channel- and -
- operating in Run state- and -
- configured for 3-wire (impulse) control.

See instructions below.

Failure to follow these instructions can result in injury or equipment damage.

Whenever control channel is changed to Terminal Strip control channel, operation of the LTM R controller cannot be stopped from the terminals because no terminal input is assigned to a STOP command.

If this behavior is not intended, the control channel must be changed to either Network control channel or HMI control channel to command a STOP. To implement this change, take one of the following precautionary steps:

- the commissioner should configure the LTM R controller for either bump transfer of control channel or 2-wire control.
- the installer should provide the LTM R controller with a means of interrupting current to the contactor coil - for example, a push button station wired in series with the LTM R controller outputs.
- the controls engineer should assign a terminal input to disable the Run command using Custom Configuration Mode assignments.

Fallback Transitions

The LTM R controller enters a fallback state when communication with the control source is lost, and exits the fallback state when communication is restored. The transition into and out of the fallback state is as follows:

Transition	Control Source Transfer
Entering the fallback state	Bumpless, when the Control Direct Transition bit is on
Exiting the fallback state	Determined by the settings for Control Transfer Mode (bump or bumpless) and Control Direct Transition (on or off)

For information on how to configure communications fallback parameters, refer to the topic Communication Loss, page 64.

When using LTM CU, the parameters Control Transfer Mode and Control Direct Transition parameters are set in the Control Setting register.

Operating States

Introduction

The LTM R controller responds to the state of the motor and provides control, monitoring and protection functions appropriate to each of the motor’s operating states. A motor can have many operating states. Some operating states are persistent while others are transitional.

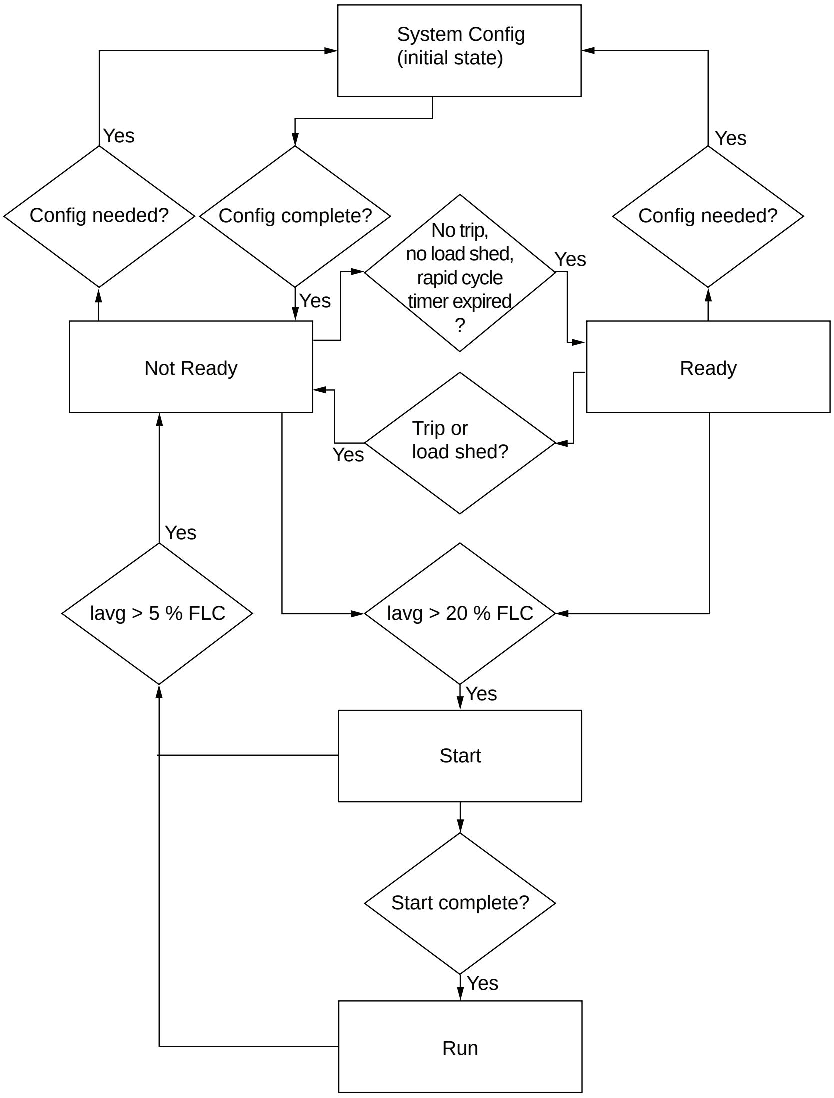
A motor’s primary operating states are:

Operating State	Description
Ready	• The motor is stopped. • The LTM R controller: ◦ detects no trip ◦ is not performing load shedding ◦ is not counting down the rapid cycle timer ◦ is ready to start
Not Ready	• The motor is stopped. • The LTM R controller: ◦ detects a trip ◦ is performing load shedding ◦ is counting down the rapid cycle timer

Operating State	Description
Start	• The motor starts. • The LTM R controller: ◦ detects that current has reached the On Level Current threshold ◦ detects that current has not both crossed and re-crossed the long start trip threshold ◦ continues to count down the long start trip timer.
Run	• The motor is running. • The LTM R controller detects that current has both crossed and re-crossed the long start trip threshold before the LTM R controller fully counted down the long start trip timer.

Operating State Chart

The operating states of the LTM R controller firmware, as the motor progresses from Off to Run state, are described below. The LTM R controller verifies current in each operating state. The LTM R controller can transition to an internal trip condition from any operating state.



Protection Monitoring by Operating States

The motor operating states, and the trip and alarm protections provided by the LTM R controller while the motor is in each operating state (denoted with an X), are described below. It can transition to an internal trip condition from any operating state.

Protection Category	Monitored Trip/Alarm	Operating States				
		Sys Config	Ready	Not Ready	Start	Run
Diagnostic	Run Command Check	–	X	–	–	–
	Stop Command Check	–	–	X	X	X
	Run Check Back	–	–	–	X	X
	Stop Check Back	–	–	–	X	X
Wiring / configuration trips	PTC connection	–	X	X	X	X
	CT Reversal	–	–	–	X	–
	Voltage Phase Loss	–	X	X	–	–
	Phase Configuration	–	–	–	X	–
Internal trips	Minor	X	X	X	X	X
	Major	X	X	X	X	X
Motor temp sensor	PTC Binary	–	X	X	X	X
	PT100	–	X	X	X	X
	PTC Analog	–	X	X	X	X
	NTC Analog	–	X	X	X	X
Thermal overload	Definite	–	–	–	–	X
	Inverse Thermal	–	X	X	X	X
Current	Long Start	–	–	–	X	–
	Jam	–	–	–	–	X
	Current Phase Imbalance	–	–	–	X	X
	Current Phase Loss	–	–	–	X	X
	Overcurrent	–	–	–	–	X
	Undercurrent	–	–	–	–	X
	Ground Current Trip (Internal)	–	–	–	X	X
	Ground Current Trip (External)	–	–	–	X	X
Voltage	Overvoltage Level	–	X	X	–	X
	Undervoltage Level	–	X	X	–	X
	Voltage Phase Imbalance	–	–	–	X	X
Power / Power Factor	Over Power Factor Level	–	–	–	–	X
	Under Power Factor Level	–	–	–	–	X
	Overpower Level	–	–	–	–	X
	Underpower Level	–	–	–	–	X
X Monitored **–** Not monitored						

Start Cycle

Description

The start cycle is the time period allowed for the motor to reach its normal FLC level. The LTM R controller measures the start cycle in seconds, beginning when it detects On Level Current, defined as maximum phase current equal to 20 % of FLC.

During the start cycle, the LTM R controller compares:

- detected current against the configurable Long Start Trip Threshold parameter, and
- elapsed start cycle time against the configurable Long Start Trip Timeout parameter.

There are 3 start cycle scenarios, each based on the number of times (0,1 or 2) maximum phase current crosses the Long Start Trip Threshold. A description of each scenario is described below.

For information on the statistics the LTM R controller retains describing motor starts, see Motor Starts Counters, page 71. For information about the long start protection function, see Long Start, page 100.

Start Cycle Operating States

During the start cycle, the LTM R controller transitions through the motor's operating states as follows:

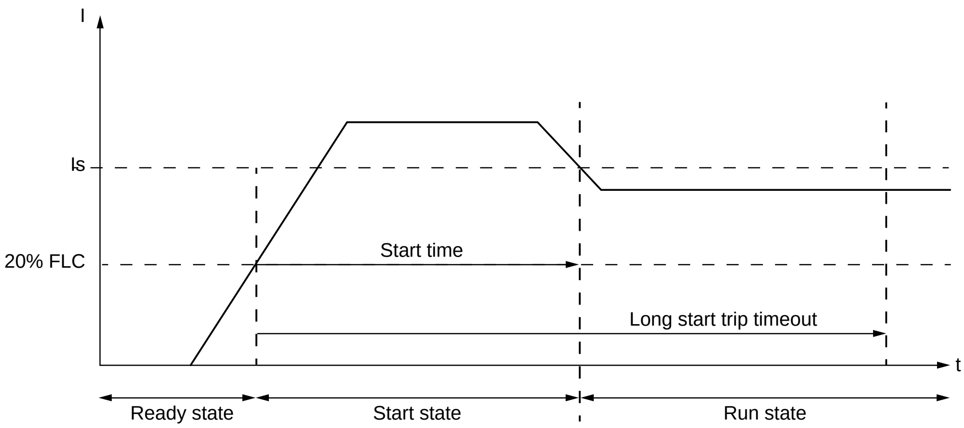
Step	Event	Operating State
1	LTM R controller receives a start command input signal.	Ready
2	The LTM R controller confirms that all startup preconditions exist (e.g. no trips, load shedding, or rapid cycle timer).	Ready
3	The LTM R controller closes the appropriate output contacts designated as terminals 13-14 or 23-24, thereby closing the control circuit of the motor starting contactors.	Ready
4	The LTM R controller detects that maximum phase current exceeds the On Level Current threshold.	Start
5	The LTM R controller detects that current rises above and then falls below the Long Start Trip Threshold before the Long Start Trip Timeout timer expires.	Run

2 Threshold Crosses

In this start cycle scenario, the start cycle executes successfully:

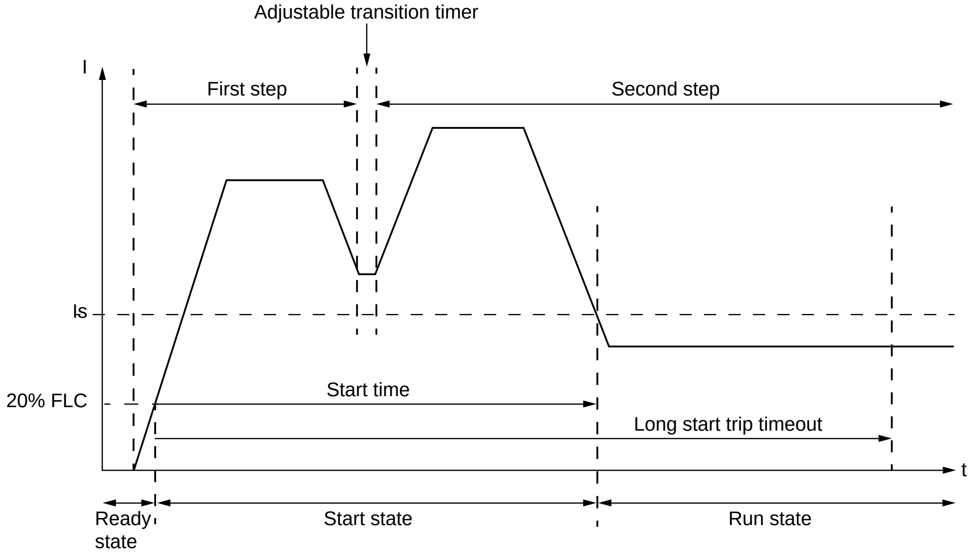
- Current rises above, then drops below, the trip threshold.
- The LTM R controller reports the actual start cycle time, i.e. the time elapsed from detection of On Level Current until the maximum phase current drops below the trip threshold.

Start cycle with 2 threshold crosses, single step:



Is Long start trip threshold

Start cycle with 2 threshold crosses, 2 step:

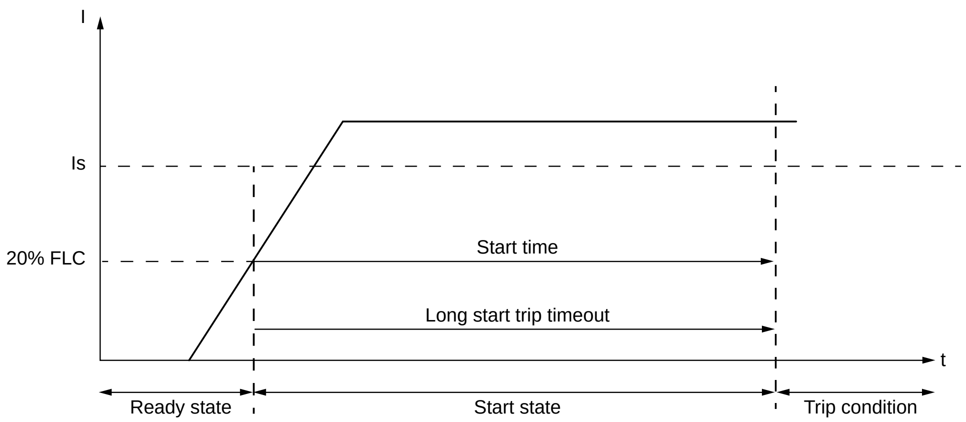


1 Threshold Cross

In this start cycle scenario, the start cycle does not occur.:

- Current rises above, but does not drop below, the Long Start Trip Threshold.
- If Long Start protection is enabled, the LTM R controller signals a trip when the Long Start Trip Timeout is reached
- If Long Start protection is disabled, the LTM R controller does not signal a trip and the run cycle begins after the Long Start Trip Timeout has expired.
- Other motor protection functions begin their respective duration times after the Long Start Trip Timeout.
- The LTM R controller reports start cycle time as 9999, indicating that current exceeded and remained above the trip threshold.
- The LTM R controller reports the maximum current detected during the start cycle.

Start cycle with 1 threshold cross:



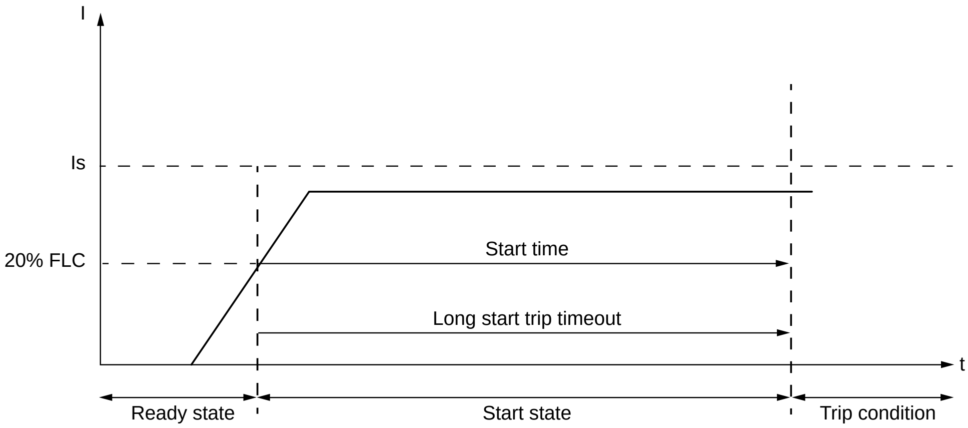
0 Threshold Cross

In this start cycle scenario, the start cycle does not occur.:

- Current never rises above the trip threshold.
- If Long Start protection is enabled, the LTM R controller signals a trip when the Long Start Trip Timeout is reached

- If Long Start protection is disabled, the LTM R controller does not signal a trip and the run cycle begins after the Long Start Trip Timeout has expired.
- Other motor protection functions begin their respective duration times after the Long Start Trip Timeout.
- The LTM R controller reports both the start cycle time and the maximum current detected during start cycle as 0000, indicating current never reached the trip threshold.

Start cycle with 0 threshold cross:



Is Long start trip threshold

Operating Modes

Overview

The LTM R controller can be configured to 1 of 10 predefined operating modes. Selecting custom operating mode allows you to select one of the 10 predefined operating modes and customize it to your specific application.

The selection of a predefined operating mode determines the behavior of all LTM R controller inputs and outputs.

Each predefined operating mode selection includes a control wiring selection:

- 2-wire (maintained), or
- 3-wire (impulse)

Control Principles

Overview

The LTM R controller performs control and monitoring functions for single-phase and 3-phase electric motors.

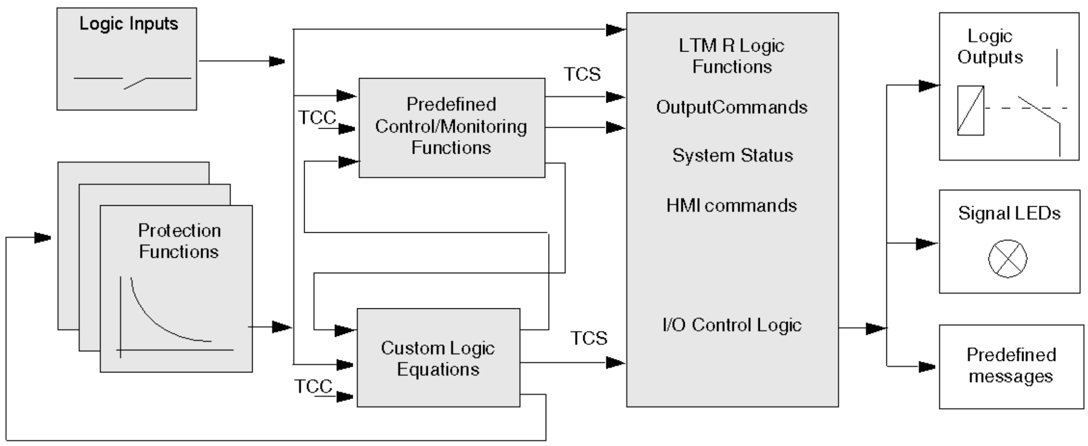
- These functions are predefined and fit the applications most frequently used. They are ready to use and are implemented by simple parameter setting after the LTM R controller has been commissioned.
- The predefined control and monitoring functions can be adapted for particular needs using the custom logic editor in the TeSys T DTM to:
  - customize the use of results of protection functions
  - change the operation of control and monitoring functions
  - alter the predefined LTM R controller I/O logic

Operating Principle

The processing of control and monitoring functions has 3 parts:

- acquisition of input data:
  - the output of protection function processing
  - external logic data from logic inputs
  - telecommunication commands (TCC) received from the control source
- logic processing by the control or monitoring function
- utilization of the processing results:
  - activation of logic outputs
  - display of predefined messages
  - activation of LEDs
  - telecommunication signals (TCS) sent via a communications link.

The control and monitoring function process is displayed below:



Logic Inputs and Outputs

The LTM R controller provides 6 logic inputs and 4 logic outputs. By adding an LTM E expansion module, you can add 4 more logic inputs.

Selecting a predefined operating mode automatically assigns the logic inputs to functions and defines the relationship between logic inputs and outputs. Using the custom logic editor, you can change these assignments.

Predefined Operating Modes

Overview

The LTM R controller can be configured in 1 out of 10 predefined operating modes. Each operating mode is designed to meet the requirements of a common application configuration.

When you select an operating mode, you specify both the:

- operating mode type, which determines the relationship between logic inputs and logic outputs, and
- control circuit type, which determines logic input behavior, based on the control wiring design

Operating Mode Types

There are 10 types of operating modes:

Operating Mode Type	Best used for:
Overload, page 152	All motor starter applications in which the user defines assignment of: • logic inputs I.1, I.2, I.3 and I.4 • logic outputs O.1 and O.2 • Aux1, Aux2 and Stop commands from the HMI keypad. The I/O can be defined using a control program managed by the primary network controller in remote control, by an HMI tool, or by using custom logic.
Independent, page 154	Direct-on-line (across-the-line) full-voltage non-reversing motor starting applications
Reverser, page 156	Direct-on-line (across-the-line) full-voltage reversing motor starting applications
Two-Step, page 160	Reduced voltage starting motor applications, including: • Wye-Delta • Open Transition Primary Resistor • Open Transition Autotransformer
Two-Speed, page 165	Two-speed motor applications for motor types, including: • Dahlander (consequent pole) • Pole Changer

Logic Input Behavior

When you select an operating mode, you also specify that logic inputs are wired for either 2-wire (maintained) or 3-wire (impulse) control. Your selection determines the valid start and stop commands from the various control sources, and sets the behavior of the input command following the return of power after an outage:

Control Circuit Type	Behavior of Logic Inputs I.1 and I.2
2-wire (maintained)	The LTM R controller, after detecting the rising edge on the input assigned to start the motor, issues a run command. The run command remains active only while the input is active. The signal is not latched.
3-wire (impulse)	The LTM R controller: • After detecting the rising edge on the input assigned to start the motor, latch the run command, and • After a stop command, disables the run command to disable the output relay wired in series with the coil of the contactor that turns the motor on or off • Following a stop, must detect a rising edge on the input to latch the run command.

Control logic assignments for logic inputs I.1, I.2, I.3 and I.4 are described in each of the predefined motor operating modes.

NOTE: In Network control channel, network commands behave as 2-wire control commands, regardless of the control circuit type of the selected operating mode. For information on Control Channels, see Control Channels, page 139.

In each predefined operating mode, logic inputs I.3, I.4, I.5 and I.6 behave as follows:

Logic Input	Behavior
I.3	• When it is configured to be used as the external system ready input (Logic Input 3 External Ready Enable = 1), this input provides a feedback on the system state (Ready or not): ◦ If I.3 = 0, the external system is not ready. System Ready bit (455.0) is set to 0. ◦ If I.3 = 1, the external system is ready. System Ready bit (455.0) can be set to 1 depending on other conditions on the system. • When it is not configured to be used as the external system ready input (Logic Input 3 External Ready Enable = 0), this input is user defined and only sets a bit in a register.
I.4	• In 3-wire (impulse) control: a Stop command. Note that this stop command can be disabled in terminal strip control by setting the parameter Stop terminal strip disable in the Control setting register. • In 2-wire (maintained) control: a user-defined input that can be configured to send information to a PLC address over the network. Note: In Overload operating mode, logic input I.4 is not used and can be user-defined.
I.5	A Trip Reset command is recognized when this input receives the rising edge of a signal. **Note:** this input must first become inactive, and then receive the rising edge of a subsequent signal, for another reset to occur.
I.6	Local/Remote control of the LTM R controller's outputs: • Active: Remote control (can be associated to any Control channel). • Inactive: Local control through either the terminal strip or the HMI port, as determined by the Control Local Channel Setting parameter.

⚠ WARNING

LOSS OF MOTOR PROTECTION IN HMI CONTROL

If the terminal strip Stop is disabled, the trip output (terminal NC 95-96) must be wired in series with the contactor coil.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Logic Output Behavior

The behavior of logic outputs O.1 and O.2 is determined by the selected operating mode. See the topics that follow for a description of the 10 predefined operating mode types and the behavior of logic outputs O.1 and O.2.

When the LTM R controller has lost communication with either the network or the HMI, the LTM R controller enters a fallback condition. When it receives a stop command in a fallback condition, logic outputs O.1 and O.2 behave as follows:

Control Circuit Type	Response of Logic Outputs O.1 and O.2 to a Stop Command
2-wire (maintained)	A stop command overrides the fallback condition and turns off logic outputs O.1 and O.2 while the stop command is active. After the stop command is no longer active, logic outputs O.1 and O.2 return to their programmed fallback state.
3-wire (impulse)	A stop command overrides the fallback condition and turns off logic outputs O.1 and O.2. The outputs remain off after the stop command is removed and do not return to their programmed fallback state.

For more information about configuring fallback parameters, refer to the Fallback Condition, page 64 portion of the topic describing Communication Loss.

In all operating mode types, the following logic outputs behave as described below:

Logic Output	Behavior
O.3	Activated by any enabled protection alarm: • Terminals NO 33-34
O.4	Activated by any enabled protection trip: • Terminals NC 95-96 • Terminals NO 97-98 **Note:** When control voltage is too low or off: • NC 95-96 open • NO 97-98 close

Control Wiring and Trip Management

Overview

When Overload predefined operating mode is selected, the LTM R controller does not manage logic output O.1, O.2, and O.3.

For all other predefined operating modes (Independent, Reverser, 2-Step, and 2-Speed) the predefined control logic in the LTM R controller is designed to meet the objectives of many common motor starting applications. This includes managing motor behavior in response to:

- start and stop actions, and
- trip and reset actions

Because the LTM R controller can be used in special applications, such as fire pumps that require the motor to run despite a known external trip condition, the predefined control logic is designed so that the control circuit, and not the predefined control logic, determines how the LTM R controller interrupts current flow to the contactor coil.

Control Logic Action on Starts and Stops

Predefined control logic acts upon start and stop commands as follows:

- For all 3-wire (impulse) control wiring diagrams, when input 4 is configured as a stop command, the LTM R controller must detect input current at logic input I.4 in order to act on a start command.
- If logic input I.4 is active and a user start action initiates current at logic inputs I.1 or I.2, the LTM R controller detects the rising edge of the current and sets an internal (firmware) latch command that directs the appropriate relay output to close and remain closed until the latch command is disabled.
- A stop action that interrupts current at logic input I.4, causes the LTM R controller to disable the latch command. Disabling the firmware latch causes the output to open–and remain open–until the next valid start condition.
- For all 2-wire (maintained) control wiring diagrams, the LTM R controller detects the presence of current at logic inputs I.1 or I.2 as start commands, and the absence of current disables the start command.

Control Logic Action on Trips and Resets

Predefined control logic manages trips and reset commands as follows:

- Logic output O.4 opens in response to a trip condition.
- Logic output O.4 closes in response to a reset command.

Control Logic and Control Wiring Together Managing Trips

The control circuits, shown in the wiring diagrams in this chapter and in the Appendix, indicate how the LTM R controller's control logic and the control circuit combine to stop a motor in response to a trip:

- For 3-wire (impulse) control circuits, the control strategy links the state of logic output O.4 to the state of the current at logic input I.4:
  - Control logic opens logic output O.4 in response to a trip.
  - Logic output O.4 opening interrupts current at logic input I.4, disabling the control logic latch command on logic output O.1.
  - Logic output O.1 opens, due to control logic described above, and stops the flow of current to the contactor coil.

  In order to restart the motor, the trip must be reset and a new start command must be issued.
- For 2-wire (maintained) control circuits, the control strategy links the state of logic output O.4 directly with the logic inputs I.1 or I.2.
  - Control logic opens logic output O.4 in response to a trip.
  - Logic output O.4 opening interrupts current to the logic inputs I.1 or I.2
  - Control logic disables the start commands opening logic outputs O.1 or O.2.

  In order to restart the motor, the trip must be reset and the state of Start/Stop operators determines the state of logic inputs I.1 or I.2.

The control circuits needed to run a motor, during a motor protection trip, are not shown in the wiring diagrams that follow. However, the control strategy is to not link the state of logic output O.4 to the state of the input commands. In this way, trip conditions may be annunciated, while control logic continues to manage Start and Stop commands.

Overload Operating Mode

Description

Use Overload operating mode when motor load monitoring is required and motor load control (start/stop) is performed by a mechanism other than the LTM R controller.

Functional Characteristics

The Overload operating mode includes the following features:

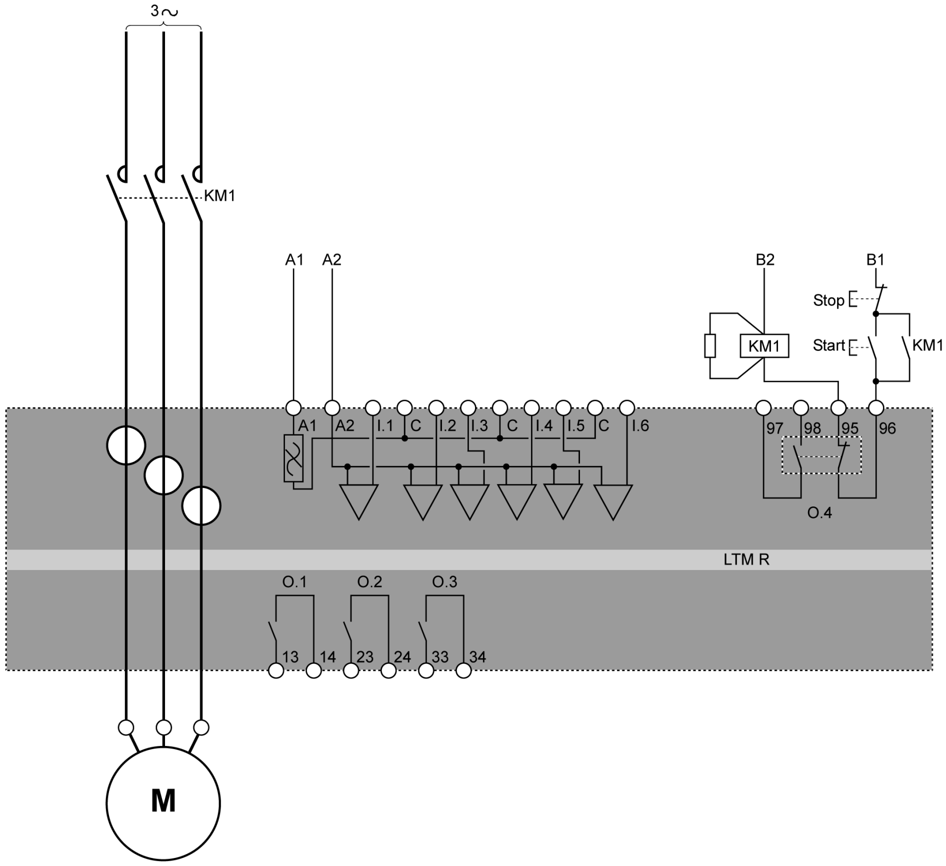
- The LTM R controller overload operating mode does not manage logic outputs O.1, O.2, and O.3. The logic output O.1 and O.2 commands are accessible in Network control channel.
- Logic output O.4 opens in response to a diagnostic detected error.

  NOTE: In Overload operating mode, diagnostic detected error is disabled by default. If needed, it can be enabled by the user.
- The LTM R controller sets a bit in a status word when it detects an active signal:
  - on logic inputs I.1, I.2, I.3, or I.4, or
  - from the Aux 1, Aux 2, or Stop buttons on the HMI keypad.

  NOTE: When a bit is set in the input status word, it can be read by a PLC which can write a bit to the LTM R controller's command word. When the LTM R controller detects a bit in its command word, it can turn on the respective output (or outputs).

Overload Application Diagram

The following wiring diagram represents a simplified example of the LTM R controller in a 3-wire (impulse) terminal strip control overload application.



For additional examples of overload operating mode IEC diagrams, refer to relevant diagrams .

For examples of overload operating mode NEMA diagrams, refer to relevant diagrams .

I/O Assignment

Overload operating mode provides the following logic inputs:

Logic Inputs	Assignment
I.1	Free
I.2	Free
I.3	Free
I.4	Free
I.5	Reset
I.6	Local (0) or Remote (1)

Overload operating mode provides the following logic outputs:

Logic Outputs	Assignment
O.1 (13 and 14)	Responds to network control commands
O.2 (23 and 24)	Responds to network control commands
O.3 (33 and 34)	Alarm signal
O.4 (95, 96, 97, and 98)	Trip signal

Overload operating mode uses the following HMI keys:

HMI Keys	Assignment
Aux 1	Free
Aux 2	Free
Stop	Free

Parameters

Overload operating mode requires no associated parameter settings.

Independent Operating Mode

Description

Use Independent operating mode in single direct-on-line (across-the-line) full-voltage, non-reversing motor starting applications.

Functional Characteristics

This function includes the following features:

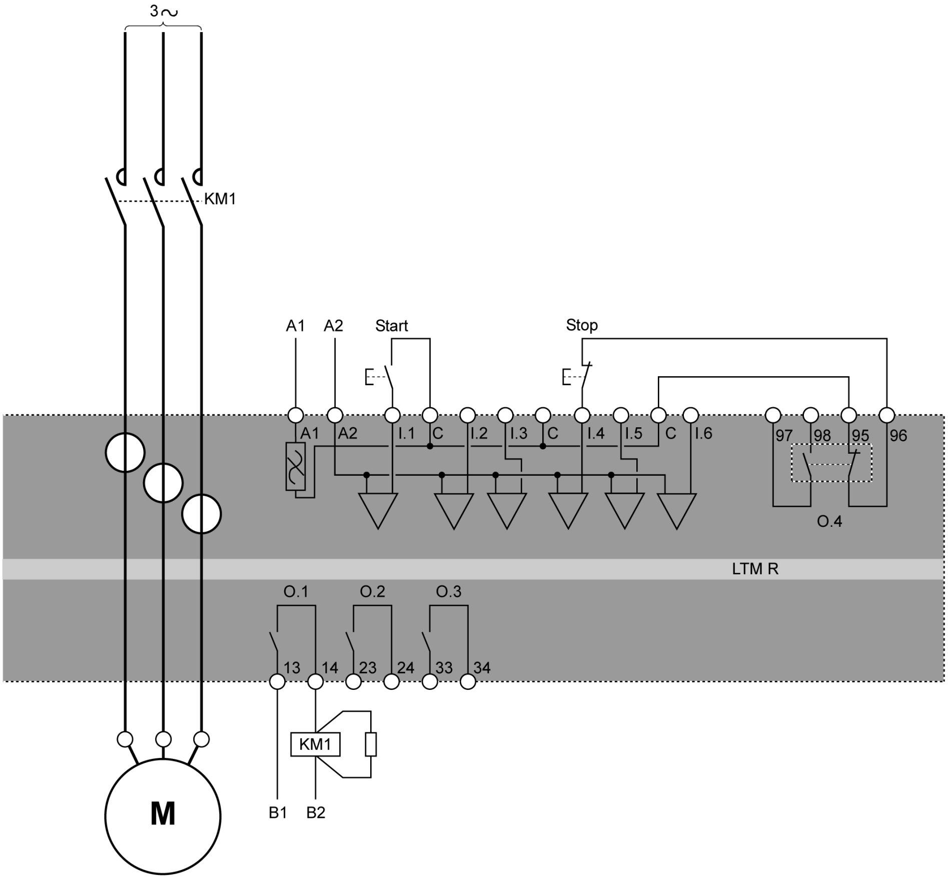
- Accessible in 3 control channels: Terminal Strip, HMI, and Network.
- The LTM R controller does not manage the relationship between logic outputs O.1 and O.2.
- In terminal strip control channel, logic input I.1 controls logic output O.1, and logic input I.2 controls logic output O.2.
- In network or HMI control channels, the Motor Run Forward Command parameter controls logic output O.1 and the Logic Output 23 Command parameter controls logic output O.2.
- Logic input I.3 is not used in the control circuit, but can be configured to set a bit in memory.
- Logic outputs O.1 and O.2 deactivate (and the motor stops) when control voltage becomes too low.
- Logic outputs O.1 and O.4 deactivate (and the motor stops) in response to a diagnostic detected error.

  NOTE: See Control Wiring and Trip Management, page 151 for information about the interaction between

  - the LTM R controller's predefined control logic, and
  - the control wiring, an example of which appears in the following diagram.

Independent Application Diagram

The following wiring diagram represents a simplified example of the LTM R controller in a 3-wire (impulse) terminal strip control independent application.



For additional examples of independent operating mode IEC diagrams, refer to relevant diagrams .

For examples of independent operating mode NEMA diagrams, refer to relevant diagrams .

I/O Assignment

Independent operating mode provides the following logic inputs:

Logic Inputs	2-Wire (Maintained) Assignment	3-Wire (Impulse) Assignment
I.1	Start/Stop motor	Start motor
I.2	Open/Close O.2	Close O.2
I.3	Free	Free
I.4	Free	Stop motor and open O.1 and O.2
I.5	Reset	Reset
I.6	Local (0) or Remote (1)	Local (0) or Remote (1)

Independent operating mode provides the following logic outputs:

Logic Outputs	Assignment
O.1 (13 and 14)	KM1 contactor control
O.2 (23 and 24)	Controlled by I.2

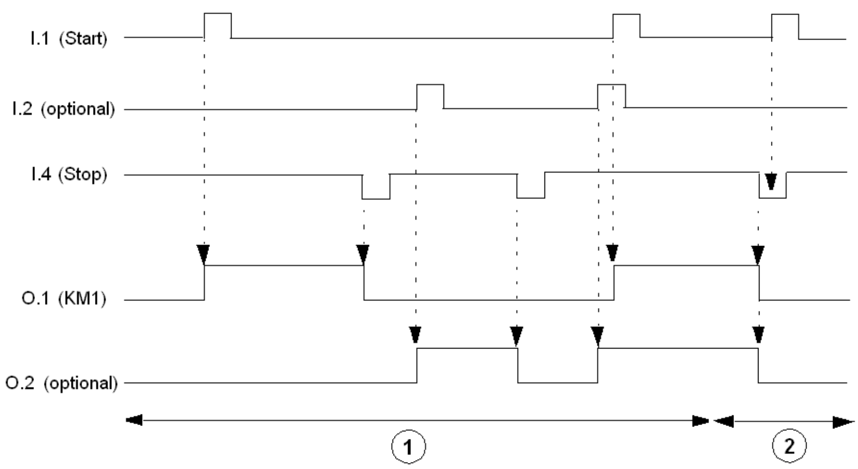
Logic Outputs	Assignment
O.3 (33 and 34)	Alarm signal
O.4 (95, 96, 97, and 98)	Trip signal

Independent operating mode uses the following HMI keys:

HMI Keys	2-Wire (Maintained) Assignment	3-Wire (Impulse) Assignment
Aux 1	Control motor	Start motor
Aux 2	Control O.2	Close O.2
Stop	Stop motor and open O.2 while pressed	Stop motor and open O.2

Timing Sequence

The following diagram is an example of the timing sequence for the Independent operating mode that shows the inputs and outputs for a 3-wire (impulse) configuration:



1 Normal operation

2 Start command ignored: stop command active

Parameters

Independent operating mode requires no associated parameters.

Reverser Operating Mode

Description

Use Reverser operating mode in direct-on-line (across-the-line) full-voltage, reversing motor starting applications.

Functional Characteristics

This function includes the following features:

- Accessible in 3 control channels: Terminal Strip, HMI, and Network.

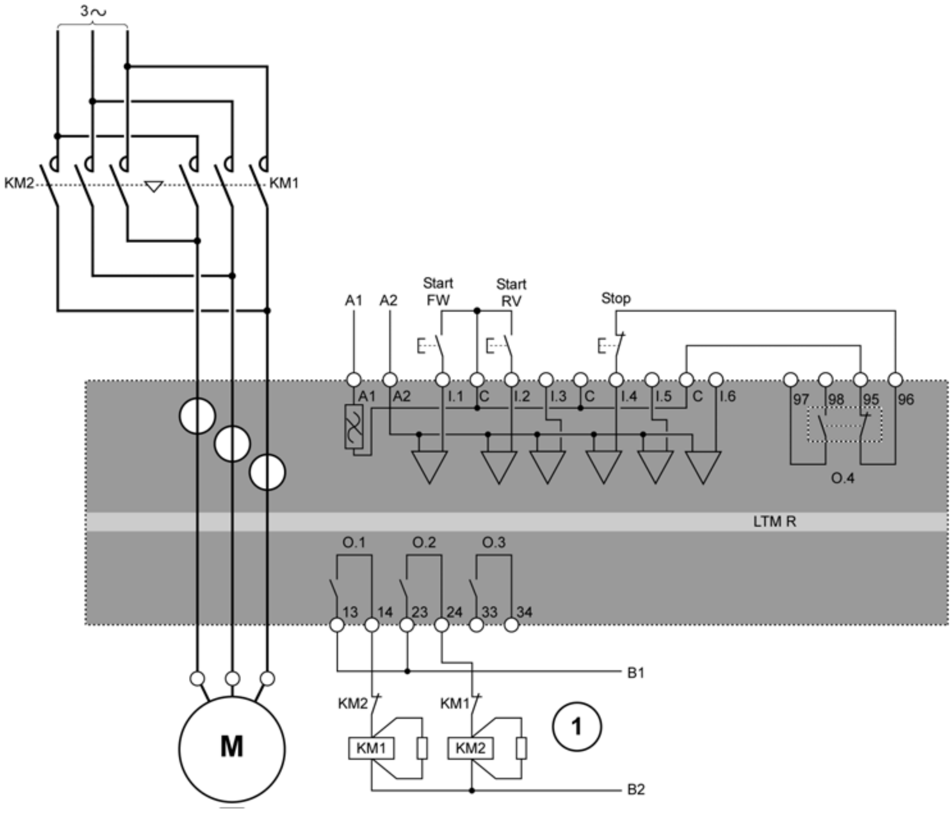
- Firmware interlocking helps prevent simultaneous activation of the O.1 (forward) and O.2 (reverse) logic outputs: in case of simultaneous forward and reverse commands, only the logic output O.1 (forward) is activated.
- The LTM R controller can change direction from forward to reverse and reverse to forward in 1 of 2 modes:
  - Standard Transition mode: The Control Direct Transition bit is Off. This mode requires a Stop command followed by count-down of the adjustable Motor Transition Timeout (anti-backspin) timer.
  - Direct Transition mode: The Control Direct Transition bit is On. This mode automatically transitions after the count-down of the adjustable Motor Transition Timeout (anti-backspin) timer.
- In terminal strip control channel, logic input I.1 controls logic output O.1, and logic input I.2 controls logic output O.2.
- In Network or HMI control channels, the Motor Run Forward Command parameter controls logic output O.1 and the Motor Run Reverse Command controls logic output O.2.
- Logic input I.3 is not used in the control circuit, but can be configured to set a bit in memory.
- Logic outputs O.1 and O.2 deactivate (and the motor stops) when control voltage becomes too low.
- Logic outputs O.1, O.2 and O.4 deactivate (and the motor stops) in response to a diagnostic detected error.

NOTE: See Control Wiring and Trip Management, page 151 for information about the interaction between

- the LTM R controller's predefined control logic, and
- the control wiring, an example of which appears in the following diagram.

Reverser Application Diagram

The following wiring diagram represents a simplified example of the LTM R controller in a 3-wire (impulse) terminal strip control reverser application.



Start FW Start forward

Start RV Start reverse

1 The N.C. interlock contacts KM1 and KM2 are not mandatory because the LTM R controller firmware interlocks O.1 and O.2.

For additional examples of reverser operating mode IEC diagrams, refer to relevant diagrams .

For examples of reverser operating mode NEMA diagrams, refer to relevant diagrams .

I/O Assignment

Reverser operating mode provides the following logic inputs:

Logic Inputs	2-Wire (Maintained) Assignment	3-Wire (Impulse) Assignment
I.1	Forward run	Start motor forward
I.2	Reverse run	Start motor reverse
I.3	Free	Free
I.4	Free	Stop motor
I.5	Reset	Reset
I.6	Local (0) or Remote (1)	Local (0) or Remote (1)

Reverser operating mode provides the following logic outputs:

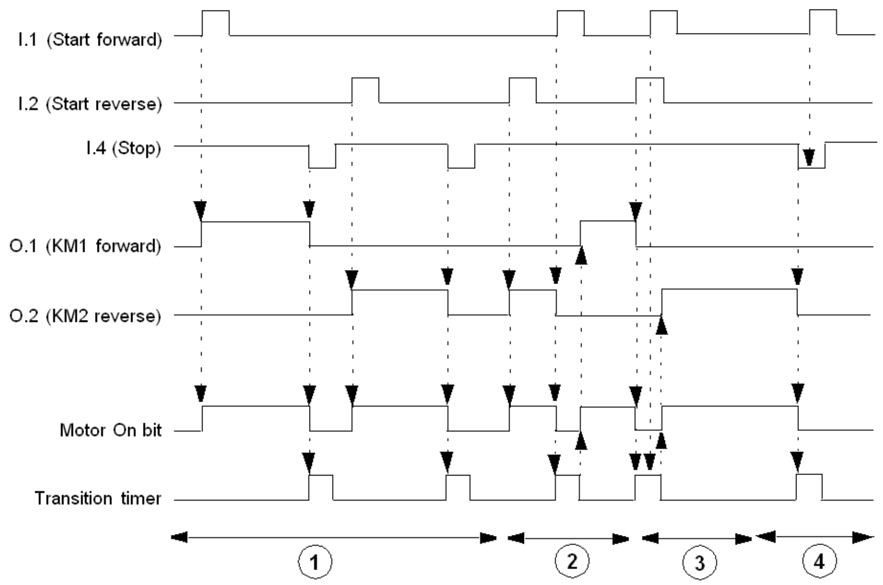
Logic Outputs	Assignment
O.1 (13 and 14)	KM1 contactor control Forward
O.2 (23 and 24)	KM2 contactor control Reverse
O.3 (33 and 34)	Alarm signal
O.4 (95, 96, 97, and 98)	Trip signal

Reverser operating mode uses the following HMI keys:

HMI Keys	2-Wire (Maintained) Assignment	3-Wire (Impulse) Assignment
Aux 1	Forward run	Start motor forward
Aux 2	Reverse run	Start motor reverse
Stop	Stop while pressed	Stop

Timing Sequence

The following diagram is an example of the timing sequence for the Reverser operating mode that shows the inputs and outputs for a 3-wire (impulse) configuration when the control direct transition bit is On:



1 Normal operation with stop command

2 Normal operation without stop command

3 Forward run command ignored: transition timer active

4 Forward run command ignored: stop command active

Parameters

Reverser operating mode has the following parameters:

Parameters	Setting Range	Factory Setting
Motor transition timeout	0…999.9 s	0.1 s
Control direct transition	On/Off	Off

Two-Step Operating Mode

Description

Use Two-Step operating mode in reduced voltage starting motor applications such as:

- Wye-Delta
- Open Transition Primary Resistor
- Open Transition Autotransformer

Functional Characteristics

This function includes the following features:

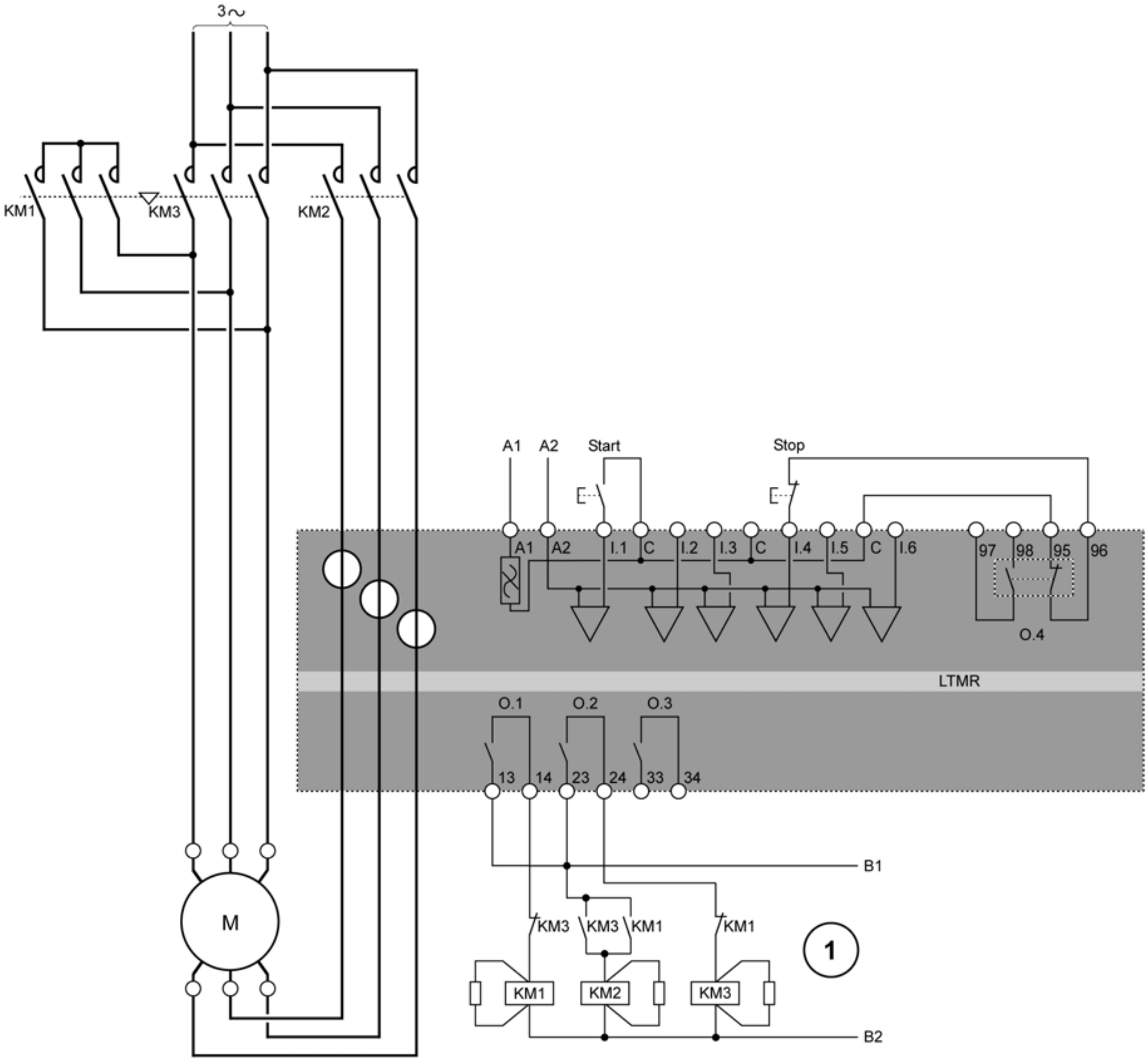
- Accessible in 3 control channels: Terminal Strip, HMI, and Network.
- Two-Step operation settings include:
  - A Motor Step 1 To 2 Timeout that starts when current reaches 10% of FLC min.
  - A Motor Step 1 To 2 Threshold setting.
  - A Motor Transition Timeout setting that starts upon the earlier of the following events: expiration of the Motor Step 1 To 2 Timeout, or current falling below the Motor Step 1 To 2 Threshold.
- Firmware interlocking helps prevent simultaneous activation of O.1 (step 1) and O.2 (step 2) logic outputs.
- In terminal strip control channel, logic input I.1 controls logic outputs O.1 and O.2.
- In Network or HMI control channels, the Motor Run Forward Command parameter controls logic outputs O.1 and O.2. The Motor Run Reverse Command parameter is ignored.
- Logic outputs O.1 and O.2 deactivate, and the motor stops, when control voltage becomes too low.
- Logic outputs O.1, O.2 and O.4 deactivate, and the motor stops, in response to a diagnostic detected error.

  NOTE: See Control Wiring and Trip Management, page 151 for information about the interaction between:

  - the LTM R controller's predefined control logic, and
  - the control wiring, an example of which appears in the following diagrams.

Two-Step Wye-Delta Application Diagram

The following wiring diagram represents a simplified example of the LTM R controller in a two-step 3-wire (impulse) terminal strip control wye-delta application.



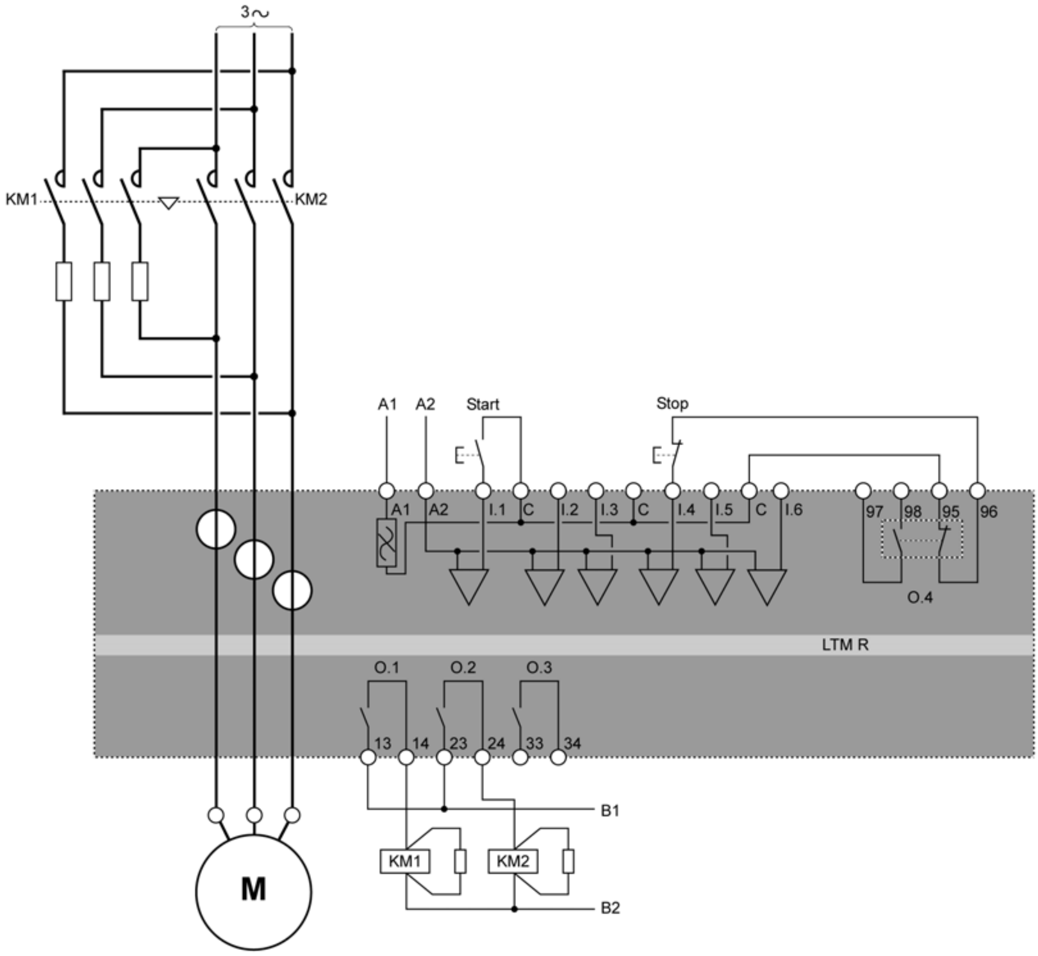
1 The N.C. interlock contacts KM1 and KM3 are not mandatory because the LTM R controller electronically interlocks O.1 and O.2.

For additional examples of two-step Wye-Delta IEC diagrams, refer to relevant diagrams .

For examples of two-step Wye-Delta NEMA diagrams, refer to relevant diagrams .

Two-Step Primary Resistor Application Diagram

The following wiring diagram represents a simplified example of the LTM R controller in a two-step 3-wire (impulse) terminal strip control primary resistance application.

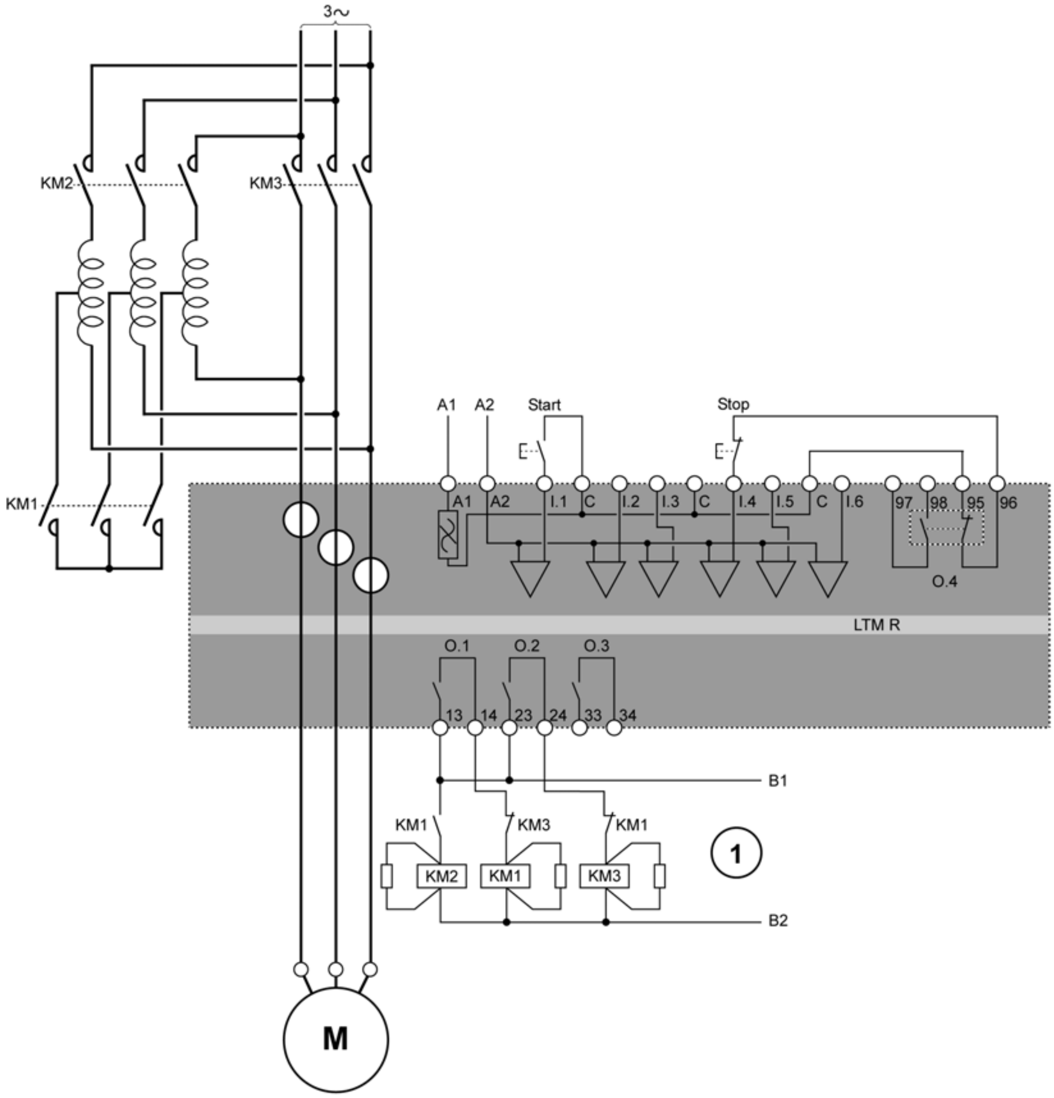


For additional examples of two-step primary resistor IEC diagrams, refer to relevant diagrams .

For examples of two-step primary resistor NEMA diagrams, refer to relevant diagrams .

Two-Step Autotransformer Application Diagram

The following wiring diagram represents a simplified example of the LTM R controller in a two-step 3-wire (impulse) terminal strip control autotransformer application.



1 The N.C. interlock contacts KM1 and KM3 are not mandatory because the LTM R controller electronically interlocks O.1 and O.2.

For additional examples of two-step autotransformer IEC diagrams, refer to relevant diagrams .

For examples of two-step autotransformer NEMA diagrams, refer to relevant diagrams .

I/O assignment

Two-step operating mode provides the following logic inputs:

Logic Inputs	2-Wire (Maintained) Assignment	3-Wire (Impulse) Assignment
I.1	Control motor	Start motor
I.2	Free	Free
I.3	Free	Free
I.4	Free	Stop motor
I.5	Reset	Reset
I.6	Local (0) or Remote (1)	Local (0) or Remote (1)

Two-step operating mode provides the following logic outputs:

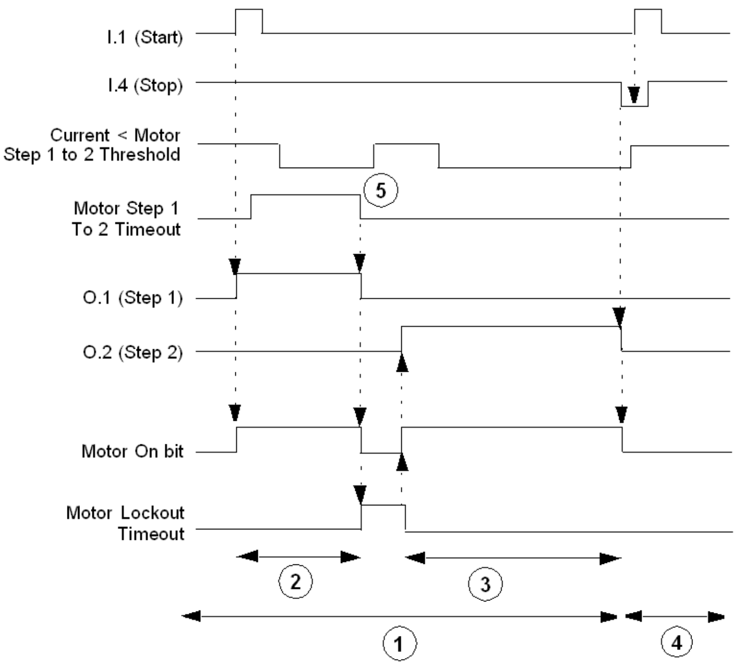
Logic Outputs	Assignment
O.1 (13 and 14)	Step 1 contactor control
O.2 (23 and 24)	Step 2 contactor control
O.3 (33 and 34)	Alarm signal
O.4 (95, 96, 97, and 98)	Trip signal

Two-step operating mode uses the following HMI keys:

HMI Keys	2-Wire (Maintained) Assignment	3-Wire (Impulse) Assignment
Aux 1	Control motor	Start motor
Aux 2	Free	Free
Stop	Stop motor while pressed	Stop motor

Timing Sequence

The following diagram is an example of the timing sequence for the Two-Step operating mode that shows the inputs and outputs for a 3-wire (impulse) configuration:



1 Normal operation

2 Step 1 start

3 Step 2 start

4 Start command ignored: Stop command active

5 Current falling below the Motor Step 1 To 2 Threshold ignored: preceded by expiration of the Motor Step 1 To 2 Timeout.

Parameters

Two-step operating mode has the following parameters:

Parameter	Setting Range	Factory Setting
Motor step 1 to 2 timeout	0.1…999.9 s	5 s
Motor transition timeout	0…999.9 s	100 ms
Motor step 1 to 2 threshold	20-800 % FLC in 1 % increments	150 % FLC

Two-Speed Operating Mode

Description

Use Two-Speed operating mode in two-speed motor applications for motor types such as:

- Dahlander (consequent pole)
- Pole Changer

Functional Characteristics

This function includes the following features:

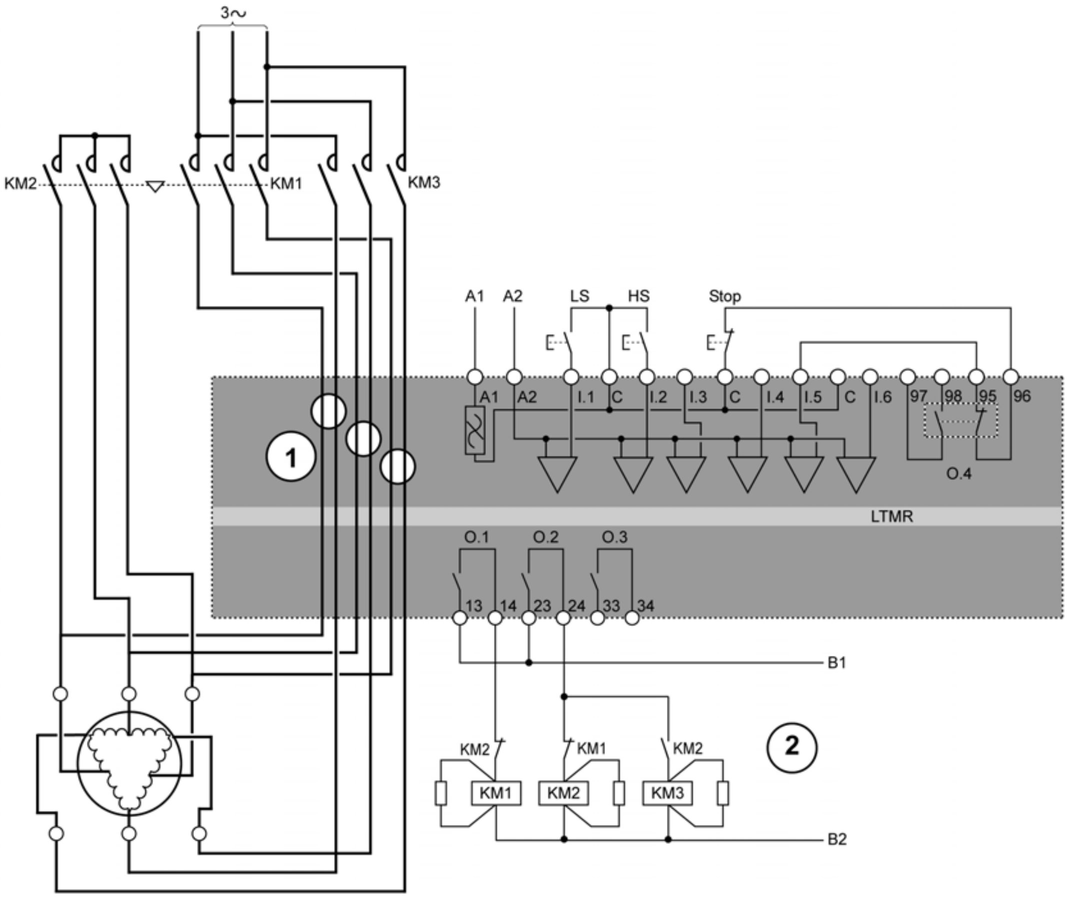
- Accessible in 3 control channels: Terminal Strip, HMI, and Network.
- Firmware interlocking helps prevent simultaneous activation of O.1 (low speed) and O.2 (high speed) logic outputs.
- 2 measures of FLC:
  - FLC1 (Motor Full Load Current Ratio) at low speed
  - FLC2 (Motor High Speed Full Load Current Ratio) at high speed
- The LTM R controller can change speed in 2 scenarios:
  - The Control Direct Transition bit is Off: requires a Stop command followed by expiration of the Motor Transition Timeout.
  - The Control Direct Transition bit is On: automatically transitions from high speed to low speed after a time-out of the adjustable Motor Transition Timeout.
- In terminal strip control channel, logic input I.1 controls logic output O.1, and logic input I.2 controls logic output O.2.
- In Network or HMI control channels, when the Motor Run Forward Command parameter is set to 1 and:
  - Motor Low Speed Command is set to 1, logic output O.1 is enabled.
  - Motor Low Speed Command is set to 0, logic output O.2 is enabled.
- Logic input I.3 is not used in the control circuit, but can be configured to set a bit in memory.
- Logic outputs O.1 and O.2 deactivate (and the motor stops) when control voltage becomes too low.
- Logic outputs O.1, O.2 and O.4 deactivate (and the motor stops) in response to a diagnostic detected error.

  NOTE: See Control Wiring and Trip Management, page 151 for information about the interaction between:

  - the LTM R controller's predefined control logic, and
  - the control wiring, an example of which appears in the following diagrams

Two-Speed Dahlander Application Diagram

The following wiring diagram represents a simplified example of the LTM R controller in a two-speed 3-wire (impulse) terminal strip control Dahlander consequent pole application.



LS Low speed

HS High speed

1 A Dahlander application requires 2 sets of wires passing through the CT windows. The LTM R controller can also be placed upstream of the contactors. If this is the case, and if the Dahlander motor is used in variable torque mode, all the wires downstream of the contactors must be the same size.

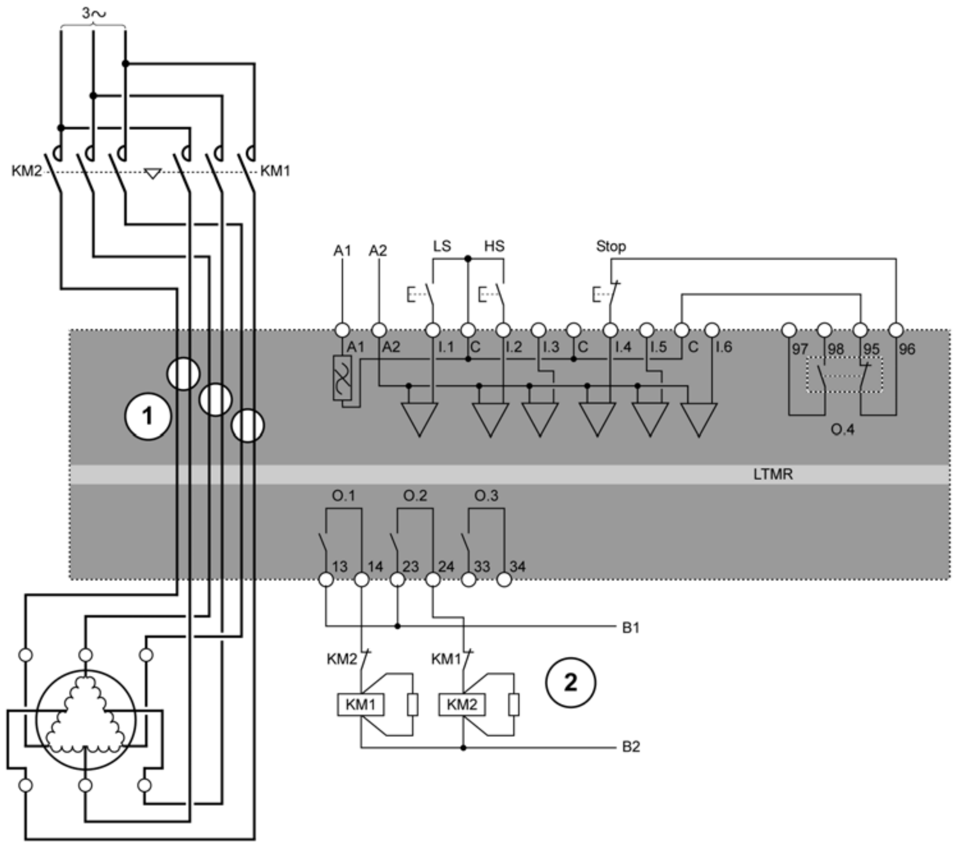
2 The N.C. interlock contacts KM1 and KM2 are not mandatory because the LTM R controller firmware interlocks O.1 and O.2.

For additional examples of two-speed Dahlander IEC diagrams, refer to relevant diagrams .

For examples of two-speed Dahlander NEMA diagrams, refer to relevant diagrams .

Two-Speed Pole-Changing Application Diagram

The following wiring diagram represents a simplified example of the LTM R controller in a two-speed 3-wire (impulse) terminal strip control pole-changing application.



LS Low speed

HS High speed

1 A pole-changing application requires 2 sets of wires passing through the CT windows. The LTM R controller can also be placed upstream of the contactors. If this is the case, all the wires downstream of the contactors must be the same size.

2 The N.C. interlock contacts KM1 and KM2 are not mandatory because the LTM R controller firmware interlocks O.1 and O.2.

For additional examples of pole-changing IEC diagrams, refer to relevant diagrams .

For examples of pole-changing NEMA diagrams, refer to relevant diagrams .

I/O Assignment

Two-Speed operating mode provides the following logic inputs:

Logic Inputs	2-Wire (Maintained) Assignment	3-Wire (Impulse) Assignment
I.1	Low speed command	Low speed start
I.2	High speed command	High speed start
I.3	Free	Free
I.4	Free	Stop
I.5	Reset	Reset
I.6	Local (0) or Remote (1)	Local (0) or Remote (1)

Two-Speed operating mode provides the following logic outputs:

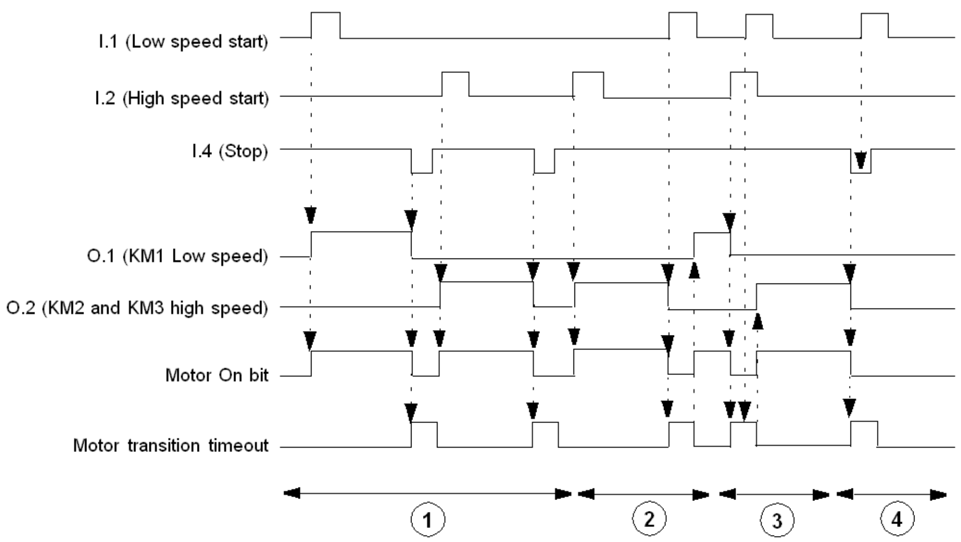
Logic outputs	Assignment
O.1 (13 and 14)	Low speed control
O.2 (23 and 24)	High speed control
O.3 (33 and 34)	Alarm signal
O.4 (95, 96, 97, and 98)	Trip signal

Two-speed operating mode uses the following HMI keys:

HMI Keys	2-Wire (Maintained) Assignment	3-Wire (Impulse) Assignment
Aux 1	Low speed control	Low speed start
Aux 2	High speed control	High speed start
Stop	Stop the motor	Stop the motor

Timing Sequence

The following diagram is an example of the timing sequence for the two-speed operating mode that shows the inputs and outputs for a 3-wire (impulse) configuration when the Control Direct Transition bit is On:



1 Normal operation with stop command

2 Normal operation without stop command

3 Low-speed start command ignored: motor transition timeout active

4 Low-speed start command ignored: stop command active

Parameters

The following table lists the parameters associated with the Two-Speed operating mode.

Parameters	Setting Range	Factory Setting
Motor transition timeout (high speed to low speed)	0…999.9 s	100 ms
Control direct transition	On/Off	Off

NOTE: The low speed to high speed timer is fixed at 100 ms.

Custom Operating Mode

Overview

The predefined control and monitoring functions can be adapted for particular needs using the custom logic editor in the TeSys T DTM to:

- customize the use of results of protection functions
- change the operation of control and monitoring functions
- alter the predefined LTM R controller I/O logic

Configuration Files

The configuration of the LTM R controller consists of 2 files:

- a configuration file that contains parameter configuration settings
- a logic file that contains a series of logic commands that manage LTM R controller behavior, including:
  - motor start and stop commands
  - motor transitions between steps, speeds and directions
  - the valid control source and transitions between control sources
  - trip and alarm logic for relay outputs 1 and 2, and the HMI
  - terminal strip reset functions
  - PLC and HMI communication loss and fallback
  - load shed
  - rapid cycle
  - starting and stopping LTM R controller diagnostics

When a predefined operating mode is selected, the LTM R controller applies a predefined logic file that permanently resides in the LTM R controller.

When custom operating mode is selected, the LTM R controller uses a customized logic file created in the custom logic editor and downloaded to the LTM R controller from the TeSys T DTM.

Trip Management and Clear Commands

Overview

This section describes how the LTM R controller manages the trip handling process, and explains:

- how to select a trip reset mode, and
- controller behavior for each trip reset mode selection.

Trip Management - Introduction

Overview

When the LTM R controller detects a trip condition and activates the appropriate response, the trip becomes latched. Once a trip becomes latched, it remains latched, even if the underlying trip condition is eliminated, until cleared by a reset command.

The setting of the Trip Reset Mode parameter determines how the LTM R controller manages trips. The trip reset mode selections, listed below, are described in the topics that follow:

- Manual, page 172 (Factory setting)
- Automatic, page 173
- Remote, page 177

The trip reset mode cannot be changed while a trip remains active. All trips must be reset before the trip reset mode can be changed.

Trip Reset Methods

A Reset command can be issued using any of the following means:

- cycling power
- reset button on the LTM R controller
- reset button on the HMI keypad
- reset command from the HMI engineering tool
- logic input I.5
- a network command
- automatic reset

⚠ WARNING

RISK OF UNINTENDED OPERATION

When the LTM R controller is operating in 2-wire control with an active Run command, a Reset command will immediately restart the motor.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Trip Specific Reset Behaviors

The LTM R controller's response to trips depends on the nature of the trip that has occurred and how the related protection function is configured. For example:

- Thermal trips can be reset after the Trip Reset Timeout counts down and the utilized thermal capacity falls below the Trip Reset Threshold level.
- If the trip includes a reset timeout setting, the timeout must fully count down before a reset command executes.
- Internal device trips can be reset only by cycling power.
- LTM R controller memory does not retain diagnostic and wiring trips after a power loss, but does retain all other trips after a power loss.
- Internal, diagnostic, and wiring trips cannot be automatically reset.
- All wiring and diagnostic trips can be manually reset by local reset methods.
- For diagnostic trips, network reset commands are valid only in remote (network) control channel.
- For wiring trips, network reset commands are not valid in any control channel.

Trip Characteristics

The LTM R controller trip monitoring functions save the status of communications monitoring and motor protection trips on a power loss so that these trips must be acknowledged and reset as part of an overall motor maintenance strategy.

Protection Category	Monitored Trip	LTM R Controller	LTM R with LTM E	Saved On Power Loss
Diagnostic	Run Command Check	X	X	–
	Stop Command Check	X	X	–
	Run Check Back	X	X	–
	Stop Check Back	X	X	–
Wiring / configuration trips	PTC connection	X	X	–
	CT Reversal	X	X	–
	Voltage Phase Reversal	–	X	–
	Current Phase Reversal	X	X	–
	Voltage Phase Loss	–	X	–
	Phase Configuration	X	X	–
Internal	Stack Overflow	X	X	–
	Watchdog	X	X	–
	ROM Checksum	X	X	–
	EEROM	X	X	–
	CPU	X	X	–
	Internal Temperature	X	X	–
Motor temp sensor	PTC Binary	X	X	X
	PT100	X	X	X
	PTC Analog	X	X	X
	NTC Analog	X	X	X
Thermal overload	Definite	X	X	X
	Inverse Thermal	X	X	X
Current	Long Start	X	X	X
	Jam	X	X	X
	Current Phase Imbalance	X	X	X
	Current Phase Loss	X	X	X
	Overcurrent	X	X	X
	Undercurrent	X	X	X
	Internal Ground Current	X	X	X
	External Ground Current	X	X	X
Voltage	Overvoltage	–	X	X
	Undervoltage	–	X	X
	Voltage Phase Imbalance	–	X	X
Power	Underpower	–	X	X
	Overpower	–	X	X
	Under Power Factor	–	X	X
	Over Power Factor	–	X	X
Communication loss	PLC to LTM R	X	X	X
	HMI to LTM R	X	X	X
X Monitored **–** Not monitored				

Manual Reset

Introduction

When the Trip Reset Mode parameter is set to **Manual**, the LTM R controller allows resets–usually performed by a person–via a power cycle of the control power or by using a local reset means, including:

- Terminal Strip (logic input I.5)
- Reset button on the LTM R controller
- Reset commands from the HMI

A manual reset provides on-site personnel the opportunity to inspect the equipment and wiring before performing the reset.

NOTE: A manual reset blocks all reset commands from the LTM R controller's network port—even when the Control Channel is set to **Network**.

Manual Reset Methods

The LTM R controller provides the following manual reset methods:

Protection Category	Monitored Trip	Control Channel		
		Terminal Strip	**HMI**	**Network**(1)
Diagnostic	Run Command Check	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Stop Command Check	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Run Check Back	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Stop Check Back	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
Wiring / configuration trips	PTC connection	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	CT Reversal	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Voltage Phase Reversal	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Current Phase Reversal	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Voltage Phase Loss	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Phase Configuration	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
Internal	Stack Overflow	PC	PC	PC
	Watchdog	PC	PC	PC
	ROM Checksum	PC	PC	PC
	EEROM	PC	PC	PC
	CPU	PC	PC	PC
	Internal Temperature	PC	PC	PC
Motor temp sensor	PTC Binary	RB, I.5	RB, I.5	RB, I.5
	PT100	RB, I.5	RB, I.5	RB, I.5
	PTC Analog	RB, I.5	RB, I.5	RB, I.5
	NTC Analog	RB, I.5	RB, I.5	RB, I.5
Thermal overload	Definite	RB, I.5	RB, I.5	RB, I.5
	Inverse Thermal	RB, I.5	RB, I.5	RB, I.5

Protection Category	Monitored Trip	Control Channel		
		Terminal Strip	HMI	Network[(1)]
Current	Long Start	RB, I.5	RB, I.5	RB, I.5
	Jam	RB, I.5	RB, I.5	RB, I.5
	Current Phase Imbalance	RB, I.5	RB, I.5	RB, I.5
	Current Phase Loss	RB, I.5	RB, I.5	RB, I.5
	Undercurrent	RB, I.5	RB, I.5	RB, I.5
	Overcurrent	RB, I.5	RB, I.5	RB, I.5
	External Ground Current	RB, I.5	RB, I.5	RB, I.5
	Internal Ground Current	RB, I.5	RB, I.5	RB, I.5
Voltage	Undervoltage	RB, I.5	RB, I.5	RB, I.5
	Overvoltage	RB, I.5	RB, I.5	RB, I.5
	Voltage Phase Imbalance	RB, I.5	RB, I.5	RB, I.5
Power	Underpower	RB, I.5	RB, I.5	RB, I.5
	Overpower	RB, I.5	RB, I.5	RB, I.5
	Under Power Factor	RB, I.5	RB, I.5	RB, I.5
	Over Power Factor	RB, I.5	RB, I.5	RB, I.5
Communication loss	PLC to LTM R	RB, I.5	RB, I.5	RB, I.5
	LTM E to LTM R	RB, I.5	RB, I.5	RB, I.5
RB Test/Reset button on the LTM R controller front face or an HMI **PC** Power cycle on the LTM R controller **I.5** Set I.5 logic input on the LTM R controller				
(1) Remote network reset commands are not allowed even when the LTM R controller is configured for network control channel.				

Automatic Reset

Introduction

Setting the Trip Reset Mode parameter to **Automatic** lets you:

- configure the LTM R controller to attempt to reset motor protection and communications trips without the intervention of either a human operator or the remote PLC, for example:
  - for a non-networked LTM R controller installed at a location that is physically remote, or locally hard to access
- configure trip handling for each protection trip group in a manner that is appropriate to the trips in that group:
  - set a different timeout delay
  - permit a different number of reset attempts
  - disable automatic trip resetting

The Trip Reset Mode parameter selection determines the available reset methods.

Each protection trip is included in 1 of 3 auto-reset trip groups, based on the characteristics of that trip, as described below. Each trip group has 2 configurable parameters:

- a timeout: the Auto-Reset Group (number 1, 2, or 3) Timeout parameter, and
- a maximum number of permissible trip resets: the Auto-Reset Attempts Group (number 1, 2, or 3) Setting parameter

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

An auto-reset command may restart the motor if the LTM R controller is used in a 2-wire control circuit.

Equipment operation must conform to local and national safety regulations and codes.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Reset Behavior

After power is cycled, the LTM R controller clears and sets to 0 the values of the following parameters:

- Auto-Reset Group (number 1, 2, or 3) Timeout and
- Auto Reset Group (number 1, 2, or 3) Setting.

On a successful reset, the Number of Resets count is cleared and set to 0. A reset is successful if, after reset, the motor runs for 1 minute without a trip of a type in the designated group.

If the maximum number of automatic resets has been reached and if the last reset has is unsuccessful, the reset mode turns to Manual. When the motor restarts, the automatic mode parameters are set to 0.

Emergency Restart

Use the Clear Thermal Capacity Level Command, in applications where it is necessary, to clear the Thermal Capacity Level parameter following a Thermal Overload inverse thermal trip. This command permits an emergency restart before the motor has actually cooled.

⚠ WARNING

LOSS OF MOTOR PROTECTION

Clearing the thermal capacity level inhibits thermal protection and can cause equipment overheating and fire. Continued operation with inhibited thermal protection must be limited to applications where immediate restart is vital.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Number of Resets

Each protection group can be set to manual, 1, 2, 3, 4 or 5.

Select "0" to disable automatic reset of protection trip groups—and require a manual reset—even though the Trip Reset Mode parameter is configured for automatic reset.

Select "5" to enable unlimited auto-reset attempts. After the time delay has expired the LTM R controller continually attempts to reset every trip in that reset group.

Auto-Reset Group 1 (AU-G1)

Group 1 trips require a predefined cooling time after the monitored parameter returns to and falls below a predefined threshold. Group 1 trips include Thermal

Overload and Motor Temp Sensor trips. The cooling time delay is non-configurable. However, you can:

- add to the cooling time delay by setting the Auto-Reset Group 1 Timeout parameter to a value greater than 0, or
- disable auto-reset by setting the Auto-Reset Group 1 Timeout parameter to 0

Auto-reset group 1 has the following configurable parameters:

Parameters	Setting Range	Factory Setting
Auto-Reset Attempts Group 1 Setting	0 = manual, 1, 2, 3, 4, 5 = unlimited number of reset attempts	5
Auto-Reset Group 1 Timeout	0...65,535 s	480 s

Auto-Reset Group 2 (AU-G2)

Group 2 trips generally do not include a predefined cooling time delay before a reset can be executed, but can be reset as soon as the trip condition clears. Many group 2 trips can result in some motor overheating, depending upon the severity and duration of the trip condition, which in turn depends upon the protection function configuration.

You can add a cooling time delay, if appropriate, by setting the Auto-Reset Group 2 Timeout parameter to a value greater than 0. You may also want to limit the number of reset attempts to help prevent premature wear or incorrect operation of the equipment.

Auto-reset group 2 has the following configurable parameters:

Parameters	Setting Range	Factory Setting
Auto-Reset Attempts Group 2 Setting	0 = manual, 1, 2, 3, 4, 5 = unlimited number of reset attempts	0
Auto-Reset Group 2 Timeout	0...65,535 s	1,200 s

Auto-Reset Group 3 (AU-G3)

Group 3 trips often apply to equipment monitoring and generally do not require a motor cooling period. These trips can be used to detect equipment conditions–for example, an undercurrent trip that detects the loss of a belt, or an overpower trip that detects an increased loading condition in a mixer. You may want to configure group 3 trips in a way that differs significantly from groups 1 or 2, for example by setting the number of resets to 0, thereby requiring a manual reset after the equipment event has been discovered and corrected.

Auto-reset group 3 has the following configurable parameters:

Parameters	Setting Range	Factory Setting
Auto-Reset Attempts Group 3 Setting	0 = manual, 1, 2, 3, 4, 5 = unlimited number of reset attempts	0
Auto-Reset Group 3 Timeout	0...65,535 s	60 s

Auto-Reset Methods

The LTM R controller allows the following auto-reset methods:

- RB - Test / Reset button on the LTM R or the HMI
- PC - Power cycle on the LTM R controller
- I.5 - Set I.5 logic input on the LTM R
- NC - Network command

- Automatic with conditions configured for the protection function group (where AU-GX = AU-G1, AU-G2, or AU-G3)

The table below lists the possible auto-reset methods for each monitored trip:

Protection Category	Monitored Trip	Control Channel		
		Terminal Strip	HMI	Network
Diagnostic	Run Command Check	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5, NC
	Stop Command Check	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5, NC
	Run Check Back	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5, NC
	Stop Check Back	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5, NC
Wiring / configuration trips	PTC connection	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	CT Reversal	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Voltage Phase Reversal	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Current Phase Reversal	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Voltage Phase Loss	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5
	Phase Configuration	RB, PC, I.5	RB, PC, I.5	RB, PC, I.5, NC
Internal	Stack Overflow	PC	PC	PC
	Watchdog	PC	PC	PC
	ROM Checksum	PC	PC	PC
	EEROM	PC	PC	PC
	CPU	PC	PC	PC
	Internal Temperature	PC	PC	PC
Motor temp sensor	PTC Binary	AU-G1	AU-G1	AU-G1
	PT100	AU-G1	AU-G1	AU-G1
	PTC Analog	AU-G1	AU-G1	AU-G1
	NTC Analog	AU-G1	AU-G1	AU-G1
Thermal overload	Definite	AU-G1	AU-G1	AU-G1
	Inverse Thermal	AU-G1	AU-G1	AU-G1
Current	Long Start	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
	Jam	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
	Current Phase Imbalance	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
	Current Phase Loss	RB, I.5	RB, I.5	RB, I.5, NC
	Undercurrent	RB, I.5, AU-G3	RB, I.5, AU-G3	RB, I.5, NC, AU-G3
	Overcurrent	RB, I.5, AU-G3	RB, I.5, AU-G3	RB, I.5, NC, AU-G3
	External Ground Current	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
	Internal Ground Current	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
Voltage	Undervoltage	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
	Overvoltage	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
	Voltage Phase Imbalance	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
Power	Underpower	RB, I.5, AU-G3	RB, I.5, AU-G3	RB, I.5, NC, AU-G3
	Overpower	RB, I.5, AU-G3	RB, I.5, AU-G3	RB, I.5, NC, AU-G3
	Under Power Factor	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
	Over Power Factor	RB, I.5, AU-G2	RB, I.5, AU-G2	RB, I.5, NC, AU-G2
Communication Loss	PLC to LTM R	RB, I.5, AU-G3	RB, I.5, AU-G3	RB, I.5, NC, AU-G3
	LTM E to LTM R	RB, I.5, AU-G3	RB, I.5, AU-G3	RB, I.5, NC, AU-G3

Remote Reset

Introduction

Setting the Trip Reset Mode parameter to **Remote** adds resetting trips from the PLC over the LTM R network port. This provides centralized monitoring and control of equipment installations. The Control channel parameter selection determines the available reset methods.

Both manual reset methods and remote reset methods reset a trip.

Remote Reset Methods

The LTM R controller provides the following remote reset methods:

Protection Category	Monitored Trip	Control Channel		
		Terminal Strip	HMI	Network
Diagnostic	Run Command Check	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
	Stop Command Check	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
	Run Check Back	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
	Stop Check Back	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
Wiring / configuration trips	PTC connection	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
	CT Reversal	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
	Voltage Phase Reversal	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
	Current Phase Reversal	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
	Voltage Phase Loss	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
	Phase Configuration	RB, PC, I.5, NC	RB, PC, I.5, NC	RB, PC, I.5, NC
Internal	Stack Overflow	PC	PC	PC
	Watchdog	PC	PC	PC
	ROM Checksum	PC	PC	PC
	EEROM	PC	PC	PC
	CPU	PC	PC	PC
	Internal Temperature	PC	PC	PC
Motor temp sensor	PTC Binary	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	PT100	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	PTC Analog	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	NTC Analog	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
Thermal overload	Definite	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Inverse Thermal	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
Current	Long Start	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Jam	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Current Phase Imbalance	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Current Phase Loss	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Undercurrent	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Overcurrent	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	External Ground Current	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Internal Ground Current	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC

Protection Category	Monitored Trip	Control Channel		
		Terminal Strip	HMI	Network
Voltage	Undervoltage	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Overvoltage	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Voltage Phase Imbalance	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
Power	Underpower	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Overpower	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Under Power Factor	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	Over Power Factor	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
Communication Loss	PLC to LTM R	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
	LTM E to LTM R	RB, I.5, NC	RB, I.5, NC	RB, I.5, NC
RB Test/Reset button on the LTM R controller front face or the HMI **PC** Power cycle on the LTM R controller **I.5** Set I.5 logic input on the LTM R controller **NC** Network command				

Trip and Alarm Codes

Trip Codes

Each trip is identified by a numerical trip code.

Trip code	Description
0	No detected error
3	Ground current
4	Thermal overload
5	Long start
6	Jam
7	Current phase imbalance
8	Undercurrent
10	Test
11	HMI port detected error
12	HMI port communication loss
13	Network port internal detected error
16	External trip
18	On-Off diagnostic
19	Wiring diagnostic
20	Overcurrent
21	Current phase loss
22	Current phase reversal
23	Motor temp sensor
24	Voltage phase imbalance
25	Voltage phase loss
26	Voltage phase reversal
27	Undervoltage

Trip code	Description
28	Overvoltage
29	Underpower
30	Overpower
31	Under power factor
32	Over power factor
33	LTME configuration
34	Temperature sensor short-circuit
35	Temperature sensor open-circuit
36	CT reversal
37	Out of boundary CT ratio
46	Start check
47	Run checkback
48	Stop check
49	Stop checkback
51	Controller internal temperature detected error
55	Controller internal detected error (Stack overflow)
56	Controller internal detected error (RAM detected error)
57	Controller internal detected error (RAM checksum trip)
58	Controller internal detected error (Hardware watchdog trip)
60	L2 current detected in single-phase mode
64	Non volatile memory detected error
65	Expansion module communication detected error
66	Stuck reset button
67	Logic function detected error
100-104	Network port internal detected error
109	Network port comm detected error
111	Fast device replacement trip
555	Network port configuration detected error

Alarm Codes

Each alarm is identified by a numerical alarm code.

Alarm code	Description
0	No alarm
3	Ground current
4	Thermal overload
5	Long start
6	Jam
7	Current phase imbalance
8	Undercurrent
10	HMI port
11	LTM R internal temperature
18	Diagnostic

Alarm code	Description
19	Wiring
20	Overcurrent
21	Current phase loss
23	Motor temp sensor
24	Voltage phase imbalance
25	Voltage phase loss
27	Undervoltage
28	Overvoltage
29	Underpower
30	Overpower
31	Under power factor
32	Over power factor
33	LTM E configuration
46	Start check
47	Run checkback
48	Stop check
49	Stop checkback
109	Network port comm loss
555	Network port configuration

LTM R Controller Clear Commands

Overview

Clear commands allow the user to clear specific categories of LTM R controller parameters:

- Clear all parameters
- Clear the statistics
- Clear the thermal capacity level
- Clear the controller settings
- Clear the network port settings

The Clear commands can be executed from:

- a PC running SoMove with the TeSys T DTM
- an HMI device
- a PLC via the network port

Clear All Command

If you want to change the configuration of the LTM R controller, you may want to clear all existing parameters in order to set new parameters for the controller.

The Clear All Command forces the controller to enter configuration mode. A power-cycle is performed to restart correctly in this mode. This enables the controller to pick up the new values for the cleared parameters.

When you clear all parameters, static characteristics are also lost. Only the following parameters are not cleared after a Clear All Command:

- Motor LO1 Closings Count
- Motor LO2 Closings Count
- Controller Internal Temperature Max

Clear Statistics Command

Statistics parameters are cleared without the LTM R controller being forced into configuration mode. Static characteristics are preserved.

The following parameters are not cleared after a Clear Statistics Command:

- Motor LO1 Closings Count
- Motor LO2 Closings Count
- Controller Internal Temperature Max

Clear Thermal Capacity Level Command

The Clear Thermal Capacity Level Command clears the following parameters:

- Thermal Capacity Level
- Rapid Cycle Lockout Timeout

Thermal memory parameters are cleared without the controller being forced into configuration mode. Static characteristics are preserved.

NOTE: This bit is writable at any time, even when the motor is running.

For more information about the Clear Thermal Capacity Level Command, see Reset for Emergency Restart, page 79.

Clear Controller Settings Command

The Clear Controller Settings Command restores the LTM R controller protection factory settings (timeouts and thresholds).

The following settings are not cleared by this command:

- Controller characteristics
- Connections (CT, temperature sensor, and I/O settings)
- Operating mode

Controller setting parameters are cleared without the controller being forced into configuration mode. Static characteristics are preserved.

Clear Network Port Settings Command

The Clear Network Port Settings Command restores the LTM R controller network port factory settings (address, and so on).

Network port settings are cleared without the controller being forced into configuration mode. Static characteristics are preserved. Only the network communication becomes ineffective.

After the IP addressing parameters are cleared, power must be cycled to the LTM R controller for it .

Communication Functions

This chapter presents the TeSys T communication functions using the network port or HMI port.

Configuration of LTM R Ports

Overview

This section describes how to configure the LTM R network port for every communication protocol and the LTM R HMI port.

Configuration of the LTM R Modbus Network Port

Communication Parameters

Before any communication can start, use the TeSys T DTM or the HMI to configure the Modbus port communication parameters:

- Network port address setting
- Network port baud rate setting
- Network port parity setting
- Network port comm loss timeout
- Network port endian setting

Network Port Address Setting

The device address can be set between 1 and 247.

Factory setting is 1, which corresponds to an undefined value.

Network Port Baud Rate Setting

Possible transmission rates are:

- 1200 Baud
- 2400 Baud
- 4800 Baud
- 9600 Baud
- 19,200 Baud
- Autodetection

Factory settings is Autodetection. In Autodetection, the controller is able to adapt its baud rate to that of the primary. 19,200 Baud is the first baud rate to be tested.

Network Port Parity Setting

The parity can be selected from:

- Even
- Odd
- None

When Network port baud rate setting is in Autodetection, the controller is able to adapt its parity and stop bit to that of the primary. Even parity is the first parity to be tested.

In Autodetection, the parity is set automatically; any previous setting is ignored.

Parity and stop bit behavior is linked:

If the parity is...	Then the number of stop bits is...
even or odd	1
none	2

Network Port Comm Loss Timeout

Network port comm loss timeout is used to determine the timeout value after a loss of communication with the PLC.

- Range: 1-9,999

Network Port Fallback Setting

Network port fallback setting, page 64 is used to adjust the fallback mode in case of a loss of communication with the PLC.

Network Port Endian Setting

The Network port endian setting allows to swap the 2 words in a double word.

- 0 = least significant word first (little endian)
- 1 = most significant word first (big endian, factory setting)

Configuration of the LTM R PROFIBUS DP Network Port

Communication Parameters

Use the TeSys T DTM or the HMI to configure the PROFIBUS DP communication parameters:

- Network port address setting
- Network port baud rate setting
- Configuration channel setting

Setting the Node-ID

The Node-ID is the address of the module on the PROFIBUS DP bus. You can assign an address from 1 to 125. The factory setting for the address is 126.

You must set the Node-ID before any communication can begin. Use the TeSys T DTM or the HMI to configure the communication parameter Network Port Address Setting.

NOTE: Address 0 is an invalid value and is not permitted. A return to factory settings command sets the Node-ID to the invalid value 126.

Setting the Baud Rate

Set the baud rate to the only possible speed: 65,535 = Autobaud.

Use the TeSys T DTM or the HMI to configure the communication parameter Network Port Baud Rate Setting.

The factory setting for the Network Port Baud Rate Setting parameter is Autobaud (0xFFFF). Using Autobaud, the LTM R Controller adapts its baud rate to that of the primary.

Setting the Configuration Channel

The LTM R configuration can be managed:

- locally through the HMI port using the TeSys T DTM or the HMI
- remotely through the network.

To manage the configuration locally, the Config via Network Port Enable parameter must be disabled to help prevent an overwrite of the configuration through the network.

To manage the configuration remotely, the Config via Network Port Enable parameter must be enabled (factory setting).

Configuration of the LTM R CANopen Network Port

Communication Parameters

Use the TeSys T DTM or the HMI to configure the CANopen communication parameters:

- Network port address setting
- Network port baud rate setting
- Configuration channel setting

Setting the Node-ID

The Node-ID is the address of the module on the CANopen bus. With CANopen class S20, you can assign an address from 1 to 127.

You must set the Node-ID before any communication can begin. Use the TeSys T DTM or the HMI to configure the communication parameter Network Port Address Setting.

NOTE: A return to factory settings command sets the Node-ID to the invalid value 0.

Setting the Baud Rate

Set the baud rate to one of the following speeds:

- 10 kBaud
- 20 kBaud
- 50 kBaud
- 250 kBaud
- 500 kBaud
- 800 kBaud
- 1000 kBaud

To set the baud rate, use the TeSys T DTM or the HMI to configure the communication parameter Network Port Baud Rate Setting.

The parameter has the following possible settings:

Network Port Baud Rate Setting	Baud Rate
0	10 kBaud
1	20 kBaud
2	50 kBaud
3	125 kBaud
4	250 kBaud
5	500 kBaud
6	800 kBaud
7	1000 kBaud
8	Autobaud
9	Factory setting (250 kBaud)

The factory setting for the Network Port Baud Rate Setting parameter is 250 kBaud. Using Autobaud, the LTM R Controller adapts its baud rate to that of the primary.

NOTE: The Autobaud functionality can only be used if at least one primary and one secondary are already communicating on the network.

Setting the Configuration Channel

The LTM R configuration can be managed:

- locally through the HMI port using the TeSys T DTM or the HMI
- remotely through the network.

To manage the configuration locally, the Config via Network Port Enable parameter must be disabled to help prevent an overwrite of the configuration through the network.

To manage the configuration remotely, the Config via Network Port Enable parameter must be enabled (factory setting).

Configuration of the LTM R DeviceNet Network Port

Communication Parameters

Use the TeSys T DTM or the HMI to configure the DeviceNet communication parameters:

- Network Port Address Setting
- Network Port Baud Rate Setting
- Config Via Network Port Enable

Setting the MAC-ID

The MAC-ID is the address of the module on the DeviceNet™ bus. A DeviceNet network is limited to 64 addressable nodes (node IDs 0 to 63). This means that you can assign a MAC-ID of 0-63.

You must set the MAC-ID before any communication can start. To do this, use the TeSys T DTM or the HMI to configure the communication parameter Network Port Address Setting. The factory setting for the address is 63.

Setting the Baud Rate

You can also set a baud rate of the following speeds:

- 125 kBaud
- 250 kBaud
- 500 kBaud

To set the baud rate, use the TeSys T DTM or the HMI to configure the communication parameter Network Port Baud Rate Setting.

The parameter has the following possible settings:

Network Port Baud Rate Setting	Baud Rate
0	125 kBaud (factory setting)
1	250 kBaud
2	500 kBaud
3	Autobaud

Autobaud automatically detects the baud rate required.

NOTE: The Autobaud functionality can only be used if a valid communication is already present on the network, that is to say, that at least one primary and one secondary are already communicating.

Setting the Configuration Channel

The LTM R configuration can be managed via 2 different modes:

- locally through the HMI port using the TeSys T DTM or the HMI
- remotely through the network

To manage the configuration locally, parameter Config Via Network Port Enable must be disabled to help prevent overwriting of the configuration through the network.

To manage the configuration remotely, parameter Config Via Network Port Enable must be enabled (factory setting).

Configuration of the LTM R Ethernet Network Port

Communication Parameters

Before network port communication can begin, configure the following Ethernet communication services and settings:

- Primary IP address setting
- Frame type setting
- Stored IP addressing settings
- Network port endian setting
- Fast device replacement (FDR) service
- Network Protocol selection
- Rapid Spanning Tree Protocol (RSTP)
- Communication loss settings
- Configuration control

NOTE: Only the TeSys T DTM software can configure all of these services and settings.

Primary IP Address Setting

Configure the Ethernet Primary IP Address Setting parameter to add the IP address of the client device, page 194 dedicated to remotely control the motor. This parameter consists of 4 integer values, from 0 to 255, separated by dots (xxx.xxx.xxx.xxx).

Frame Type Setting

Configure the Network Port Frame Type Setting parameter by selecting an Ethernet frame type:

- Ethernet II (Factory setting)
- 802.3

IP Addressing Settings

Unique IP address settings must be assigned to the LTM R controller (including an IP address, a subnet mask, and a gateway address) to be able to communicate over an Ethernet network. The positions of the controller's 2 rotary switches determine the source of the controller's IP address settings, page 198, which can be:

- a DHCP server
- a BootP server
- stored IP address settings

If the controller's *Ones* rotary switch is set to **Stored IP**, the controller will apply its stored IP address settings, page 200.

To input the LTM R controller's stored IP address settings, configure the following parameters:

- Ethernet IP Address Setting
- Ethernet Subnet Mask Setting
- Ethernet Gateway Address Setting

Each of these parameters consists of 4 integer values, from 0 to 255, separated by dots (xxx.xxx.xxx.xxx).

Network Port Endian Setting

The Network port endian setting allows to swap the 2 words in a double word.

- 0 = least significant word first (little endian)
- 1 = most significant word first (big endian, factory setting)

Fast Device Replacement Service

The Fast Device Replacement, page 203 (FDR) service stores the LTM R controller's operating parameters on a remote server and, if the controller is replaced, sends the replacement controller a copy of the original device's operating parameters.

To verify the server always contains an accurate, updated copy of the controller's operating parameters, the FDR service can be configured to automatically backup these parameter settings to the FDR server.

To enable the automatic backup of the controller's operating parameters to the FDR server, configure the following parameters:

- Network Port FDR Auto Backup Enable parameter. It can be set to:
  - no auto backup
  - automatic backup (copies the parameters from the controller to the FDR server)
- Network Port FDR Controller Interval parameter: the time (in seconds) between automatic backup transmissions.
  - Range = 1...65535s
  - Factory setting = 120s

Network Protocol Setting

Select with this parameter the network protocol you want to use:

- Modbus/TCP
- EtherNet/IP

Rapid Spanning Tree Protocol

The Rapid Spanning Tree Protocol (RSTP) service manages the state on every port of each device in the local area network (LAN) loop. The RSTP is configured to respond and resolve a communication loss of a device on the network within 50 milliseconds.

NOTE: 16 devices are the maximum connections allowed on the loop network for the 50 milliseconds to be fully efficient.

To enable the Rapid Spanning Tree Protocol (RSTP) service, set the parameter RSTP Disable to No.

Network Port Comm Loss Settings

Configure the following parameters to determine how the LTM R controller will handle communication loss with the PLC:

- Network Port Comm Loss Timeout: the length of time communication with the PLC defined as Primary IP must be lost before the controller will trigger a trip or alarm.
  - Range = 0...9999 s
  - Increments = 0.01 s
  - Factory setting = 2 s
- Network Port Fallback Setting: determines—with the controller's operating mode, page 147—the behavior of logic outputs 1 and 2, when communication with the PLC is lost. For more information, refer to the explanation of the Fallback Condition, page 64. Values include:
  - Hold
  - Run
  - O.1, O.2 off
  - O.1, O.2 on
  - O.1 on
  - O.2 on

  The factory setting is O.1, O.2 off.
- Network Port Trip Enable: reports a network trip after the Network Port Comm Loss Timeout setting has expired.
- Network Port Alarm Enable: reports a network alarm after the Network Port Comm Loss Timeout setting has expired.

Configuration of the HMI Port

HMI Port

The HMI port is the RJ45 port on the LTM R controller, or on the LTM E expansion module used to connect the LTM R controller to an HMI device, such as a Magelis® XBT or a TeSys® T LTM CU, or to a PC running SoMove with the TeSys T DTM.

Communication Parameters

Use the TeSys T DTM or the HMI to modify the HMI port communication parameters:

- HMI port address setting
- HMI port baud rate setting
- HMI port parity setting
- HMI port endian setting

HMI Port Address Setting

The HMI port address can be set between 1 and 247.

Factory setting is 1.

HMI Port Baud Rate Setting

Possible transmission rates are:

- 4800 Baud
- 9600 Baud
- 19,200 Baud (Factory setting)

HMI Port Parity Setting

The parity can be selected from:

- Even (Factory setting)
- None

Parity and stop bit behavior is linked:

If the parity is...	Then the number of stop bits is...
Even	1
None	2

HMI Port Endian Setting

The HMI port endian setting allows to swap the 2 words in a double word.

- 0 = least significant word first (little endian)
- 1 = most significant word first (big endian, factory setting)

HMI Port Fallback Setting

HMI port fallback setting, page 64 is used to adjust the fallback mode in case of a loss of communication with the PLC.

Miscellaneous

User Map Variables

Overview

User Map variables are designed to optimize the access to several non-contiguous registers in one single request.

You can define several read and write areas.

The user map can be defined via:

- a PC running SoMove with TeSys T DTM
- a PLC via the network port

User Map Variables

User Map Variables are described below:

User map variable groups	Modbus/TCP (Register addresses)	EtherNet/IP (Object addresses)
User Map addresses	800 - 899	6D : 01 : 01 - 6D : 01 : 64
User Map values	900 - 999	6E : 01 : 01 - 6E : 01 : 64

Modbus/TCP (Register addresses)	EtherNet/IP (Object addresses)	Variable type	Read/Write variables	
800-898	6D : 01 : 01 - 6D : 01 : 63	Word[99]	User map addresses setting	
899	6D : 01 : 64	Word	*(Reserved)*	

Modbus/TCP (Register addresses)	EtherNet/IP (Object addresses)	Variable type	Read/Write variables	
900-998	6E : 01 : 01 - 6E : 01 : 63	Word[99]	User map values	
999	6E : 01 : 64	Word	*(Reserved)*	

The User Map Address group is used to select a list of addresses to read or write. It can be considered as a configuration area.

The User Map Value group is used to read or write values associated to addresses configured in the User Map Address area:

- Read or write of register 900 allows to read or write the register address defined in register 800
- Read or write of register 901 allows to read or write the register address defined in register 801,...

Example of Use

The User Map Address configuration below gives an example of user map address configuration to access non-contiguous registers:

Modbus/TCP (Register addresses)	EtherNet/IP (Object addresses)	Value configured	Read/Write variables
800	6D : 01 : 01	452	Trip register 1
801	6D : 01 : 02	453	Trip register 2
802	6D : 01 : 03	461	Alarm register 1
803	6D : 01 : 04	462	Alarm register 2
804	6D : 01 : 05	450	Minimum wait time
805	6D : 01 : 06	500	Average current (0.01 A) MSW
806	6D : 01 : 07	501	Average current (0.01 A) LSW
850	6D : 01 : 51	651	HMI display items register 1
851	6D : 01 : 52	654	HMI display items register 2
852	6D : 01 : 53	705	Control register 2

With this configuration, monitoring information is accessible with one single read request through register addresses 900 to 906.

Configuration and command can be written with one single write using register addresses 950 to 952.

E_TeSys T Fast Access Profile Registers

Overview

The profile E_TeSys T Fast Access for LTM R Modbus/TCP controller is selected in the **Setting Process Channel Mode** of the parameter tab, page 41.

Status Registers (Read)

Status Registers (Read)	Signification
2500	Mirror status register
2501	Reserved
2502	System status 1 (= reg 455)
2503	System status 2 (= reg 456)
2504	Logic input status 3 (= reg 457)
2505	Logic output status (= reg 458)

Status Registers (Write)

Status Registers (Write)	Signification
2506	Logic output command (= reg 700). Used for custom Logic
2507	Control register (= reg 704)
2508	Analog output command 1 (= reg 706). For future use

EIOS_TeSys T Profile Registers

Overview

The profile EIOS_TeSys T for LTM R Modbus/TCP controller is selected in the **Setting Process Channel Mode** of the parameter tab, page 41.

Status Registers (Read)

Status Registers (Read)	Signification
451	Trip code
452	Trip register 1
453	Trip register 2
454	Logic input status 3 (= reg 457)
455	System Status register 1
456	System Status register 1
457	Logic Input status
458	Logic Output status
459	I/O status
460	Alarm code
461	Alarm register 1
462	Alarm register 2
463	Alarm register 3
464	Motor Temperature Sensor Degree
465	Thermal Capacity Level
466	Average current Ratio
467	L1 current ratio
468	L2 current ratio
469	L3 current ratio
470	Ground Current ratio
471	Current phase Imbalance
472	Controller: Internal Temperature
473	Controller config checksum
474	Frequency
475	Motor temperature sensor
476	Average voltage
477	L3L1 voltage
478	L1L2 voltage
479	L2L3 voltage
480	Voltage phase Imbalance
481	Power factor
482	Active power
483	Reactive power
484	Auto restart status register

Status Registers (Read)	Signification
485	Controller: Last power off duration
486	Reserved
487	Reserved
488	Reserved
489	Reserved
490	Network port monitoring register 1
491	Network port monitoring register 2
492	Network port monitoring register 3
493	Network port monitoring register 4
494	Network port monitoring register 5
495	Network port monitoring register 6
496	Network port monitoring register 7
497	Network port monitoring register 8
498	Network port monitoring register 9
499	Network port monitoring register 10
500	Average current MSB
501	Average current LSB
502	L1 current MSB
503	L1 current LSB
504	L2 current MSB
505	L2 current LSB
506	L3 current MSB
507	L3 current LSB
508	Ground current MSB
509	Ground current LSB
510	Controller port ID
511	Time to trip
512	Motor Last start current radio
513	Motor Last start duration
514	Motor Starts per hour count

Status Registers (Write)

Status Registers (Write)	Signification
700	Logic outputs command register
701	Reserved
702	Reserved
703	Reserved
704	Control register 1

Using Ethernet Services

Overview

This section describes the Ethernet services, and the related Ethernet configuration parameters, supported by EtherNet/IP and Modbus®/TCP.

NOTE: Changes in parameter settings for any Ethernet service take effect only after a power cycle of the LTM R controller.

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical functions, provide a means to achieve a safe state during and after a detected path failure. Examples of critical control functions are emergency stop and overtravel stop.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of anticipated transmission delays or failures of the link.(1)
- Each implementation of an LTM R controller must be individually and thoroughly tested for proper operation before being placed into service.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

(1) For additional information, refer to NEMA ICS 1.1 (latest edition), "Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control".

⚠ WARNING

UNEXPECTED RESTART OF THE MOTOR

Check that the PLC application software

- considers the change from local to remote control,
- manages appropriately the motor control commands during those changes.
- manages appropriately the motor control to avoid contradictory commands from all possible Ethernet connections

When switching to the Network control channels, depending on the communication protocol configuration, the LTM R controller can take into account the latest known state of the motor control commands issued from the PLC and restart automatically the motor.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Primary IP

Overview

Each LTM R controller, in its role as communication server, could be configured to recognize another Ethernet device (typically a PLC) as the client device that controls the motor. This device is usually a device that initiates communication to exchange Process Data (control and status). The Primary IP is the IP address of this device.

The PLC should continuously maintain at least 1 connection, called a virtual connection or socket, with the communication server.

If all connections between the communication clients and the LTM R server do not occur, the LTM R controller waits a prescribed time, the Network Port Comm Loss Timeout, for a new connection to be established and messages sent between the PLC and the communication server.

If a connection is not opened and messages are not received, the LTM R controller assumes its fallback state, set by the Network Port Fallback Setting.

⚠WARNING

LOSS OF CONTROL

- Configure a server IP on the Ethernet network.
- Do not use an IP address other than Primary IP to send network start and stop commands to the LTM R controller.
- Design the Ethernet network to block unauthorized network start and stop commands sent to the LTM R controller.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Prioritized Primary IP Connections with Modbus/TCP

Connections between the LTM R controller and the Modbus client has a priority over connections between the controller and other Ethernet devices.

After the controller has reached its maximum number of 8 simultaneous Modbus connections, the controller must close an existing connection to be able to open a new connection. The controller closes existing connections based on the time of a connection's most recent transaction, closing the connection whose most recent transaction is the oldest.

However, all connections between the LTM R controller and the Modbus client are preserved. The controller will not close a connection with the Modbus server in order to open a new connection.

Configuring Primary IP

To enable connections to be made to a Modbus client, use a configuration tool to configure the following parameters:

Parameter	Setting Range	Factory Setting
Ethernet Primary IP address setting (3010-3011)	Valid Class A, B, and C addresses in the range: 0.0.0.0...223.255.255.255	0.0.0.0
Network port comm loss timeout (693)	0...9999 s in increments of 0.01 s	2 s
Network port fallback setting (682)	• Hold • Run • O.1, O.2 Off • O.1, O.2 On • O.1 Off • O.2 Off	O.1, O.2 Off

I/O Scanning Configuration

Mirroring High Priority Registers

The LTM R controller provides a block of 9 contiguous registers dedicated to scanning that mirror the values and functionality of selected high priority registers.

The LTM R controller reads the values of all high priority registers whenever it detects a change to any single high priority register, and writes the values of all high priority registers to the mirroring registers.

Because the mirroring registers are contiguous, it is possible to execute a single Modbus block read or block write request to these registers, thereby saving the time it would take to make separate Modbus read/write requests directly to each underlying high priority register.

Mirroring Status

Mirroring status is the first register, in the sequence of eight contiguous mirroring registers. Bits 0...2 of this register describe the status of read-only commands, and bits 8...10 describe the status of read/write commands.

NOTE: Use only the 2 Ethernet ports to read mirroring status register bit values. Using the HMI/LTM E port produces an invalid, constant value of 0 for each bit.

All other mirroring status registers can be read accurately using either the HMI/LTM E port or the 2 Ethernet ports.

Configuring I/O Scanning

Your success in configuring I/O scanning of registers depends upon:

- the register type
- the I/O scanning period
- the I/O scanning health timeout period

The following table describes the I/O scanning and I/O scanning health timeout settings for read and write transactions for registers of varying types with only 1 connection on the LTM R controller:

Transaction	Register Type	I/O Scan Period (Minimum)	I/O Scan Health Timeout (Minimum)
Any combination of 100 read/ write transactions	Any register except: Mirroring, FDR, or diagnostic	200 ms	500 ms
10 max, and 5 max write transactions	Any register except: Mirroring, FDR, or diagnostic	50 ms	200 ms
Read transactions	Mirroring registers: 2500 to 2505 address range	5 ms	100 ms
Write transactions	Mirroring registers: 2506 to 2508 address range	50 ms	200 ms
Read/Write transaction	Mirroring registers: • 2500 to 2505 address range: read • 2506 to 2508 address range: write	50 ms	200 ms
Any number of read transactions	FDR registers: 10001 to 10010 address range	200 ms	500 ms
Any number of read transactions	Diagnostic registers: 2000 to 2039 address range	1000 ms	2000 ms

NOTE: Any settings for I/O scan period or I/O scan health timeout, lower than described above, can cause the LTM R controller to send Modbus exception packets.

If there are multiple connections to the LTM R Controller, the I/O scanning and I/O scanning health timeout settings for read and write transactions for registers are reduced.

For example, with 8 connections:

Connection	Start of Read Register	Number of Read Register	Start of Write Register	Number of Write Registers	Scan Rate
1	2500	7	–	–	50
2	451	64	2503	3	200
3	900	99	–	–	200
4	2000	39	–	–	1000
5	1001	10	–	–	200
6	600	20	–	–	500
7	660	20	–	–	500
8	680	20	–	–	500

Ethernet Link Management

Overview

The LTM R controller can receive or provide Ethernet services only if an Ethernet communications link exists. An Ethernet communications link can exist only when a cable connects one of the controller's network ports to the network. If no network cable connection exists, no Ethernet service can start.

The behavior of the controller is described in each of the following situations:

- The LTM R powers up with no network cable connected.
- A network cable is connected to a previously unconnected controller after startup.
- All network cables are disconnected from the controller after startup.
- One (or more) network cables are re-connected to a controller after all network cables had previously been disconnected.

No link while LTM R is powered up

When the LTM R powers up with no network cable connected, the LTM R

- goes into an FDR Trip if the rotary switches are in DHCP position,
- goes into an FDR Trip for 10s and then clears the trip automatically if the rotary switches are in Stored, BootP, ClearIP or Disabled positions.

No Link at Startup

When, after controller startup, an Ethernet network cable is initially attached to a previously unconnected controller

- the controller starts its IP addressing service, page 198, which
  - obtains IP address settings,
  - validates IP address settings,
  - checks that the obtained IP address settings are not duplicate,
  - assigns the received IP address settings to the controller.

- after its IP address settings are assigned, the controller
  - starts the FDR service and obtains its operating parameter settings, then
  - starts its Modbus service.

The time to recover the link and start Ethernet services takes about 1 second.

Link Disconnected After Startup

When all Ethernet network cables are disconnected from the controller after startup:

- the FDR service is disabled,
- all Modbus service connections are re-set,
- if a Primary IP connection exists and:
  - the link cannot be re-established, i.e., the cable is not plugged back into the controller, before the Network Port Comm Loss Timeout expires, the controller enters its pre-configured fallback state if the LTM R is in Network control,
  - the link is re-established before the Network Port Comm Loss Timeout expires, the connection to the Primary IP is maintained and the controller does not enter its fallback state.

Link Reconnected After Disconnection

When one or more Ethernet network cables are re-attached to the controller, after all network cables had been detached after startup, the controller performs many, but not all, of the same tasks as when there is No Link at Startup, page 197. Specifically, the controller

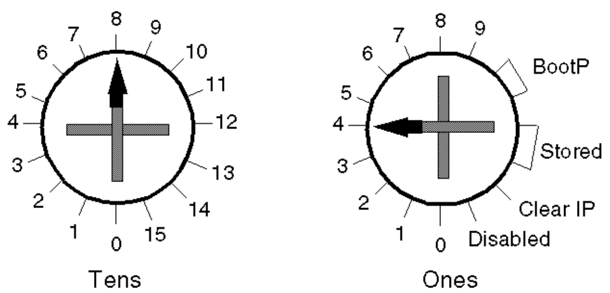
- presumes the previously obtained IP address settings remain valid, then
  - checks that the IP address settings are not duplicate,
  - re-assigns the IP address settings to the controller.
- after the IP address settings are assigned, the controller
  - starts its FDR service and obtains its operating parameter settings, then
  - starts its Modbus service.

The time to recover the link and start Ethernet services takes about 1 second.

IP Addressing

Overview

The LTM R controller must obtain a unique IP address, subnet mask and gateway address to communicate over an Ethernet network. The settings of the 2 rotary switches on the front of the LTM R controller determine the source of these essential settings. These settings are applied only on power-up. The rotary switches look like this:



The settings of the rotary switches determine the source of the LTM R controller's IP address parameters and the FDR service activation, as follows:

Left switch (Tens)	Right switch (Ones)	Source of IP parameters
0 to 15(1)	0 to 9(1)	DHCP server and FDR service
N/A(2)	BootP	BootP server
N/A(2)	Stored	The rotary switch is not used to determine IP parameters. LTM R configured settings are used. If none, IP parameters are derived from the MAC address. Modbus service is disabled.
N/A(2)	Clear IP	Clears the stored IP settings. No IP addressing settings are assigned. The network port is disabled.
N/A(2)	Disabled	The LTMR controller is not available for network communication. The LTMR controller does not initiate any IP acquisition process (host register, DHCP...) or announcements of IP on the network. Network related errors do not occur. However, the LTMR controller stays active on at the Ethernet switch level allowing the daisy chain to function normally.

(1) The 2 switches yield a value from 000 to 159, which uniquely identifies the device to the DHCP server. In the above figure, this value is 084, which is the concatenation of the:

- Tens switch (08), and the
- Ones switch (4)

  The individual values of each rotary switch - in this case 08 and 4 - are incorporated into the device name, as described below.

(2) The left (Tens) rotary switch is not used. The right (Ones) rotary switch alone determines the source of IP parameters.

IP settings are assigned to the following parameters:

- Ethernet IP Address
- Ethernet subnet Mask
- Ethernet Gateway

Getting IP Parameters from a DHCP Server

To obtain IP parameters from a DHCP server, point each rotary switch to a numerical setting, as follows:

Step	Description
1	Set the left–Tens–switch to a value from 0 to 15, and
2	Set the right–Ones–switch to a value from 0 to 9

Device Name: The settings of the 2 rotary switches are used to determine each LTM R controller's device name. The device name consists of a fixed part ("TeSysT") and a dynamic part, composed of:

the two-digit value (00 to 15) of the Tens rotary switch (*xx*), and

the one-digit value (0 to 9) of the Ones rotary switch (*y*)

The DCHP server must be pre-configured with the LTM R controller's device name and its associated IP parameters. When the DHCP server receives the LTM R controller's broadcast request, it returns:

- the LTM R controller's:
  - IP address
  - subnet mask
  - gateway address
- the DHCP server's IP address

  NOTE: While the IP address is not provided by the DHCP server, the TeSys T product declares a major trip network port FDR (Alarm LED steady red).

NOTE: The LTM R controller uses the DHCP server's IP address during the Fast Device Replacement (FDR) process , page 198, when making an FTP or TFTP request for device configuration parameters.

In the figure, above, the device name is: TeSysT084.

NOTE: The DHCP server can provide an IP address to a server device only after the DHCP server has been configured with the Device Name, described above, for a server device.

Getting IP Parameters from a BootP Server

To obtain IP parameters from a BootP server, point the right—Ones—rotary switch to either of the 2 **BootP** settings. (The left—Tens—rotary switch is not used.) The LTM R controller broadcasts a request for IP parameters to a BootP server, and includes its MAC address in the request.

The BootP server must be pre-configured with the LTM R controller's MAC address and associated IP parameters. When the BootP server receives the LTM R controller's broadcast request, it returns to the LTM R controller its:

- IP address
- subnet mask
- gateway address

NOTE: The Fast Device Replacement (FDR) service is not available if the LTM R controller is configured to receive IP parameters from a BootP server.

Using Stored IP Parameters

You can configure the LTM R controller to apply IP settings that have been previously configured and stored in the device itself. These stored IP parameters can be configured using your choice of configuration tool.

To apply stored IP parameters set the right–Ones–switch to either of the **Stored** positions. (The left—Tens—switch is not used.)

The LTM R controller uses as its:

- IP address: the Ethernet IP Address Setting parameter
- Subnet mask: the Ethernet Subnet Mask Setting parameters
- Gateway address: the Ethernet Gateway Address Setting parameter

NOTE: If these parameters are not pre-configured, the LTM R controller cannot apply stored settings, but instead applies default IP parameters, as described below.

NOTE: The FDR service is not available when the LTM R controller is configured to use stored IP parameters.

Configuring Default IP Parameters from the MAC Address

The LTM R controller derives its default IP parameters from its MAC address, (stored in the device's Ethernet MAC Address parameter). The MAC address is a unique identifier associated with the device's network interface card (NIC).

As a prerequisite for using the default IP address, all bytes of the configured IP address must be set to zero.

To apply the LTM R controller's default IP parameters, you must proceed in two steps:

Step	Action
1	Clear the existing IP address by setting the right—Ones—rotary switch to **Clear IP**, then cycle power.
2	Apply the stored IP address settings by setting the right—Ones—rotary switch to **Stored**, then cycle power.

The default IP parameters are generated as follows:

- the first 2 byte values of the IP address are always 85.16
- the last 2 byte values of the IP address are derived from the last 2 bytes of the MAC address
- the default subnet mask are always 255.0.0.0
- the default gateway is the same as the device's default IP address

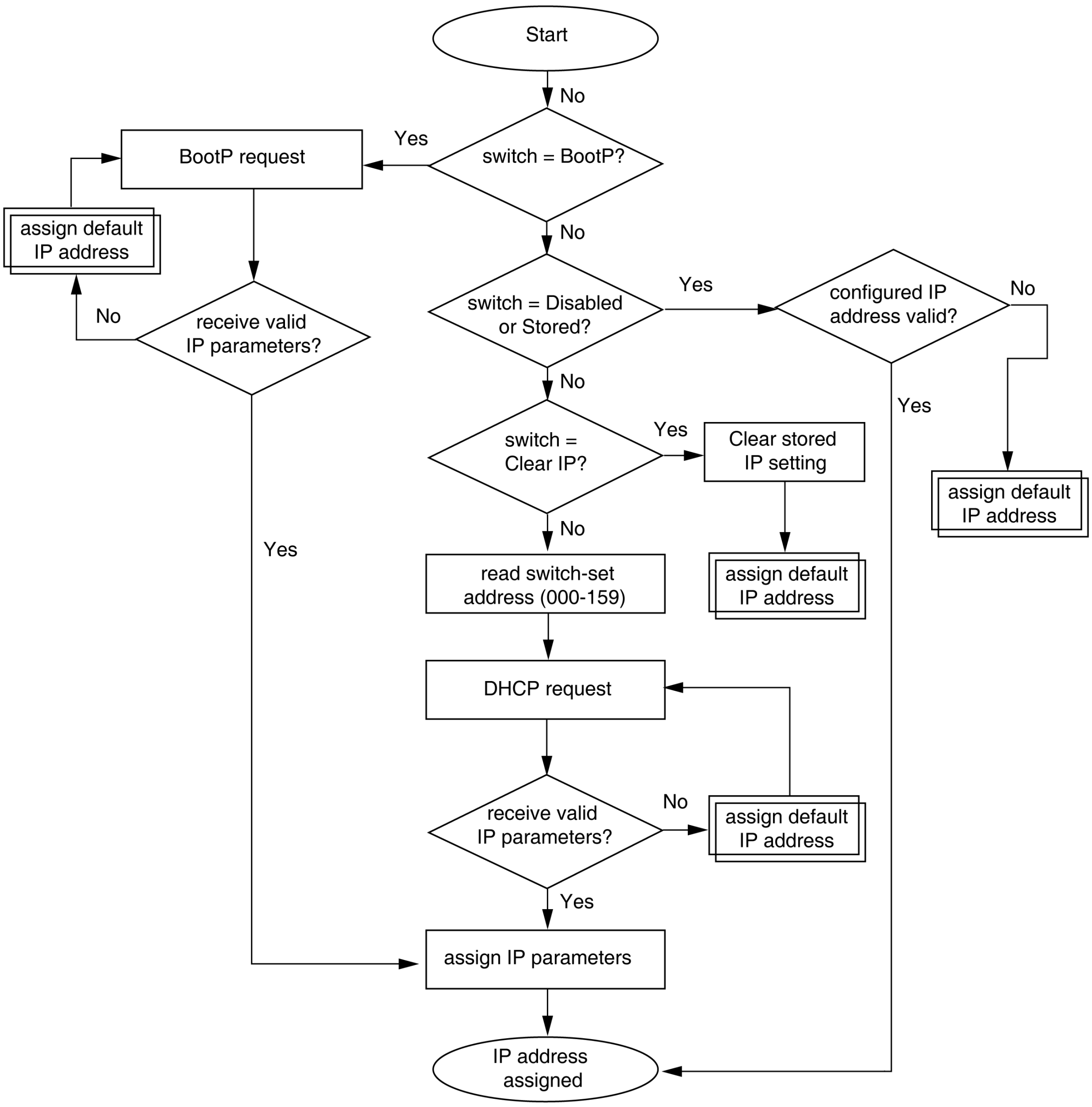
For example, for a device with a hexadecimal MAC address of 0x000054EF1001, the last two bytes are 0x10 and 0x01. These hexadecimal values translate to decimal values of "16" and "01". The default IP parameters for this MAC address are:

- IP address: 85.16.16.01
- subnet mask: 255.0.0.0
- gateway address: 85.16.16.01

NOTE: Both the Fast Device Replacement (FDR) service and the Modbus service are not available when default IP parameters are used.

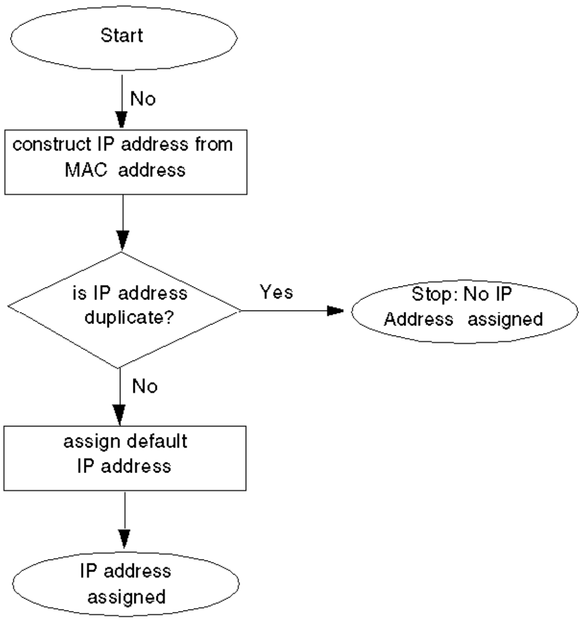
IP Assignment Process

As depicted in the following graphic, the LTM R controller performs a sequence of inquiries to determine its IP address:



NOTE: Both the Fast Device Replacement (FDR) service and the Modbus service are not available when default IP parameters are used.

The following diagram depicts the *assign default IP address* process, referenced above:



IP Assignment and STS/NS LED

During the IP address assignment process, while the LTM R is operating normally and is not experiencing an internal trip, the green STS/NS LED may indicate the following conditions:

Switch setting(s)	STS/NS LED behavior	Description
BootP	Flashes 5 times, then repeats	The controller sent a BootP request, but the BootP server did not deliver valid, unique IP address settings. Waiting for BootP server.
	Flashes 5 times, then solid ON	The controller sent a BootP request, and the BootP server delivered valid and unique IP address settings.
Stored	Solid ON	The LTM R controller is configured with valid, unique stored IP address settings.
	Flashes 6 times, then repeats	No valid, unique IP parameters are stored. Default IP settings are generated using the MAC address.
Clear IP	Flashes 2 times, then repeats	IP address settings have been cleared. No IP address settings are available. Controller cannot communicate using its Ethernet network ports.
Disabled	Solid ON	The LTM R controller is configured with valid, unique stored IP address settings.
	Flashes 6 times, then repeats	No valid, unique IP parameters are stored. Default IP settings are generated using the MAC address.
Left (Tens) switch set to 0-15 (*xx*) Right (Ones) switch set to 0-9 (*y*)	Flashes 5 times, then repeats	The controller sent a DHCP request for device name (TeSysT*xxy*), but the DHCP server did not deliver valid, unique IP address settings. Waiting for DHCP server.
	Flashes 5 times, then solid ON	The controller sent a DHCP request for device name (TeSysT*xxy*), and the DHCP server delivered valid and unique IP address settings.

NOTE: A repeating series of 8 flashes by the STS/NS LED indicates an unrecoverable FDR inoperable condition. The causes and potential cures for an unrecoverable FDR event include:

- An internal communication loss within the LTM R controller: Cycle power to the controller; if communication is not restored, replace the controller.
- An invalid configuration of the Ethernet properties (typically IP address settings or the Primary IP address): Verify the IP address parameter settings.
- An invalid or corrupt operating parameter file: Transfer a corrected parameter file from the controller to the parameter file server, page 206. Refer to the topic Handling Unrecoverable FDR Trips for additional information. The transfer of a parameter file to the FDR server is only available with the LTM R controller Ethernet version.

Fast Device Replacement

Overview

The FDR service employs a central server to store both the IP addressing parameters and the operating parameters for an LTM R controller. When a inoperable LTM R controller is replaced, the server automatically configures the replacement LTM R controller with the same IP addressing and operating parameters as the inoperable controller.

NOTE: The FDR service is available only when the controller's Ones rotary switch is set to integers. The FDR service is not available when the Ones rotary switch is set to *BootP*, *Stored*, *Clear IP*, or *Disabled*.

The FDR service includes configurable commands and settings that you can access using your choice of configuration tool. These commands and settings include:

- Commands that let you manually:
  - backup the LTM R controller's operating parameters, by uploading a copy of the device's parameter file to the server from the controller, or
  - restore the LTM R controller's parameters, by downloading a copy of the device's operating parameter file from the server to the controller.
- Settings that cause the FDR server to automatically synchronize the operating parameter files, in both the LTM R controller and the server, at configurable time intervals. If a difference is detected, a parameter file is sent from the controller to the FDR server (auto backup).

Preconditions to FDR

Before the FDR service can function, the FDR server must be configured with:

- the LTM R controller's network address and related IP addressing parameters, this is done as part of the IP addressing service, page 198,
- a copy of the LTM R controller's operating parameter file, this can be sent from the controller to the server either manually or automatically, as described below.

FDR and Custom Logic File

The FDR service save custom logic to the operating parameters file if the custom logic file size is lower than 3 kbytes.

If the custom logic file size is bigger than 3 kbytes, only the operating parameters file is saved.

In this case, when you are replacing a device with a custom logic file size bigger than 3 kbytes, the STS/NS LED of the new device flashes 8 times signaling the detection of a system recoverable FDR trip condition.

To resolve the trip and resume operations:

Step	Action
1	Use the TeSys T DTM software to download the configuration
2	Cycle power to the LTM R controller

FDR Process

The FDR process consists of 3 parts:

- the assignment of IP address settings,
- a check of the operating parameter file at every LTM R controller startup,
- if auto-synchronization is enabled, periodic checks of the LTM R controller's operating parameter file.

These 3 processes are described below:

IP address settings assignment process:

Sequence	Event
1	Your service personnel uses the rotary switches on the front of the replacement LTM R controller to assign it the same network address (000 to 159) as the replaced device.
2	Your service personnel places the replacement LTM R controller on the network.
3	The LTM R controller automatically sends a DHCP request to the server for its IP parameters.
4	The server sends the LTM R controller: • IP parameters, including: ◦ IP address ◦ subnet mask ◦ gateway address • the server's IP address
5	The LTM R controller applies its IP parameters.

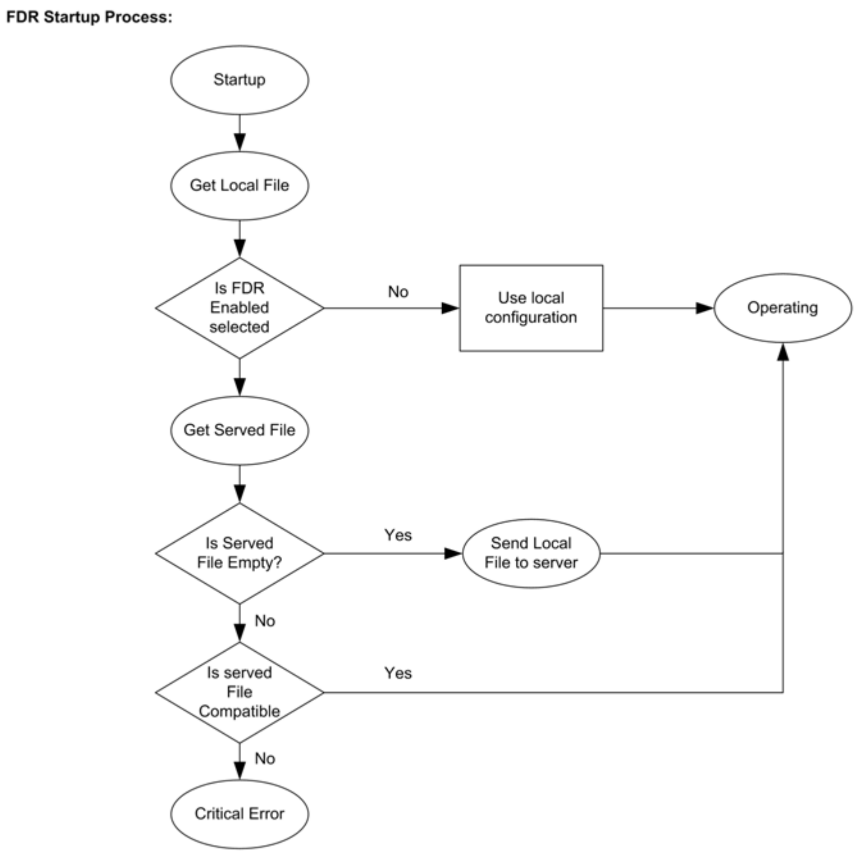
Startup FDR process:

<table>
<tr><th>Sequence</th><th colspan="2">Event</th></tr>
<tr><td rowspan="6">6</td><td colspan="2">• If FDR is enabled in the FDR configuration screen:</td></tr>
<tr><td>a</td><td>The controller sends a request to the FDR server for a copy of the served configuration file.</td></tr>
<tr><td>b</td><td>The FDR server sends the controller a copy of the served file.</td></tr>
<tr><td>c</td><td>The controller checks the served file's version number and size for compatibility with the device. If the served file is
• compatible, the served file is applied,
• not compatible, the controller will attempt to manage the compatibility and upload the new file to the server. If not able to manage the compatibility, the controller then signals a system recoverable FDR trip(1).</td></tr>
<tr><td colspan="2">Notes:
1. Because the factory setting of FDR Enable is selected, a new LTM R controller always downloads and attempts to apply a served file on initial startup.
2. If the downloaded file is empty, the controller will use its local file and send a copy of that file to the server.</td></tr>
<tr><td colspan="2">• If FDR Enable is de-selected: The controller applies the operating parameter file stored in the LTM R controller's non-volatile memory.</td></tr>
<tr><td>7</td><td colspan="2">The LTM R controller resumes operation.</td></tr>
<tr><td colspan="3">(1) In the event the controller enters the Not Ready state, the underlying problem must be resolved and power must be cycled to the controller before operations can resume.</td></tr>
</table>

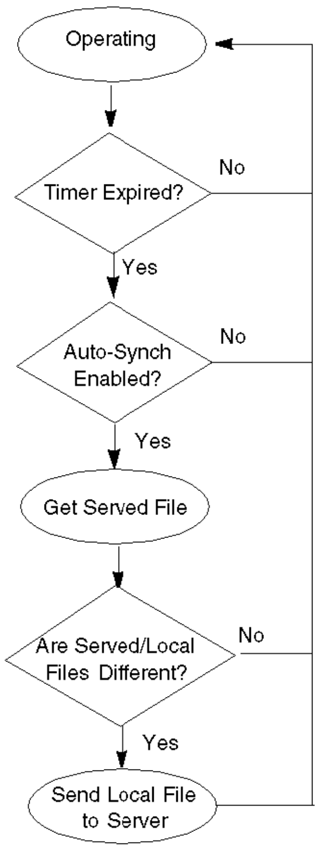
Auto-synchronization FDR process:

Sequence	Event
8	The controller checks the *Network Port FDR Auto Backup Period Setting* (697) parameter to determine if the FDR auto-synchronization timer has expired.
9	If the timer has: • **Not expired**: No action is taken. • **Expired**: The controller checks the *Network Port FDR Auto Backup Enable* (690.3) parameter.
10	If the *Network Port FDR Auto Backup Enable* (690.3) parameter is: • **Auto backup (1)**: The controller sends a copy of the local file to the FDR server. • **No synchro (0)**: The controller takes no action.
11	The LTM R controller resumes operation.

The following diagrams describe the controller’s FDR processes after the assignment of an IP address:



FDR Auto-Synchro Process:



Configuring FDR

The FDR service monitors the operating parameter file maintained in your LTM R controller and compares it against the corresponding operating parameter file stored in the server.

When the FDR service detects a discrepancy between these 2 files:

- the Network Port FDR Status, page 207 parameter is set, and
- the 2 operating parameter files, 1 in the server, the other in the controller, must be synchronized.

Synchronizing operating parameter files can be performed either automatically or manually, using your choice of configuration tool.

Automatically Backup Settings: By setting the following parameters, you can configure your LTM R controller to automatically synchronize its operating parameters with the FDR server:

Parameter Name	Description
Network Port FDR Auto Backup Enable	Use this setting to enable/disable automatic synchronization of the operating parameter files. Selections are: • **No auto backup:** Automatic file synchronization is turned OFF (parameter = 0). • **Auto backup:** Automatic file synchronization is turned ON, and the file in the controller will be copied to the server in case of discrepancy (parameter = 1).
Network Port FDR Auto Backup Period Setting	The frequency, in seconds, between comparisons of the parameter file in the controller against the parameter file stored in the server. • Range = 1...65535 s • Increments = 1 s • Factory setting = 120 s

NOTE: When automatic synchronization is enabled, it is recommended to set the *Network Port FDR Auto Backup Period Setting* parameter to a value greater than **120 s**.

Manually Backup and Restore Settings: By executing the commands described below, you can manually synchronize the operating parameter files in the controller and server:

Command Name	Description
FDR Data Backup Command	Copies the operating parameter file in the controller to the server.
FDR Data Restore Command	Copies the operating parameter file in the server to the controller.

NOTE:

- If FDR Data Backup Command and FDR Data Restore Command bits are set to 1 simultaneously, an FDR Data Restore Command is proceeded.
- FDR Data Restore Command is active whether Config via network is enabled or not.
- FDR Data Restore Command cannot be done while the LTM R detects line currents.
- Any time the LTM R controller configuration changes, you should manually backup the new configuration file to the server by clicking **Device > File transfer > backup command**.

FDR Trip Recovery

When the LTM R controller detects a trip condition that requires intervention during the FDR startup process, the STS/NS LED flashes as follows:

Number of flashes...	Indicates the trip is...
8 flashes per second	LTMR Recoverable
10 flashes per second	System Recoverable

System Recoverable Trips:

Operations can resume after fixing the cause of the trip outside of the LTMR. System recoverable trips include:

- No file on the parameter server (Network Port FDR Status = 3)
- The parameter file server, or TFTP service, is down (Network Port FDR Status = 2)

LTMR Recoverable Trips:

When the parameter file in the server is invalid or corrupt, the trip requires manual intervention to be cleared. Operations can resume only after a new parameter file is manually copied from the controller to the server using the FDR Data Backup Command and power is cycled to the controller. LTMR recoverable trips include:

- Version mismatch of the parameter file on the parameter server and the LTM R controller (Network Port FDR Status = 13)
- CRC mismatch between parameter file on the server and the LTM R controller (Network Port FDR Status = 9)
- Content of the parameter file is invalid (Network Port FDR Status = 4)

FDR Status

The Network Port FDR Status parameter describes the state of the FDR service, as described below.

FDR Status:

Value	Description
0	Ready, IP available
1	No response from IP server
2	No response from parameter server
3	No file on parameter server
4	Corrupt file on parameter server
5	Empty file on parameter server
6	Detection of Internal Communication error
7	Backup of settings from Device to Parameter Server unsuccessful
8	Invalid settings provided by the controller
9	CRC mismatch between parameter server and controller
10	Invalid IP
11	Duplicate IP
12	FDR disabled
13	Device Parameter File Version Mismatch (for example, when attempting to replace an LTM R 08EBD with an LTM R 100 EBD)

Rapid Spanning Tree Protocol

Overview

The Rapid Spanning Tree Protocol (RSTP) service manages the state on every port of each device in the local area network (LAN) loop. The RSTP is configured to respond and resolve a communication loss of a device on the network within 50 milliseconds.

NOTE: 16 devices are the maximum connections allowed on the loop network for the 50 milliseconds to be fully efficient.

Discovery Procedure

Discovery is an automated connection to a device with an unknown IP address, using a direct PC connection and a web page access interface.

Discovery only operates on MS Windows Vista, 7 and 8 operating systems.

Step	Automated Action
1	Stop the antivirus on the PC that is connected to the TeSys T.
2	Connect the PC to the TeSys T using a RJ45 cable.
3	• Open Windows Explorer • Expand Network to view all network connections • The Connected device should appear in the list within a few seconds
4	Double-click the connected TeSys T. To find the name of TeSys T: • TeSys T is not configured in DHCP mode: TeSysT-XXYYZZ with XXYYZZ the last 3 bytes of MAC address. • TeSys T is configured in DHCP mode TeSysTXYZ with XY the position of Tens rotary switch and Z the position of Ones rotary switch.
5	Access the TeSys T in the webpage interface.

NOTE: If the product cannot be detected, retry the procedure with the antivirus deactivated. Do not forget to restart the antivirus when finished.

Ethernet Diagnostics

Overview

The LTM R controller reports diagnostic data describing its Ethernet network communications interface, including:

- data parameters that describe the controller's:
  - IP addressing settings
  - IP address assignment processes
  - virtual connections
  - communication history
  - communication services and their status
- one parameter that describes the validity of the data in each data parameter

  NOTE: It is recommended to read the diagnostics registers every second.

  NOTE: The response to the first request contains either all zeroes or old data. The response to the second and subsequent requests contains current network port diagnostic data.

Ethernet Basic HW Diag Validity

The Ethernet Basic HW Diag Validity parameter evaluates and reports the validity of Ethernet network diagnostic data. A bit in this parameter represents the state of an associated Ethernet network data parameter.

Bit values are:

Value	Indicates the parameter data is...
0	invalid
1	valid

The Ethernet Basic HW Diag Validity parameter is 32 bits long.

The bits of this parameter represent the validity of the following Ethernet data parameters:

Bit	Describes the validity of data in this parameter...
0	IP address assignment mode
1	Ethernet device name
2	Ethernet MB messages received counter
3	Ethernet MB messages sent counter
4	Ethernet MB detected error messages sent counter
5	Ethernet opened servers counter
6	Ethernet opened clients counter
7	Ethernet transmitted correct frames counter
8	Ethernet received correct frames counter
9	Ethernet frame format
10	Ethernet MAC address
11	Ethernet gateway
12	Ethernet subnet mask
13	Ethernet IP address
14	Ethernet service status
15	(not applicable - always 0)

Bit	Describes the validity of data in this parameter...
16	Ethernet services
17	Ethernet global status
18...31	(*Reserved* - always 0)

Ethernet Global Status

The Ethernet Global Status parameter indicates the status of the following services provided by the LTM R controller:

- fast device replacement (FDR)
- Modbus port 502 messaging (Modbus/TCP only)

This parameter is 2 bits long.

Parameter values are:

Bit	Indicates...
0	at least 1 enabled service is operating with an unresolved detected error
1	all enabled services are operating properly

Ethernet Global Status is cleared on power cycle and controller reset.

Ethernet Services Validity

The Ethernet Services Validity parameter indicates whether the LTM R controller supports the port 502 messaging service.

NOTE: Port 502 is exclusively reserved for Modbus messages.

The Ethernet Supported Services parameter is 1 bit long.

Parameter values are:

Value	Indicates the port 502 messaging service is...
0	not supported
1	supported

Ethernet Services Status

The Ethernet Services Status parameter indicates the status of the Ethernet Supported Services parameter, i.e., the status of the controller’s port 502 messaging service.

This parameter is 3 bits long.

Parameter values are:

Value	Indicates the port 502 messaging service is...
1	idle
2	operational

Ethernet Services Status is cleared on power cycle and controller reset.

Ethernet IP Address

The Ethernet IP Address parameter describes the IP address that has been assigned to the LTM R controller by the IP address assignment process, page 198.

The Ethernet IP Address consists of 4 byte values, in dot-decimal notation. Each byte value is an integer from 000 to 255.

Ethernet Subnet Mask

The Ethernet Subnet Mask parameter is applied to the Ethernet IP Address value to define the host address of the LTM R controller.

The Ethernet Subnet Mask consists of 4 byte values, in dot-decimal notation. Each byte value is an integer from 000 to 255.

Ethernet Gateway Address

The Ethernet Gateway Address parameter describes the address of the default gateway, i.e., the node that serves as an access point to other networks for communications from or to the LTM R controller.

The Ethernet Gateway Address consists of 4 byte values, in dot-decimal notation. Each byte value is an integer from 000 to 255.

Ethernet MAC Address

The Ethernet MAC Address parameter describes the media access control (MAC) address, or hardware identifier, uniquely assigned to an LTM R controller.

The Ethernet MAC Address consists of 6 hexadecimal byte values, from 0x00 to 0xFF.

Ethernet II Framing

The Ethernet II Framing parameter describes the Ethernet frame formats supported by the LTM R controller, including:

- capability: can the device support a frame format?
- configuration: is the device configured to support a frame format?
- operational: is the configured frame format operating successfully?

NOTE: The Ethernet frame type, Ethernet II or 802.3, is configured using the Network Port Frame Type Setting parameter.

This parameter is 3 words long.

Ethernet II framing data is stored as follows:

Word	Bit	Description	Values
1	0	Ethernet II framing **supported**	• 0 = not supported • 1 = supported
	1	Ethernet II framing receiver **supported**	• 0 = not supported • 1 = supported
	2	Ethernet II framing sender **supported**	• 0 = not supported • 1 = supported
	3	Ethernet auto detection **supported**	• 0 = not supported • 1 = supported
	4-15	(*Reserved*)	always 0
2	0	Ethernet II framing **configured**	• 0 = not configured • 1 = configured
	1	Ethernet II framing receiver **configured**	• 0 = not configured • 1 = configured
	2	Ethernet II framing sender **configured**	• 0 = not configured • 1 = configured
	3	Ethernet auto detection **configured**	• 0 = not configured • 1 = configured
	4-15	(*Reserved*)	always 0
3	0	Ethernet II framing **operational**	• 0 = not operational • 1 = operational
	1	Ethernet II framing receiver **operational**	• 0 = not operational • 1 = operational
	2	Ethernet II framing sender **operational**	• 0 = not operational • 1 = operational
	3	Ethernet auto detection **operational**	• 0 = not operational • 1 = operational
	4-15	(*Reserved*)	always 0

Ethernet Received Correct Frames Counter

The Ethernet Received Correct Frames Counter parameter contains a count of the total number of Ethernet frames that have been successfully received by the LTM R controller.

This parameter is an UDInt parameter. It is cleared on power cycle and controller reset.

The Ethernet Received Correct Frames Counter consists of 4 hexadecimal values, from 0x00 to 0xFF.

Ethernet Transmitted Correct Frames Counter

The Ethernet Transmitted Correct Frames Counter parameter contains a count of the total number of Ethernet frames that have been successfully transmitted by the LTM R controller.

This parameter is an UDInt parameter. It is cleared on power cycle and controller reset.

The Ethernet Transmitted Correct Frames Counter consists of 4 hexadecimal values, from 0x00 to 0xFF.

Ethernet Opened Clients Counter

The Ethernet Opened Clients Counter parameter contains a count of the number of open TCP client connections. It applies only to devices with TCP clients.

This parameter is an UInt parameter. It is cleared on power cycle and controller reset.

The Ethernet Opened Clients Counter consists of 2 hexadecimal values, from 0x00 to 0xFF.

Ethernet Opened Servers Counter

The Ethernet Opened Servers Counter parameter contains a count of the number of open TCP server connections. It applies only to devices with TCP servers.

This parameter is an UInt parameter. It is cleared on power cycle and controller reset.

The Ethernet Opened Servers Counter consists of 2 hexadecimal values, from 0x00 to 0xFF.

Ethernet MB Detected Error Messages Sent Counter

The Ethernet MB Detected Error Messages Sent Counter parameter contains a count of the number of:

- EtherNet/IP or Modbus/TCP request packets with errors in the header that have been received by this LTM R controller (does not count errors in the data portion of EtherNet/IP or Modbus/TCP request packets)
- EtherNet/IP or Modbus/TCP exceptions due to incorrect combination of physical port and Unit ID

This parameter is an UDInt parameter. It is cleared on power cycle and controller reset.

Ethernet MB Messages Sent Counter

The Ethernet MB Messages Sent Counter parameter contains the total number of Modbus messages, excluding Modbus detected error messages, that have been sent by this LTM R controller.

This parameter is an UDInt parameter. It is cleared on power cycle and controller reset.

Ethernet MB Messages Received Counter

The Ethernet MB Messages Received Counter parameter contains the total number of Modbus messages that have been received by this LTM R controller.

This parameter is an UDInt parameter. It is cleared on power cycle and controller reset.

Ethernet Device Name

The Ethernet Device Name parameter contains the 16 character string used to identify the LTM R controller.

This parameter is 16 bytes long.

Ethernet IP Assignment Capability

The Ethernet IP Assignment Capability parameter describes the available IP addressing sources for the LTM R controller. Up to 4 different IP addressing sources can be described.

This parameter is 4 bits long.

The Ethernet IP Assignment Capability parameter stores data as follows:

Bit	IP addressing source...	Values
0	A DHCP server, using the device name set by the 2 rotary switches	• 0 = not available • 1 = available
1	Derived from the MAC address. The Ones rotary switch is set to BootP, but no IP address was received from the server.	• 0 = not available • 1 = available
2	Derived from the MAC address. Both rotary switches are set to integers, but no IP address was received from the DHCP server.	• 0 = not available • 1 = available
3	The stored configuration parameters: • Ethernet IP Address Setting • Ethernet Subnet Mask Setting • Ethernet Gateway Address Setting	• 0 = not available • 1 = available

Ethernet IP Assignment Operational

The Ethernet IP Assignment Operational parameter describes how the current IP address was assigned to the LTM R controller. Only 1 (of 4) different IP address sources can be operational at any one time.

This parameter is 4 bits long.

The Ethernet IP Assignment Operational parameter stores data as follows:

Bit	IP addressing source...	Values
0	A DHCP server, using the device name set by the 2 rotary switches	• 0 = not operational • 1 = operational
1	Derived from the MAC address. The Ones rotary switch is set to BootP, but no IP address was received from the server.	• 0 = not operational • 1 = operational
2	Derived from the MAC address. Both rotary switches are set to integers, but no IP address was received from the DHCP server.	• 0 = not operational • 1 = operational
3	The stored configuration parameters: • Ethernet IP Address Setting • Ethernet Subnet Mask Setting • Ethernet Gateway Address Setting	• 0 = not operational • 1 = operational

Introduction to Custom Logic Editor

Overview

This chapter provides a description of the custom logic editor.

Presentation of the Custom Logic Editor

Overview

A programmable controller reads inputs, solves logic based on a control program, and writes to outputs. You can customize LTM R controller pre-defined control programs using the custom logic editor. The custom logic editor is a powerful programming tool that is only available in SoMove with the TeSys T DTM. Creating a control program for an LTM R controller consists of writing a series of instructions (logic commands) in one of the custom logic programming languages.

Purpose of the Custom Logic Editor

The primary purpose of the custom logic editor is to modify the commands used in the control program that:

- manage local/remote control source.
- define LTM R controller I/O logic assignment.
- direct timers such as those used to manage the transitions from low-voltage to high-voltage contactor in a two-step reduced voltage starter used to implement the start, stop, and reset function of a motor controller.
- manage trips.
- manage resets.

The custom logic editor enables you to add specific functions to the LTM R controller pre-defined logic programs (operating modes) to meet individual application needs.

Logic ID

All operating mode programs are identified with a unique logic ID. The logic ID of pre-defined operating mode program are numbers from 2 to 11. When a pre-defined operating mode program is customized, the logic ID of the customized program must be equal to the logic ID of the pre-defined program + 256.

This table gives the logic ID according to the operating mode:

Operating Mode	**Logic ID of Pre-Defined Program**	**Logic ID of Customized program**
Reserved	0...1	256...257
2-wire overload	2	258
3-wire overload	3	259
2-wire independent	4	260
3-wire independent	5	261
2-wire reverser	6	262
3-wire reverser	7	263
2-wire 2-step	8	264
3-wire 2-step	9	265

Operating Mode	Logic ID of Pre-Defined Program	Logic ID of Customized program
2-wire 2-speed	10	266
3-wire 2-speed	11	267
Reserved	12...255	268...511

Customized Programs

A customized program is an LTM R controller pre-defined logic program with specific functions to meet individual application needs.

When configured with one of the pre-defined operating modes, the LTM R motor controller manages the control functions using both the firmware in the LTM R controller microprocessor and the PCode.

When configured with a customized program, the LTM R controller retains the functions controlled by the LTM R controller microprocessor. Those functions include the following characteristics that are inherent to the "parent" pre-defined operating mode:

- restrictions to what can be written to register 704 (network command register).
- display of the operating state in presentation mode (Forward/Reverse, Low Speed/High Speed for example)
- automatic adjustment of power and power factor measurement in 2-step mode with Star-Delta starting selected
- restrictions on which fallback modes may be set through the menus.
- specific behaviors regarding the start cycle in 2-step mode.
- restrictions on whether the transition timer may be set through the menus.

Pre-Defined Program Structure

There are 10 pre-defined programs available with the TeSys T DTM on SoMove.

The pre-defined programs executes the following different parts, one after the other:

- Logic identification of the program with the logic ID
- Input management
- Operating mode execution
- Output update

The execution of the operating mode is embedded and called with the function `CALL_EOM`.

This provides the possibility to customize the input and output management of your custom program without modifying the operating mode execution.

Custom Logic Editor Programming Languages and Tools

The custom logic editor provides 2 programming languages and tools:

- Structured text language, which is a list instruction language editable via the structured text editor programming tool.
- Function Block Diagram (FBD), which is an object-oriented programming language editable via the FBD editor programming tool.

Each programming method satisfies your programming objectives. However, the custom logic editor allows you to select the style of programming method that you prefer.

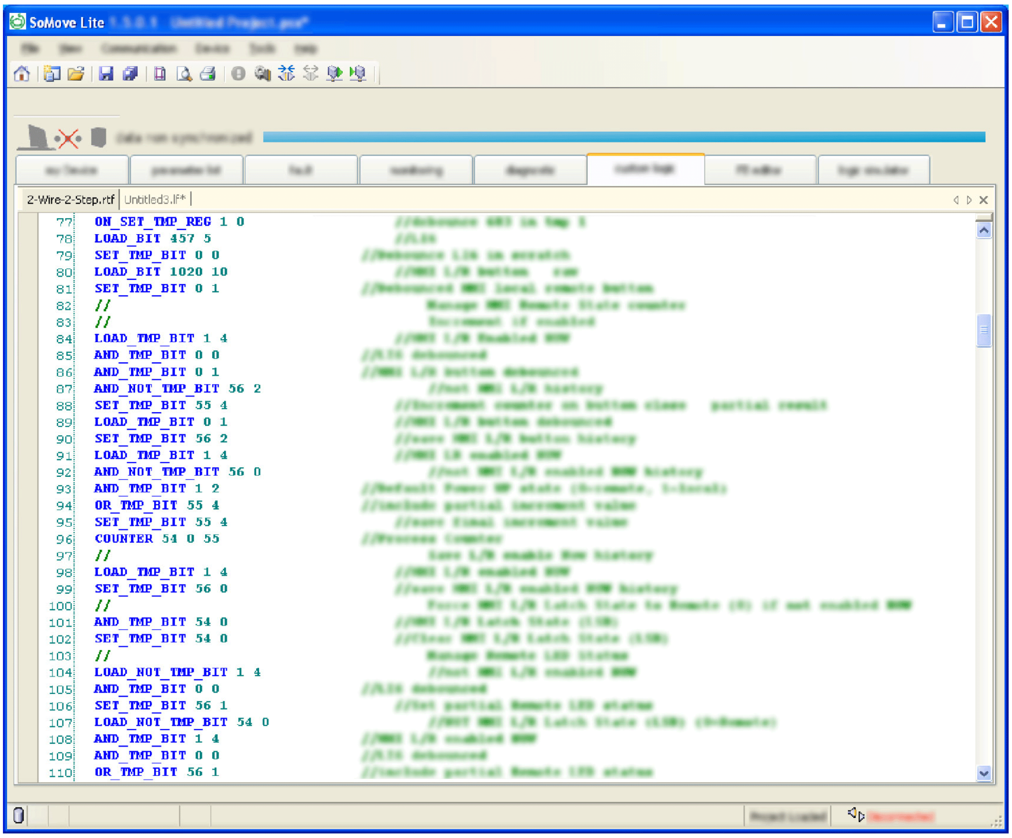
Logic Commands

Both structured text and FBD languages implement the following types of commands:

- Program logic commands
- Boolean logic commands
- Register logic commands
- Timer logic commands
- Counter logic commands
- Latch logic commands
- Math logic commands

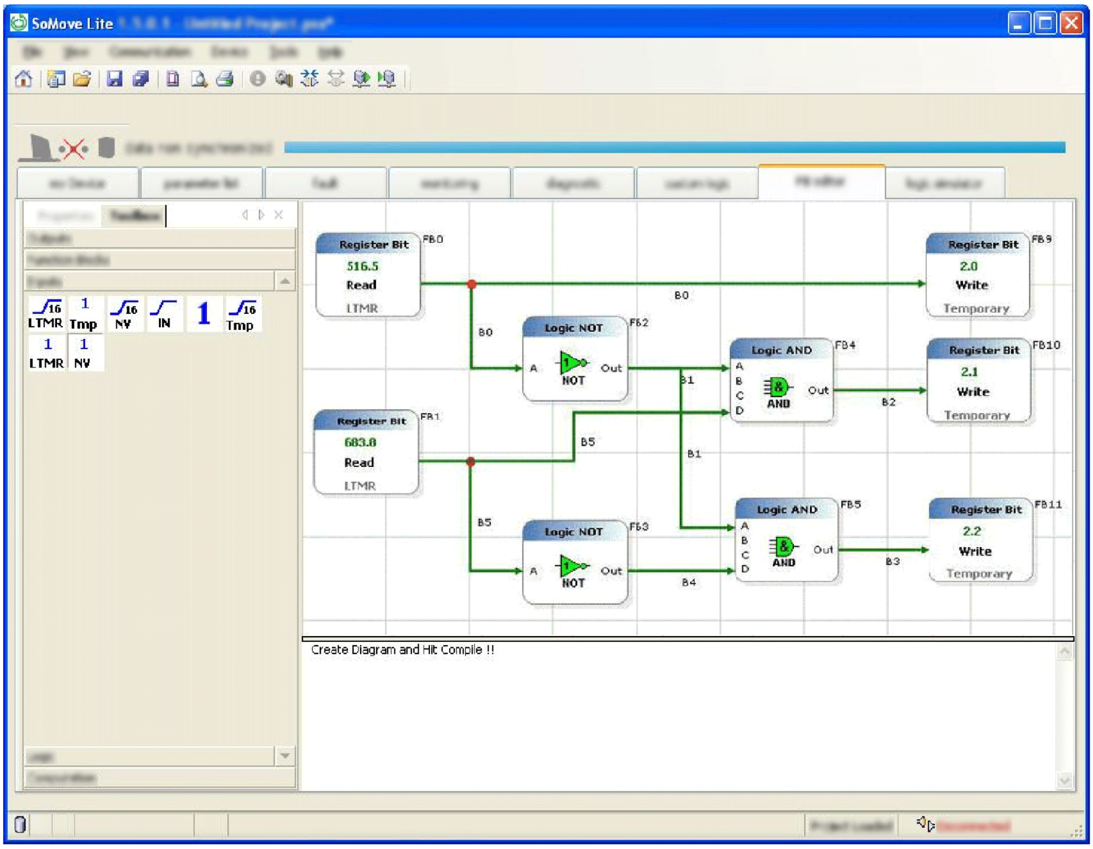
Structured Text Editor

The following illustration shows the structured text editor, integrated in the TeSys T DTM:



FBD Editor

The following illustration shows the FBD editor, integrated in TeSys T DTM:



Using the Custom Logic Editor

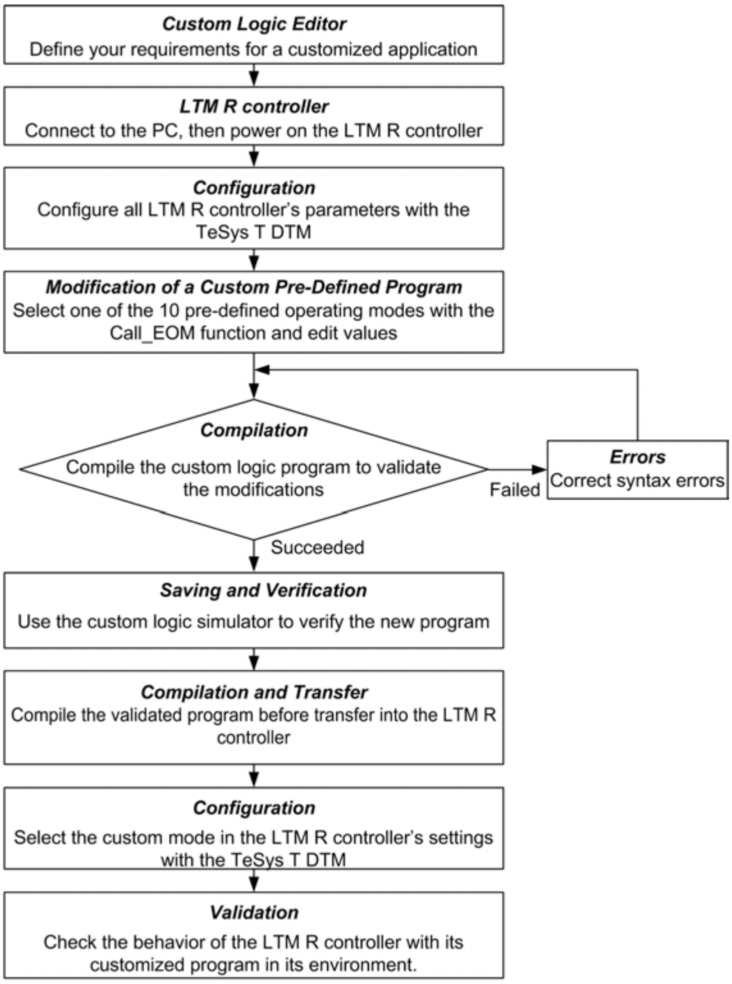
Overview

The custom logic editor enables you to create and validate your own custom logic program to match with your needs. Once it is made, the LTM R controller firmware loads and executes instructions you created.

Task Flow Diagram

The following diagram shows all of the tasks to be carried out during the creation and modification of a custom logic program.

Note: The order defined is provided as an example. The order you use will depend on your own work methods.



Customization Method in Structured Text

Step	Action
1	Define the operating modes that matches your application needs.
2	Open the pre-defined operating mode program file (*.rtf) in the custom logic editor.
3	Edit the pre-defined program in structured text, customize the program following one of the 3 methods: • the pre-defined operating mode matches your application needs: use only the `CALL_EOM` function. • the pre-defined operating mode matches your application needs but additional functions are required: use the `CALL_EOM` function and add the additional instructions after the `CALL_EOM` instructions. • the pre-defined operating mode does not match your application needs: start a new program from scratch (not recommended).
4	If required, edit the inputs of the customized program.
5	If required, edit the outputs of the customized program.
6	Update the Logic ID, page 215 according to the `CALL_EOM` and the control mode.
7	Simulate the customized program.
8	Compile the customized program.

Customization Method in FBD

Step	Action
1	Open a blank FBD program page.
2	Create the inputs management of the customized program.
3	Create the operating mode execution following one of the 3 methods: • one of the operating mode matches your application needs: use only the CALL_EOM function • one of the operating mode matches your application needs but additional functions are required: use the CALL_EOM function and add the additional instructions after the CALL_EOM instructions. • none of the operating mode matches your application needs: create a new program from scratch (not recommended).
4	Create the output management of the customized program.
5	Update the Logic ID, page 215 according to the CALL_EOM and the control mode.
6	Simulate the customized program.
7	Compile the customized program.

Characteristics of the Custom Logic Program

Introduction

The data transferred to or from the LTM R controller is in the form of 16-bit registers. The registers are numerically ordered and referenced by a 16-bit register address (0...65,535).

The custom logic program can modify the values of 3 types of registers:

- LTM R controller variables
- Temporary registers
- Non-volatile registers

Logic Memory Characteristics

The list of commands for the control program is saved in an area of the internal non-volatile memory of the LTM R controller.

The format of this logic memory is illustrated in this table:

Memory location	Item	Range	Description
0	Logic Program Size (n)	0...8,191 0 means that no customized program is loaded.	16-bit word
1	Logic Checksum	0...65,535	Sum of program memory from offset 2...n+2
2	Logic ID	0...511, page 215	Identifier of the custom logic program within the LTM R controller
3	Logic Command/Argument 1	Depending on the logic command type, page 240	One word of logic function
4	Logic Command/Argument 2		
5	Logic Command/Argument 3		
...	...	...	...
n+2	Logic Command/Argument n	–	One word of logic function

Logic Memory Limits

The program size is dependent on the number of logic commands. While in the text editor a command and its arguments will occupy a single line, in the memory, it will occupy as many memory locations as there are arguments.

As an example, the command **timer 0.1 980** will use 4 memory locations.

Definition of the Custom Logic Variables

Introduction

The custom logic editor enables you to implement commands in the control program which direct the LTM R controller to read or write to the temporary or non-volatile or LTM R variables.

The LTM R controller defines each custom logic register by an integer describing its address in custom logic memory space. The value of this integer begins at address 0 and the maximum address is equal to 1 less than the number of memory locations available for temporary registers in the LTM R controller. The LTM R controller lists the number of temporary registers available as a value in the LTM R control register 1204, which is the parameter for Custom Logic Temporary Space.

Temporary Registers

The controller provides registers in temporary memory that can be accessed by logic commands. Because these registers exist in temporary or volatile memory, they do not retain their value settings when power to the controller is cycled.

Variables can be stored in temporary registers from 0 to 299. Thus, 300 temporary registers are available.

Non-Volatile Registers

The LTM R controller provides registers in non-volatile memory for use by logic commands. Because these registers exist in non-volatile memory, they retain their value settings when power to the controller is cycled.

Variables can be stored in non-volatile registers from 0 to 63. Thus, 64 non-volatile registers are available.

Definition of the LTM R Variables

Overview

Custom logic commands can be used to change the values of read-write data registers of the LTM R controller.

LTM R Variables

Controller memory includes data registers at addresses ranging from 0 to 1399.

Each register is a 16-bit word and is either:

- read-only, with values that cannot be edited.
- read-write, with values that can be edited.

Accessing Variables

Using the custom logic editor, you can access all LTM R controller variables defined in the sections on Communication Variables in the *Use* chapter of the *TeSys T LTM R Motor Management Controller User Manuals*.

Custom Logic Register

Registers 1200...1205 are used by the TeSys T DTM to access internal register data within the LTM R controller. These registers are also the custom logic registers accessible from the communication ports. These read-only registers are described in the following sections.

This table lists these registers:

Register	Definition	Range (value)
1200	Custom logic status register	0...65,535
1201	Custom logic version	
1202	Custom logic memory space	
1203	Custom logic memory used	
1204	Custom logic temporary space	
1205	Custom logic non-volatile space	

Register 1200

Register 1200 is the custom logic status register. It enables the customized program to configure I/O assignment.

This table describes each bit in this register:

Bit number	Description
0	Custom logic run
1	Custom logic stop
2	Custom logic reset
3	Custom logic second step
4	Custom logic transition
5	Custom logic phase reverse
6	Custom logic network control
7	Custom logic FLC selection
8	*(Reserved)*
9	Custom logic auxiliary 1 LED of the LTM CU Control Operator Unit
10	Custom logic auxiliary 2 LED of the LTM CU Control Operator Unit
11	Custom logic stop LED of the LTM CU Control Operator Unit (not used)
12	Custom logic LO1
13	Custom logic LO2

Bit number	Description
14	Custom logic LO3
15	Custom logic LO4

Register 1201

Register 1201 indicates the custom logic capability version. The version number identifies a specific group of logic commands supported by the LTM R controller.

Register 1202

Register 1202 defines the logic memory space available, that is, the number of non-volatile LTM R controller logic memory words (16 bits) available to save logic commands.

Register 1203

Register 1203 defines the logic memory used, that is, the number of non-volatile LTM R logic memory words (16 bits) used by logic commands which are currently stored in the LTM R controller.

Register 1204

Register 1204 defines the number of temporary registers provided by the LTM R controller.

Register 1205

Register 1205 defines the number of non-volatile registers provided by the LTM R controller.

Registers 1301...1399

Registers 1301...1399 are the General Purpose Registers for logic functions. They are used to exchange information between external sources (such as the PLC) and the custom logic applications.

These volatile registers are read/write and can be edited either by the custom logic functions or via the communication port.

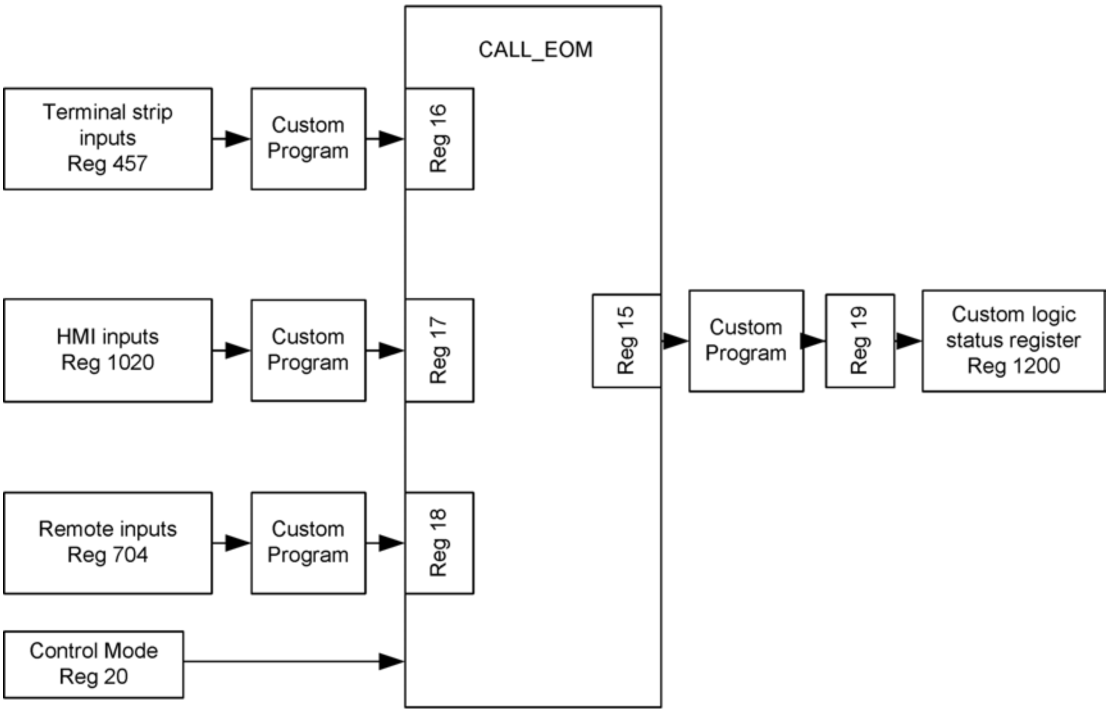
CALL_EOM Command Description

Overview

The `CALL_EOM` function allows to execute an operating mode.

For this purpose, the function uses the temporary registers 0 to 61.

To build a customized program around the CALL_EOM function, it is necessaire to understand how the different registers of the application and the LTM R are used:



- Register 16 to 18 are the input registers of the CALL_EOM function, when customized, they must be assigned bit per bit.
- Register 15 is the output register of the CALL_EOM function, its value is given after the execution of the operating mode.
- Register 19 is a temporary register used to set the register 1200 in one time. The customization of the CALL_EOM outputs must be done using the register 19.
- Register 20 bit 0 is the temporary bit used to set the terminal strip control (2-wire or 3-wire).

CALL_EOM 1 Description

When the CALL_EOM argument equals 1, the function executes the overload operating mode.

The logic ID to use in your customized program is:

- LOGID_ID 258 for 2-wire overload operating mode
- LOGID_ID 259 for 3-wire overload operating mode

The registers are used as follows:

Input assignment	
TMP REG 16: Copy of the terminal strip inputs	
Bit 0...3	Not used
Bit 4	Reset
Bit 5	Local / Remote control
Bit 6...15	Not used
TMP REG 17: Copy of the HMI inputs	
Bit 0	HMI key Aux 1
Bit 1	HMI key Aux 2

Input assignment	
Bit 2	Not used
Bit 3	HMI key Stop
Bit 4	Not used
Bit 5	Local / Remote control
Bit 6...15	Not used
TMP REG 18: Copy of the remote inputs	
Bit 0...2	Not used
Bit 3	Reset
Bit 4...15	Not used

TMP REG 20	
Bit 0	Terminal strip control (in ST only, set as a property in FBD): • 0= 2-wire • 1= 3-wire
Bit 1...15	Not used

Output assignment	
TMP REG 15: outputs of the `CALL_EOM` instruction to assign to LTM R controller outputs.	
Bit 0	CL "Motor Running" information
Bit 1	CL "Motor Stopped" information
Bit 2	CL "Reset" information
Bit 3...8	Not used
Bit 9	CL "Run1 LED" information
Bit 10	CL "Run2 LED" information
Bit 11	CL "Stop LED" information
Bit 12	CL "Run1 Cde" information
Bit 13	CL "Run2 Cde" information
Bit 14	CL "Alarm" information
Bit 15	CL "No Trip" information

CALL_EOM 2 Description

When the `CALL_EOM` argument equals 2, the function executes the independent operating mode.

The logic ID to use in your customized program is:

- LOGID_ID 260 for 2-wire independent operating mode
- LOGID_ID 261 for 3-wire independent operating mode

The registers are used as follows:

Input assignment	
TMP REG 16: Copy of the terminal strip inputs	
Bit 0	Run1
Bit 1	Run2
Bit 2...3	Not used
Bit 4	Reset
Bit 5	Local / Remote control

Input assignment	
Bit 6...15	Not used
TMP REG 17: Copy of the HMI inputs	
Bit 0	HMI key Aux 1
Bit 1	HMI key Aux 2
Bit 2	Not used
Bit 3	HMI key Stop
Bit 5	Local / Remote control
Bit 6...15	Not used
TMP REG 18: Copy of the remote inputs	
Bit 0	Run1
Bit 1	Run2
Bit 2	Not used
Bit 3	Reset
Bit 4...15	Not used

TMP REG 20	
Bit 0	Terminal strip control (in ST only, set as a property in FBD): • 0= 2-wire • 1= 3-wire
Bit 1...15	Not used

Output assignment	
TMP REG 15: outputs of the `CALL_EOM` instruction to assign to LTM R controller outputs.	
Bit 0	CL “Motor Running” information
Bit 1	CL “Motor Stopped” information
Bit 2	CL “Reset” information
Bit 3...8	Not used
Bit 9	CL “Run1 LED” information
Bit 10	CL “Run2 LED” information
Bit 11	CL “Stop LED” information
Bit 12	CL “Run1 Cde” information
Bit 13	CL “Run2 Cde” information
Bit 14	CL “Alarm” information
Bit 15	CL “No Trip” information

CALL_EOM 3 Description

When the `CALL_EOM` argument equals 3, the function executes the reverser operating mode.

The logic ID to use in your customized program is:

- LOGID_ID 262 for 2-wire reverser operating mode
- LOGID_ID 263 for 3-wire reverser operating mode

The registers are used as follows:

Input assignment	
TMP REG 16: Copy of the terminal strip inputs	
Bit 0	Forward
Bit 1	Reverse
Bit 2...3	Not used
Bit 4	Reset
Bit 5	Local / Remote control
Bit 6...15	Not used
TMP REG 17: Copy of the HMI inputs	
Bit 0	HMI key Aux 1
Bit 1	HMI key Aux 2
Bit 2	Not used
Bit 3	HMI key Stop
Bit 4	Not used
Bit 5	Local / Remote control
Bit 6...15	Not used
TMP REG 18: Copy of the remote inputs	
Bit 0	Forward
Bit 1	Reverse
Bit 2	Not used
Bit 3	Reset
Bit 4...15	Not used

TMP REG 20	
Bit 0	Terminal strip control (in ST only, set as a property in FBD): • 0= 2-wire • 1= 3-wire
Bit 1...15	Not used

Output assignment	
TMP REG 15: outputs of the `CALL_EOM` instruction to assign to LTM R controller outputs.	
Bit 0	CL “Motor Running” information
Bit 1	CL “Motor Stopped” information
Bit 2	CL “Reset” information
Bit 3...8	Not used
Bit 9	CL “Run1 LED” information
Bit 10	CL “Run2 LED” information
Bit 11	CL “Stop LED” information
Bit 12	CL “Run1 Cde” information
Bit 13	CL “Run2 Cde” information
Bit 14	CL “Alarm” information
Bit 15	CL “No Trip” information

CALL_EOM 4 Description

When the `CALL_EOM` argument equals 4, the function executes the 2-step operating mode.

The logic ID to use in your customized program is:

- LOGID_ID 264 for 2-wire 2-step operating mode
- LOGID_ID 265 for 3-wire 2-step operating mode

The registers are used as follows:

Input assignment	
TMP REG 16: Copy of the terminal strip inputs	
Bit 0	Run1
Bit 1...3	Not used
Bit 4	Reset
Bit 5	Local / Remote control
Bit 6...15	Not used
TMP REG 17: Copy of the HMI inputs	
Bit 0	HMI key Aux 1
Bit 1...2	Not used
Bit 3	HMI key Stop
Bit 4	Not used
Bit 5	Local / Remote control
Bit 6...15	Not used
TMP REG 18: Copy of the remote inputs	
Bit 0	Run1
Bit 1	Run2
Bit 2	Not used
Bit 3	Reset
Bit 4...15	Not used

TMP REG 20	
Bit 0	Terminal strip control (in ST only, set as a property in FBD): • 0= 2-wire • 1= 3-wire
Bit 1...15	Not used

Output assignment	
TMP REG 15: outputs of the `CALL_EOM` instruction to assign to LTM R controller outputs.	
Bit 0	CL “Motor Running” information
Bit 1	CL “Motor Stopped” information
Bit 2	CL “Reset” information
Bit 3...8	Not used
Bit 9	CL “Run1 LED” information
Bit 10	CL “Run2 LED” information
Bit 11	CL “Stop LED” information
Bit 12	CL “Run1 Cde” information
Bit 13	CL “Run2 Cde” information
Bit 14	CL “Alarm” information
Bit 15	CL “No Trip” information

CALL_EOM 5 Description

When the CALL_EOM argument equals 5, the function executes the 2-speed operating mode.

The logic ID to use in your customized program is:

- LOGID_ID 266 for 2-wire 2-speed operating mode
- LOGID_ID 267 for 3-wire 2-speed operating mode

The registers are used as follows:

Input assignment	
TMP REG 16: Copy of the terminal strip inputs	
Bit 0	Run1
Bit 1	Run2
Bit 2...3	Not used
Bit 4	Reset
Bit 5	Local / Remote control
Bit 6...15	Not used
TMP REG 17: Copy of the HMI inputs	
Bit 0	HMI key Aux 1
Bit 1	HMI key Aux 2
Bit 2	Not used
Bit 3	HMI key Stop
Bit 4	Not used
Bit 5	Local / Remote control
Bit 6...15	Not used
TMP REG 18: Copy of the remote inputs	
Bit 0	Run1
Bit 1	Run2
Bit 2	Not used
Bit 3	Reset
Bit 4...15	Not used

TMP REG 20	
Bit 0	Terminal strip control (in ST only, set as a property in FBD): • 0= 2-wire • 1= 3-wire
Bit 1...15	Not used

Output assignment	
TMP REG 15: outputs of the CALL_EOM instruction to assign to LTM R controller outputs.	
Bit 0	CL “Motor Running” information
Bit 1	CL “Motor Stopped” information
Bit 2	CL “Reset” information
Bit 3...8	Not used
Bit 9	CL “Run1 LED” information
Bit 10	CL “Run2 LED” information
Bit 11	CL “Stop LED” information
Bit 12	CL “Run1 Cde” information

Output assignment	
Bit 13	CL “Run2 Cde” information
Bit 14	CL “Alarm” information
Bit 15	CL “No Trip” information

Program Example

```
LOGIC_ID 256                                                 //2 WIRE INDEPENDENT MODE
//      Temp register allocation
//      Temp 0 and Temp 1 as scratch
//      Temp 2 as Requested Control Mode
//              0=PLC
//              1=HMI
//              2=TS (terminal strip)
//      Temp 3 as Active Control Mode
//              0=PLC
//              1=HMI
//              2=TS (terminal strip)
//      Temp 4 as state bits group 1
//              0=Control Transfer in process
//              1=LO1 PLC fallback value
//              2=LO2 PLC fallback value
//              3=LO1 HMI fallback value
//              4=LO2 HMI fallback value
//              5=Global Stop
//              6=Stop1|
//              7=Stop2
//              8=Run1
//              9=Run2
//              10=Forward
//              11=Reverse
//              12=Reversing Timer
//              13=Swapping
//              14=Last Direction
//              15=Two Wire Swap
//      Temp 5 as 2 Step states
//      Temp 6,7,8 as Step 1 Timer
//      Temp 9,10,11 as Step 2 Timer
//      Temp 12 as INPUT History
//              1=PLC Run 1
//              2=PLC Run 2
//              3=HMI Run 1
//              4=HMI Run 2
//              5=TS Run 1
//              6=TS Run 2
//              7=Mode Change 1
//              8=Spare
//              9=Mode Change 2
//              10=Spare
//              11=Bumpless in Process
//              12=Power up Done
//      Temp 13 as Voltage Dip and HMI keypad group
//              0=Normal Load Shed
//              1=Dip Auto Enable
//              2=Dip Stop
//              3=Dip Stop History
//              4=Dip Set Inhibit Latch
//              5=Dip Clear Inhibit Latch
//              6=Dip Inhibit Run
//              7 11=Spare
//              12=HMI Aux 1
//              13=HMI Aux 2
//              14=HMI Stop
//      Temp 14 Voltage Dip Latch Status
//              0=State
//              1=Set
//              2=Clear
//      Temp 15 Custom Logic Outputs
//              0=CL "Motor Running" information
//              1=CL "Motor Stopped" information
//              2=CL "Reset" information
//              9=CL "Run1 LED" information
//              10=CL "Run2 LED" information
//              11=CL "Stop LED" information
//              12=CL "Run1 Cde" information
//              13=CL "Run2 Cde" information
```

```
//              14=CL "Alarm" information
//              15=CL "No Fault" information
//      Temp 16 Custom Logic Terminal Strip imputs
//              0=Run 1
//              1=Run 2
//              2=External fault
//              4=Reset
//              5=Local/Remote Control
//      Temp 17 Custom Logic HMI imputs
//              0=Aux 1
//              1=Aux 2
//              3=Stop
//              5=Local/Remote Control
//      Temp 18 Custom Logic REMOTE inputs
//              0=Run 1
//              1=Run 2
//              3=Reset
//      Temp 19 Speedup image of LTMR Register 1200.
//      Temp 20  three wire status
//               0=3_wire / not 3 wire(2 wire)
//      Temp 50+ as general status registers
//      Temp 50  as ONSET status transition time value
//      Temp 51  as ONSET status Low to High timer
//      Temp 52  as ONSET status High to Low timer
//      Temp 53  Last Speed Latch Save Requested Control.in Temp 2
//      Temp 54, 55  HMI Remote State Counter (LSB is significant)
//      Temp 56 as HMI Local/Remote state bits
//              0=HMI Remote Active
//              1=Remote LED Status
//              2=HMI L/R button history
//      Temp 57, 58, 59, 60, 61 as OFF TIME adjustment of Transition Timer Reg 541.
//define 2_wire or 3_wire
//LOAD_K_BIT 1
//SET_TMP_BIT 20 0                                          3 wire
LOAD_K_BIT 1
SET_NOT_TMP_BIT 20 0                                        //2 wire
//Input
LOAD_BIT 457 0                                              //LI1
SET_TMP_BIT 16 0
LOAD_BIT 457 1                                              //LI2
SET_TMP_BIT 16 1
LOAD_BIT 457 2                                              //LI3
SET_TMP_BIT 16 2
LOAD_BIT 457 3                                              //LI4
SET_TMP_BIT 16 3
LOAD_BIT 457 4                                              //LI5
SET_TMP_BIT 16 4
LOAD_BIT 457 5                                              //LI6
SET_TMP_BIT 16 5
LOAD_BIT 1020 12                                            //HMI Aux1 button
SET_TMP_BIT 17 0
LOAD_BIT 1020 13                                            //HMI Aux2 button
SET_TMP_BIT 17 1
LOAD_BIT 1020 14                                            //HMI Stop button
SET_TMP_BIT 17 2
LOAD_BIT 1020 11                                            //HMI Reset button
SET_TMP_BIT 17 4
LOAD_BIT 1020 10                                            //HMI L/R button
SET_TMP_BIT 17 5
LOAD_BIT 704 0                                              //PLC Run1 command
SET_TMP_BIT 18 0
LOAD_BIT 704 1                                              //PLC Run2 command
SET_TMP_BIT 18 1
LOAD_BIT 704 3                                              //PLC Run2 command
SET_TMP_BIT 18 3
//End customer Zone
//Call Command
//Output
//==========================================================


//==========================================================
//                      Customer Zone: Custom application
// Add specific code for Custom Logic function here
CALL_EOM 2                                                  //Independent mode
//==========================================================
//                      Customer Zone: Outputs management
//HMI Aux 1 Led
LOAD_TMP_BIT 15 9
SET_TMP_BIT 19 9                                            //Image of HMI Aux1 LED
//HMI Aux 2 Led
LOAD_TMP_BIT 15 10
SET_TMP_BIT 19 10                                           //Image of HMI Aux2 LED
//HMI Stop Led
LOAD_TMP_BIT 15 11
SET_TMP_BIT 19 11                                           //Image of HMI Stop LED
// Output LO1
LOAD_TMP_BIT 15 12
SET_TMP_BIT 19 12                                           //Image of Output LO1
// Output LO2
LOAD_TMP_BIT 15 13
SET_TMP_BIT 19 13                                           //Image of Output LO2
// Output LO3
LOAD_TMP_BIT 15 14
SET_TMP_BIT 19 14                                           //Image of Output LO3
// Output LO4
LOAD_TMP_BIT 15 15
SET_TMP_BIT 19 15                                           //Image of Output LO4
//                      End Customer Zone
//==========================================================
//                      Schneider Zone (Do not modify)
LOAD_K_BIT 1
SET_NOT_TMP_BIT 0 3
LOAD_TMP_REG 19                                     //Get image of 1200
ON_SET_REG 1200 0                                           //Put it into 1200
```

Structured Text Language

Overview

The structured text editor enables you to create a custom logic program based on the structured text programming language.

Creating a Structured Text Program

Summary

This section describes the creation of a program with the structured text editor.

Use the structured text editor to modify the pre-defined operating program by:

- changing the input and output assignments of the logic functions
- adding new logic functions that will change the step by step instructions of the original program

Create a new program by designing the step instructions customized to the specific requirements of the application.

Introducing the Structured Text Editor

Overview

The structured text editor is a feature of SoMove with the TeSys T DTM. Use the structured text editor to view an existing logic file or to create a logic file using an instruction based text language, rather than a graphics based programming language.

Editing a Structured Text Program

The easiest way to create a logic file is to begin with a logic file for one of the pre-defined operating modes, page 219. Your installation of the custom logic editor comes with 10 pre-defined logic files, one for each combination of:

- operating mode (2-speed, 2-step, independent, overload, reverser), and
- control wiring selection (2-wire, 3-wire).

Each logic file bears a descriptive name (e.g. "3-wire-reverser") and a file extension of *.lf*.

Custom Logic Editor User Interface

To open the structured text editor, click **Device** → **custom logic** → **New custom program**.

The structured text editor is available regardless of whether the TeSys T DTM is in connected mode. However, the transfer of programs between the TeSys T DTM and the device works only in connected mode.

Structured Text Editor User Interface

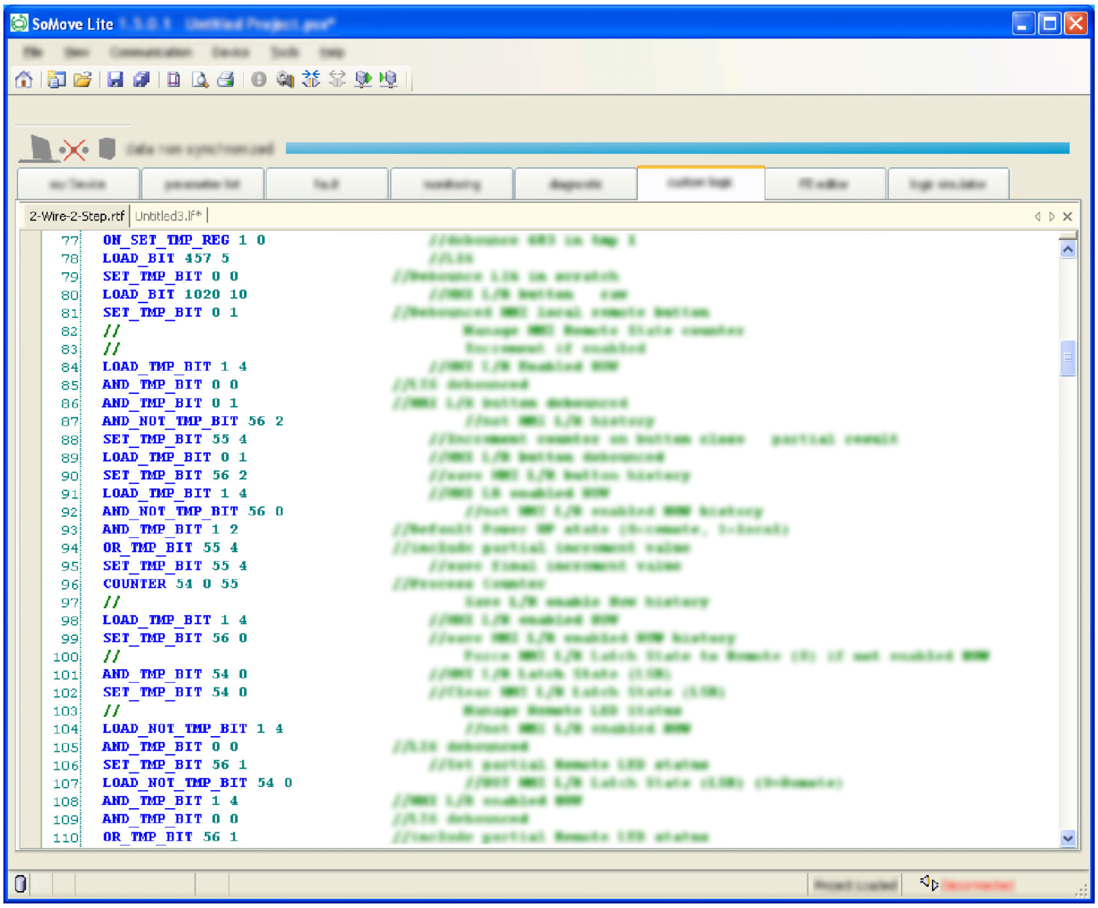
Introduction

A program written in list language consists of a series of instructions executed sequentially by the LTM R controller. Each list instruction is represented by a single program line and consists of 4 components:

- Line number
- Logic command (Mnemonics)
- Argument(s)
- Comment(s)

Example of a Structured Text Program

The following illustration is an example of a program created with the structured text editor.



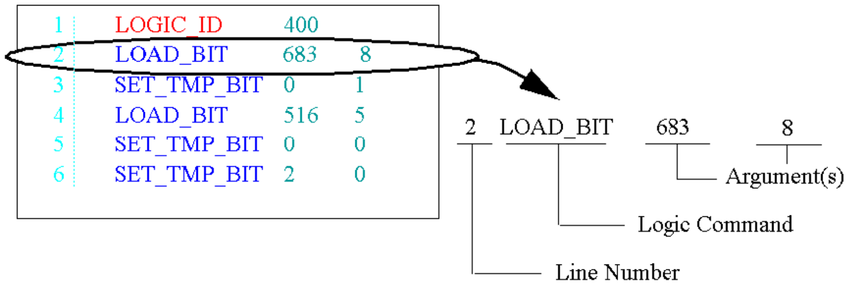
Editing Several Programs

You can create or modify several custom logic programs at the same time. Click on the file name to switch between them.

For instance, in the Text view above, click either **2-wire-2-Step.rtf** or **Untitled3.lf** depending on the program you wish to edit.

Instruction Elements

The following illustration is a sample of structured text program:



Line Number

The line number is an additional information:

- It is defined only by the editor.
- It does not have any importance in the custom logic function itself.

Logic Command

A logic command is an instruction which identifies the operation to be performed using one or more arguments. In the example, the `LOAD_BIT` command loads the value of the argument into an internal register called the 1-bit accumulator.

There are 2 types of commands:

- Setup commands

  These set-up or test for the necessary conditions to perform an action (for example, `LOAD` and `AND` commands).
- Actions commands

  These commands direct the LTM R controller to perform an action based on info in the setup instructions (for example, assignment commands such as `COMP`).

NOTE: When you type a logic command, either uppercase or lowercase, it is automatically recognized and displayed in blue.

Argument

An argument is a number representing a value (register address, bit number, or constant) that the LTM R controller can manipulate in an instruction. For example, in the sample program, the second instruction `LOAD_BIT 683 8` includes a logic command `LOAD_BIT` and 2 arguments, `683` and `8`. This instructs the LTM R controller to load the value of register 683 bit 8 into the accumulator. A logic command can have from 0 to 3 arguments depending on the type of logic command.

Using instructions with commands and arguments, the LTM R controller program can:

- Read the status of controller inputs.
- Read or write the status of controller outputs.
- Activate basic logic functions such as timers and counters.
- Perform arithmetic, logical, comparisons, and numerical operations.
- Read or write to the LTM R controller's internal registers or to individual bits in those registers.

NOTE: When you type an argument, it is automatically recognized and displayed in the color assigned to the arguments.

Comments

In the structured text editor, it is possible to add comments to the program:

- at the end of each line after the arguments
- in a whole line

NOTE:

- When you type //, the custom logic editor automatically recognizes the text after it as comments and displays it in green.
- Comments can not be retrieved from the LTM R controller.

Syntax

In the structured text editor, it is possible to write instructions:

- with blanks, commas or dots between arguments
- in upper or lower characters

Syntax Check

During typing, the text editor checks the instruction syntax:

- Correct instructions are displayed in bold blue characters.
- Incorrect instructions stay displayed in black and must be corrected before the compilation.

Keyboard Commands

Keyboard commands and shortcuts are the same as those for Windows operating systems: press DEL or DELETE to delete a character or line, press ENTER to go to the next line, etc.

Saving

To save the program you edited or created, click **Device > custom logic** then select **Save custom program** or **Save custom program as**.

NOTE: This file is saved with the extension **.lf*.

Logic Commands

Overview

All controller project files consist of a series of logic commands. Each logic command consists of the command itself, plus up to 3 arguments.

Each logic command performs its operation linked to either a 1-bit Boolean accumulator (value 0 or 1) or a 16-bit unsigned accumulator (value range 0...65,535).

The custom logic editor provides the following kinds of logic commands:

- Boolean
- Register

- Timers
- Latch
- Counters
- Math

Rising Edge Detection Mechanism

Some logic commands work on a rising edge of the 1-bit accumulator.

The rising edge of a bit is detected when its current state is 1 and its previous state was 0. The previous state of the bit is stored in a dedicated history bit.

NOTE: If this history bit is modified, the detection of the rising edge can be disturbed.

Boolean Logic Commands

Boolean commands evaluate and control simple Boolean (On/Off) values. Boolean commands include:

Command	Argument 1	Argument 2	Argument 3	Description
`LOAD_K_BIT`	Constant value (0 or 1)	–	–	Loads a constant value into the 1-bit accumulator.
`LOAD_BIT`	Register address	Register bit no. (0...15)	–	Loads a register bit from the address identified in Argument 1, and the bit identified in Argument 2 into the 1-bit accumulator.
`LOAD_TMP_BIT`	Temporary register address	Register bit no. (0...15)	–	Loads a temporary register bit into the 1-bit accumulator.
`LOAD_NV_BIT`	Non-volatile register address	Register bit no. (0...15)	–	Loads a non-volatile register bit into the 1-bit accumulator.
`LOAD_NOT_BIT`	Register address	Register bit no. (0...15)	–	Loads an inverted Boolean value of a register bit into the 1-bit accumulator.
`LOAD_NOT_TMP_BIT`	Temporary register address	Register bit no. (0...15)	–	Loads an inverted Boolean value of a temporary register bit into the 1-bit accumulator.
`LOAD_NOT_NV_BIT`	Non-volatile register address	Register bit no. (0...15)	–	Loads an inverted Boolean value of a non-volatile register bit into the 1-bit accumulator.
`AND_BIT`	Register address	Register bit no. (0...15)	–	Loads the result of a logical `AND` link between the register bit value and the 1-bit accumulator content. The result is stored in the 1-bit accumulator.
`AND_TMP_BIT`	Temporary register address	Register bit no. (0...15)	–	Loads the result of a logical `AND` link between the temporary register bit value and the 1-bit accumulator content. The result is stored in the 1-bit accumulator.
`AND_NV_BIT`	Non-volatile register address	Register bit no. (0...15)	–	Loads the result of a logical `AND` link between the non-volatile register bit value and the 1-bit accumulator content. The result is stored in the 1-bit accumulator.
`AND_NOT_BIT`	Register address	Register bit no. (0...15)	–	Loads the result of a logical `AND` of the inverted register bit and the 1-bit accumulator. The result is stored in the 1-bit accumulator.
`AND_NOT_TMP_BIT`	Temporary register address	Register bit no. (0...15)	–	Loads the result of a logical `AND` of the inverted temporary register bit and the 1-bit accumulator. The result is stored in the 1-bit accumulator.
`AND_NOT_NV_BIT`	Non-volatile register address	Register bit no. (0...15)	–	Loads the result of a logical `AND` of the inverted non-volatile register bit and the 1-bit accumulator. The result is stored in the 1-bit accumulator.
`OR_BIT`	Register address	Register bit no. (0...15)	–	Makes a logical `OR` link between the register bit value and the 1-bit accumulator content. The result is stored in the 1-bit accumulator.

Command	Argument 1	Argument 2	Argument 3	Description
`OR_TMP_BIT`	Temporary register address	Register bit no. (0...15)	–	Makes a logical `OR` link between the temporary register bit value and the 1-bit accumulator content. The result is stored in the 1-bit accumulator.
`OR_NV_BIT`	Non-volatile register address	Register bit no. (0...15)	–	Makes a logical `OR` link between the non-volatile register bit value and the 1-bit accumulator content. The result is stored in the 1-bit accumulator.
`OR_NOT_BIT`	Register address	Register bit no. (0...15)	–	Makes an logical `OR` of the inverted register bit and the 1-bit accumulator. The result is stored in the 1-bit accumulator.
`OR_NOT_TMP_BIT`	Temporary register address	Register bit no. (0...15)	–	Makes an logical `OR` of the inverted temporary register bit and the 1-bit accumulator. The result is stored in the 1-bit accumulator.
`OR_NOT_NV_BIT`	Non-volatile register address	Register bit no. (0...15)	–	Makes an logical `OR` of the inverted non-volatile register bit and the 1-bit accumulator. The result is stored in the 1-bit accumulator.
`SET_BIT`	Register address	Register bit no. (0...15)	–	Sets value of the 1-bit accumulator into a register bit.
`SET_TMP_BIT`	Temporary register address	Register bit no. (0...15)	–	Sets value of the 1-bit accumulator into a temporary register bit.
`SET_NV_BIT`	Non-volatile register address	Register bit no. (0...15)	–	Sets value of the 1-bit accumulator into a non-volatile register bit.
`SET_NOT_BIT`	Register address	Register bit no. (0...15)	–	Sets inverted value of the 1-bit accumulator into a register bit.
`SET_NOT_TMP_BIT`	Temporary register address	Register bit no. (0...15)	–	Sets inverted value of the 1-bit accumulator into a temporary register bit.
`SET_NOT_NV_BIT`	Non-volatile register address	Register bit no. (0...15)	–	Sets inverted value of the 1-bit accumulator into a non-volatile register bit.
– Argument not applicable to logic command.				

Register Logic Commands

Register commands evaluate and control 16-bit values. Register commands include:

Command	Argument 1	Argument 2	Argument 3	Description
`LOAD_K_REG`	Constant value (0...65,535)	–	–	Loads a constant value into the 16-bit accumulator.
`LOAD_REG`	Register address	–	–	Loads a copy of a register into the 16-bit accumulator.
`LOAD_TMP_REG`	Temporary register address	–	–	Loads a copy of a temporary register into the 16-bit accumulator.
`LOAD_NV_REG`	Non-volatile register address	–	–	Loads a copy of a non-volatile register into the 16-bit accumulator.
`COMP_K_REG`	Constant value (0...65,535)	Temporary register address	–	Compares the content of the Argument 1 to the 16-bit accumulator content and sets status Argument 2 bits as follows: `BIT 1 ON` if 16-bit accumulator < content of the Argument 1 `BIT 2 ON` if 16-bit accumulator = content of the Argument 1 `BIT 3 ON` if 16-bit accumulator > content of the Argument 1

Command	Argument 1	Argument 2	Argument 3	Description
COMP_REG	Register address	Temporary register address	–	Compares the content of the register defined by Argument 1 to the 16-bit accumulator content and sets status Argument 2 bits as follows: BIT 1 ON if 16-bit accumulator < content of the register defined by Argument 1 BIT 2 ON if 16-bit accumulator = content of the register defined by Argument 1 BIT 3 ON if 16-bit accumulator > content of the register defined by Argument 1
COMP_TMP_REG	Temporary register address	Temporary register address	–	Compares the content of the register defined by Argument 1 to the 16-bit accumulator content and sets status Argument 2 bits as follows: BIT 1 ON if 16-bit accumulator < content of the register defined by Argument 1 BIT 2 ON if 16-bit accumulator = content of the register defined by Argument 1 BIT 3 ON if 16-bit accumulator > content of the register defined by Argument 1
COMP_NV_REG	Non-volatile register address	Temporary register address	–	Compares the content of the register defined by Argument 1 to the 16-bit accumulator content and sets status Argument 2 bits as follows: BIT 1 ON if 16-bit accumulator < content of the register defined by Argument 1 BIT 2 ON if 16-bit accumulator = content of the register defined by Argument 1 BIT 3 ON if 16-bit accumulator > content of the register defined by Argument 1
AND_K	Constant value (0...65,535)	–	–	Makes a logical AND link between the constant value and the 16-bit accumulator content. The result is stored in the 16-bit accumulator.
AND_REG	Register address	–	–	Makes a logical AND link between the register value and the 16-bit accumulator content. The result is stored in the 16-bit accumulator.
AND_TMP_REG	Temporary register address	–	–	Makes a logical AND link between the temporary register value and the 16-bit accumulator content. The result is stored in the 16-bit accumulator.
AND_NV_REG	Non-volatile register address	–	–	Makes a logical AND link between the non-volatile register value and the 16-bit accumulator content. The result is stored in the 16-bit accumulator.
OR_K	Constant value (0...65,535)	–	–	Makes a logical OR link between the constant value and the 16-bit accumulator content. The result is stored in the 16-bit accumulator.
OR_REG	Register address	–	–	Makes a logical OR link between the register value and the 16-bit accumulator content. The result is stored in the 16-bit accumulator.
OR_TMP_REG	Temporary register address	–	–	Makes a logical OR link between the temporary register value and the 16-bit accumulator content. The result is stored in the 16-bit accumulator.
OR_NV_REG	Non-volatile register address	–	–	Makes a logical exclusive OR link between the non-volatile register value and the 16-bit accumulator content. The result is stored in the 16-bit accumulator.
XOR_K	Constant value (0...65,535)	–	–	Makes a logical exclusive OR link between the constant value and the 16-bit accumulator content. The result is stored in the 16-bit accumulator.
XOR_REG	Register address	–	–	Makes a logical exclusive OR link between the register value and the 16-bit accumulator content. The result is stored in the 16-bit accumulator.

Command	Argument 1	Argument 2	Argument 3	Description
XOR_TMP_REG	Temporary register address	–	–	Makes a logical exclusive OR link between the temporary register value and the 16-bit accumulator content. The result is stored in the 16-bit accumulator.
XOR_NV_REG	Non-volatile register address	–	–	Makes a logical exclusive OR link between the non-volatile register value and the 16-bit accumulator content. The result is stored in the 16-bit accumulator.
ON_SET_REG	Register address	Temporary register address	–	Stores the 16-bit accumulator content into the register defined by Argument 1 on a rising edge of the 1-bit accumulator.
ON_SET_TMP_REG	Temporary register address	Temporary register address	–	Stores the 16-bit accumulator content into the temporary register defined by Argument 1 on a rising edge of the 1-bit accumulator.
ON_SET_NV_REG	Non-volatile register address	Temporary register address	–	Stores the 16-bit accumulator content into the non-volatile register defined by Argument 1 on a rising edge of the 1-bit accumulator.
– Argument not applicable to logic command.				

Timer Logic Commands

Timers have a range from 0 to 65,535 and measure time in intervals of seconds or tenths of seconds:

- Argument 1 specifies the time period.
- Argument 2 is a calculated end time.
- Argument 3 is the timer status register.

Timer commands include:

Command	Argument 1	Argument 2	Argument 3	Description
TIMER_SEC	Temporary register (time period)	Temporary register (calculated end time)	Temporary register (status)	Counts in seconds the time period input in Argument 1 as described by status register bits.
TIMER_TENTHS	Temporary register (time period)	Temporary register (calculated end time)	Temporary register (status)	Counts in tenths of seconds the time period input in Argument 1 as described by status register bits.
TIMER_K_SEC	Constant value 0...65,535 (time period)	Temporary register (calculated end time)	Temporary register (status)	Counts in seconds the time period input in Argument 1 as described by status register bits.
TIMER_K_TENTHS	Constant value 0...65,535 (time period)	Temporary register (calculated end time)	Temporary register (status)	Counts in tenths of seconds the time period input in Argument 1 as described by status register bits.

Latch Logic Commands

Latch commands include:

Command	Argument 1	Argument 2	Argument 3	Description
LATCH	Temporary register (status)	–	–	Records and retains in a temporary register a history of a signal.
LATCH_NV	Non-volatile register (status)	–	–	Records and retains in a non-volatile register a history of a signal.
– Argument not applicable to logic command.				

Counter Logic Commands

Counters have a range from 0 to 65,535 and transition to 0 upon counting to the maximum value of 65,535.

Counter commands include:

Command	Argument 1	Argument 2	Argument 3	Description
`COUNTER`	Temporary register (counter value)	Constant value 0...65,535 (preset value)	Temporary register (status)	Performs a comparative count, saving both the count and status to temporary registers.
`COUNTER_NV`	Non-volatile register (counter value)	Constant value 0...65,535 (preset value)	Non-volatile register (status)	Performs a comparative count, saving both the count and status to non-volatile registers.

Math Logic Commands

Math commands perform unsigned math functions using the 16-bit accumulator and temporary registers. Math commands are executed on a rising edge of the 1-bit accumulator. Math commands include:

Command	Argument 1	Argument 2	Argument 3	Description
`ON_ADD`	Temporary register (value)	Temporary register (status)	–	Argument 1 = Argument 1 + 16-bit accumulator.
`ON_SUB`	Temporary register (value)	Temporary register (status)	–	Argument 1 = Argument 1 - 16-bit accumulator.
`ON_MUL`	Temporary register (most significant word)	Temporary register (least significant word)	Temporary register (status)	Argument 1:Argument 2 = 16-bit accumulator x Argument 2.
`ON_DIV`	Temporary register (most significant word)	Temporary register (least significant word)	Temporary register (status)	Argument 1:Argument 2 = Argument 1:Argument 2 / 16-bit accumulator.
– Argument not applicable to logic command.				

Logic Commands

Summary

This section describes in detail the logic commands and arguments provided by the custom logic editor.

Program Logic Commands

Overview

Program logic commands are used to:

- identify the logic file to the custom logic editor.
- execute a pre-defined operating mode

The following commands can be used:

- `LOGIC_ID`
- `CALL_EOM`
- `NOP`

LOGIC_ID

The LOGIC_ID statement acts as an identifier for the logic file.

LOGIC_ID values have an integer value range from 256 to 511.

Arguments	Representation
1	LOGIC_ID ID#

Input Argument	Type	Range	Description
ID#	UINT	256...511	Logic ID of the customized program

No output arguments.

CALL_EOM

The CALL_EOM executes a pre-defined operating mode in the customized program.

Arguments	Representation
1	CALL_EOM OP_MODE#

Input Argument	Type	Range	Representation
OP_MODE#	INT	1...5	Embedded operating mode (EOM): • 1 = Overload • 2 = Independent • 3 = Reverser • 4 = 2-Step • 5 = 2-Speed

No output arguments.

NOP

The NOP command performs no operation.

Use the NOP command as a placeholder in a logic file to replace a pre-existing command, or to reserve space for a future command.

Arguments	Representation
0	NOP

The NOP command has no arguments.

Boolean Logic Commands

Overview

The custom logic editor uses the following boolean logic commands:

- LOAD_K_BIT
- LOAD_BIT
- LOAD_TMP_BIT
- LOAD_NV_BIT

- LOAD_NOT_BIT
- LOAD_NOT_TMP_BIT
- LOAD_NOT_NV_BIT
- AND_BIT
- AND_TMP_BIT
- AND_NV_BIT
- AND_NOT_BIT
- AND_NOT_TMP_BIT
- AND_NOT_NV_BIT
- OR_BIT
- OR_TMP_BIT
- OR_NV_BIT
- OR_NOT_BIT
- OR_NOT_TMP_BIT
- OR_NOT_NV_BIT
- SET_BIT
- SET_TMP_BIT
- SET_NV_BIT
- SET_NOT_BIT
- SET_NOT_TMP_BIT
- SET_NOT_NV_BIT

LOAD_K_BIT

The LOAD_K_BIT command loads a constant Boolean value (0 or 1) into the 1-bit accumulator.

Arguments	Representation
1	LOAD_K_BIT KValue

Input Argument	Type	Range	Description
KValue	BOOL	0/1	A constant value

No output arguments.

LOAD_BIT

The LOAD_BIT command loads the Boolean value (0 or 1) of a register bit into the 1-bit accumulator.

Arguments	Representation
2	LOAD_BIT RegAddr BitNo

Input Argument	Type	Range	Description
RegAddr	UINT	0...1399	The register address
BitNo	UINT	0...15	The bit number

No output arguments.

LOAD_TMP_BIT

The `LOAD_TMP_BIT` command loads the Boolean value (0 or 1) of a temporary register bit into the 1-bit accumulator.

Arguments	Representation
2	`LOAD_TMP_BIT TmpReg BitNo`

Input Argument	Type	Range	Description
`TmpReg`	`UINT`	0...299	The temporary register number
`BitNo`	`UINT`	0...15	The bit number

No output arguments.

LOAD_NV_BIT

The `LOAD_NV_BIT` command loads the Boolean value (0 or 1) of a non-volatile register bit into the 1-bit accumulator.

Arguments	Representation
2	`LOAD_NV_BIT NVReg BitNo`

Input Argument	Type	Range	Description
`NVReg`	`UINT`	0...63	The non-volatile register number
`BitNo`	`UINT`	0...15	The bit number

No output arguments.

LOAD_NOT_BIT

The `LOAD_NOT_BIT` command:

- inverts the Boolean value (0 or 1) of a specified register bit, then
- loads the inverted value into the 1-bit accumulator.

Arguments	Representation
2	`LOAD_NOT_BIT RegAddr BitNo`

Input Argument	Type	Range	Description
`RegAddr`	`UINT`	0...1399	The register address
`BitNo`	`UINT`	0...15	The bit number

No output arguments.

LOAD_NOT_TMP_BIT

The `LOAD_NOT_TMP_BIT` command:

- inverts the Boolean value (0 or 1) of a specified temporary register bit, then
- loads the inverted value into the 1-bit accumulator.

Arguments	Representation
2	`LOAD_NOT_TMP_BIT TmpReg BitNo`

Input Argument	Type	Range	Description
TmpReg	UINT	0...299	The temporary register number
BitNo	UINT	0...15	The bit number

No output arguments.

LOAD_NOT_NV_BIT

The LOAD_NOT_NV_BIT command:

- inverts the Boolean value (0 or 1) of a selected non-volatile register bit, then
- loads the inverted value into the 1-bit accumulator.

Arguments	Representation
2	LOAD_NOT_NV_BIT NVReg BitNo

Input Argument	Type	Range	Description
NVReg	UINT	0...63	The non-volatile register number
BitNo	UINT	0...15	The bit number

No output arguments.

AND_BIT

The AND_BIT command makes a logical AND link between a register bit value and the accumulator content in logic memory:

- If the 1-bit accumulator equals 1 and the linked register bit equals 1, the result of the AND process is also 1.
- In all other cases the result of the AND process is 0.

The result is saved in the 1-bit accumulator.

Arguments	Representation
2	AND_BIT RegAddr BitNo

Input Argument	Type	Range	Description
RegAddr	UINT	0...1399	The register address
BitNo	UINT	0...15	The bit number

No output arguments.

AND_TMP_BIT

The AND_TMP_BIT command makes a logical AND link between a temporary register bit value and the accumulator content in logic memory.

- If the 1-bit accumulator equals 1 and the linked temporary register bit equals 1, the result of the AND process is also 1.
- In all other cases the result of the AND process is 0.

The result is saved in the 1-bit accumulator.

Arguments	Representation
2	AND_TMP_BIT TmpReg BitNo

Input Argument	Type	Range	Description
TmpReg	UINT	0...299	The temporary register number
BitNo	UINT	0...15	The bit number

No output arguments.

AND_NV_BIT

The AND_NV_BIT command makes a logical AND link between a non-volatile register bit value and the accumulator content in logic memory.

- If the 1-bit accumulator equals 1 and the linked non-volatile register bit equals 1, the result of the AND process is also 1.
- In all other cases the result of the AND process is 0.

The result is saved in the 1-bit accumulator.

Arguments	Representation
2	AND_NV_BIT NVReg BitNo

Input Argument	Type	Range	Description
NVReg	UINT	0...63	The non-volatile register number
BitNo	UINT	0...15	The bit number

No output arguments.

AND_NOT_BIT

The AND_NOT_BIT command inverts the Boolean value (0 or 1) of a specified register bit, then makes a logical AND link between it and the accumulator content in logic memory:

- If the 1-bit accumulator equals 1 and the linked register bit equals 0, the result of the AND process is also 1.
- In all other cases the result of the AND process is 0.

The result is saved in the 1-bit accumulator.

Arguments	Representation
2	AND_NOT_BIT RegAddr BitNo

Input Argument	Type	Range	Description
RegAddr	UINT	0...1399	The register address
BitNo	UINT	0...15	The bit number

No output arguments.

AND_NOT_TMP_BIT

The AND_NOT_TMP_BIT command inverts the Boolean value (0 or 1) of a specified temporary register bit, then makes a logical AND link between it and the accumulator content in logic memory:

- If the 1-bit accumulator equals 1 and the linked temporary register bit equals 0, the result of the AND process is also 1.
- In all other cases the result of the AND process is 0.

The result is saved in the 1-bit accumulator.

Arguments	Representation
2	AND_NOT_TMP_BIT TmpReg BitNo

Input Argument	Type	Range	Description
TmpReg	UINT	0...299	The temporary register number
BitNo	UINT	0...15	The bit number

No output arguments.

AND_NOT_NV_BIT

The AND_NOT_NV_BIT command inverts the Boolean value (0 or 1) of a selected non-volatile register bit, then makes a logical AND link between it and the accumulator content in logic memory:

- If the 1-bit accumulator equals 1 and the linked non-volatile register bit equals 0, the result of the AND process is also 1.
- In all other cases the result of the AND process is 0.

The result is saved in the 1-bit accumulator.

Arguments	Representation
2	AND_NOT_NV_BIT NVReg BitNo

Input Argument	Type	Range	Description
NVReg	UINT	0...63	The non-volatile register number
BitNo	UINT	0...15	The bit number

No output arguments.

OR_BIT

The OR_BIT command makes a logical OR link between a register bit value and the accumulator content in logic memory:

- If the value of either the 1-bit accumulator or the register bit equals 1, the result of the OR process is also 1.
- If the values of all compared bits equal 0, the result of the OR process is 0.

The result is saved in the 1-bit accumulator.

Arguments	Representation
2	OR_BIT RegAddr BitNo

Input Argument	Type	Range	Description
RegAddr	UINT	0...1399	The register address
BitNo	UINT	0...15	The bit number

No output arguments.

OR_TMP_BIT

The `OR_TMP_BIT` command makes a logical `OR` link between a temporary register bit value and the accumulator content in logic memory.

- If the value of either the 1-bit accumulator or the temporary register bit equals 1, the result of the `OR` process is also 1.
- If the values of all compared bits equal 0, the result of the `OR` process is 0.

The result is saved in the 1-bit accumulator.

Arguments	Representation
2	`OR_TMP_BIT TmpReg BitNo`

Input Argument	Type	Range	Description
`TmpReg`	`UINT`	0...299	The temporary register number
`BitNo`	`UINT`	0...15	The bit number

No output arguments.

OR_NV_BIT

The `OR_NV_BIT` command makes a logical `OR` link between a non-volatile register bit value and the accumulator content in logic memory.

- If the value of either the 1-bit accumulator or the non-volatile register bit equals 1, the result of the `OR` process is also 1.
- If the values of all compared bits equal 0, the result of the `OR` process is 0.

The result is saved in the 1-bit accumulator.

Arguments	Representation
2	`OR_NV_BIT NVReg BitNo`

Input Argument	Type	Range	Description
`NVReg`	`UINT`	0...63	The non-volatile register number
`BitNo`	`UINT`	0...15	The bit number

No output arguments.

OR_NOT_BIT

The `OR_NOT_BIT` command inverts the Boolean value (0 or 1) of a specified register bit, then makes a logical `OR` link between it and the accumulator content in logic memory:

- If the value of either the 1-bit accumulator or the register bit equals 0, the result of the `OR` process is also 1.
- If the values of all compared bits equal 0, the result of the `OR` process is 0.

The result is saved in the 1-bit accumulator.

Arguments	Representation
2	`OR_NOT_BIT RegAddr BitNo`

Input Argument	Type	Range	Description
RegAddr	UINT	0...1399	The register address
BitNo	UINT	0...15	The bit number

No output arguments.

OR_NOT_TMP_BIT

The OR_NOT_TMP_BIT command inverts the Boolean value (0 or 1) of a specified temporary register bit, then makes a logical OR link between it and the accumulator content in logic memory:

- If the value of either the 1-bit accumulator or the temporary register bit equals 0, the result of the OR process is also 1.
- If the values of all compared bits equal 0, the result of the OR process is 0.

The result is saved in the 1-bit accumulator.

Arguments	Representation
2	OR_NOT_TMP_BIT TmpReg BitNo

Input Argument	Type	Range	Description
TmpReg	UINT	0...299	The temporary register number
BitNo	UINT	0...15	The bit number

No output arguments.

OR_NOT_NV_BIT

The OR_NOT_NV_BIT command inverts the Boolean value (0 or 1) of a selected non-volatile register bit, then makes a logical OR link between it and the accumulator content in logic memory:

- If the value of either the 1-bit accumulator or the non-volatile register bit equals 0, the result of the OR process is also 1.
- If the values of all compared bits equal 0, the result of the OR process is 0.

The result is saved in the 1-bit accumulator.

Arguments	Representation
2	OR_NOT_NV_BIT NVReg BitNo

Input Argument	Type	Range	Description
NVReg	UINT	0...63	The non-volatile register number
BitNo	UINT	0...15	The bit number

No output arguments.

SET_BIT

The SET_BIT command sets the value of the 1-bit accumulator to a specified register bit.

Arguments	Representation
2	SET_BIT RegAddr BitNo

No input arguments.

Output Argument	Type	Range	Description
RegAddr	UINT	0...1399	The address of the specified register
BitNo	UINT	0...15	The number of the bit to be set in the specified register

SET_TMP_BIT

The SET_TMP_BIT command sets the value of the 1-bit accumulator to a specified temporary register bit.

Arguments	Representation
2	SET_TMP_BIT TmpReg BitNo

No input arguments.

Output Argument	Type	Range	Description
TmpReg	UINT	0...299	The address of the specified temporary register
BitNo	UINT	0...15	The number of the bit to be set in the specified temporary register

SET_NV_BIT

The SET_NV_BIT command sets the value of the 1-bit accumulator to a specified non-volatile register bit.

Arguments	Representation
2	SET_NV_BIT NVReg BitNo

No input arguments.

Output Argument	Type	Range	Description
NVReg	UINT	0...63	The address of the specified non-volatile register
BitNo	UINT	0...15	The number of the bit to be set in the specified non-volatile register

SET_NOT_BIT

The SET_NOT_BIT command sets the inverted value of the 1-bit accumulator to a specified register bit.

Arguments	Representation
2	SET_NOT_BIT RegAddr BitNo

No input arguments.

Output Argument	Type	Range	Description
RegAddr	UINT	0...1399	The address of the specified register
BitNo	UINT	0...15	The number of the bit to be set in the specified register

SET_NOT_TMP_BIT

The SET_NOT_TMP_BIT command sets the inverted value of the 1-bit accumulator to a specified temporary register bit.

Arguments	Representation
2	SET_NOT_TMP_BIT TmpReg BitNo

No input arguments.

Output Argument	Type	Range	Description
TmpReg	UINT	0...299	The address of the specified temporary register
BitNo	UINT	0...15	The number of the bit to be set in the specified temporary register

SET_NOT_NV_BIT

The SET_NOT_NV_BIT command sets the inverted value of the 1-bit accumulator to a specified non-volatile register bit.

Arguments	Representation
2	SET_NOT_NV_BIT NVReg BitNo

No input arguments.

Output Arguments	Type	Range	Description
NVReg	UINT	0...63	The address of the specified non-volatile register
BitNo	UINT	0...15	The number of the bit to be set in the specified non-volatile register

Register Logic Commands

Overview

Register commands evaluate and control 16-bit values.

The custom logic editor uses the following register commands:

- LOAD_K_REG
- LOAD_REG
- LOAD_TMP_REG
- LOAD_NV_REG
- COMP_K_REG
- COMP_REG
- COMP_TMP_REG
- COMP_NV_REG
- AND_K
- AND_REG
- AND_TMP_REG
- AND_NV_REG
- OR_K
- OR_REG

- OR_TMP_REG
- OR_NV_REG
- XOR_K
- XOR_REG
- XOR_TMP_REG
- XOR_NV_REG
- ON_SET_REG
- ON_SET_TMP_REG
- ON_SET_NV_REG

LOAD_K_REG

The LOAD_K_REG command loads a 16-bit constant value into the 16-bit accumulator in logic memory.

Arguments	Representation
1	LOAD_K_REG KValue

Input Argument	Type	Range	Description
KValue	UINT	0...65,535	A constant value

No output arguments.

LOAD_REG

The LOAD_REG command loads a copy of a register into the 16-bit accumulator in logic memory.

Arguments	Representation
1	LOAD_REG RegAddr

Input Argument	Type	Range	Description
RegAddr	UINT	0...1399	The register address

No output arguments.

LOAD_TMP_REG

The LOAD_TMP_REG command loads a copy of a temporary register into the 16-bit accumulator in logic memory.

Arguments	Representation
1	LOAD_TMP_REG TmpReg

Input Argument	Type	Range	Description
TmpReg	UINT	0...299	The temporary register number

No output arguments.

LOAD_NV_REG

The `LOAD_NV_REG` command loads a copy of a non-volatile register into the 16-bit accumulator in logic memory.

Arguments	Representation
1	`LOAD_NV_REG NVReg`

Input Argument	Type	Range	Description
`NVReg`	`UINT`	0...63	The non-volatile register number

No output arguments.

COMP_K_REG

The `COMP_K_REG` command compares the 16-bit accumulator content to the Argument 1 constant value and sets the result of the comparison in one bit of the Argument 2 temporary register.

Arguments	Representation
2	`COMP_K_REG KValue TmpReg`

Input Argument	Type	Range/Bit	Description
`KValue`	`UINT`	0...65,535	A constant value

Output Argument	Type	Range/Bit	Description
`TmpReg`	`UINT`	Bit1	16-bit accumulator < `KValue`
		Bit2	16-bit accumulator = `KValue`
		Bit3	16-bit accumulator > `KValue`

COMP_REG

The `COMP_REG` command compares the 16-bit accumulator content to the content of the register defined by Argument 1 and sets the result of the comparison in one bit of the Argument 2 temporary register.

Arguments	Representation
2	`COMP_REG RegAddr TmpReg`

Input Argument	Type	Range/Bit	Description
`RegAddr`	`UINT`	0...1399	The register address

Output Argument	Type	Range/Bit	Description
`TmpReg`	`UINT`	Bit1	16-bit accumulator < `RegAddr`
		Bit2	16-bit accumulator = `RegAddr`
		Bit3	16-bit accumulator > `RegAddr`

COMP_TMP_REG

The COMP_TMP_REG command compares the 16-bit accumulator content to the content of the temporary register defined by Argument 1 and sets the result of the comparison in one bit of the Argument 2 temporary register.

Arguments	Representation
2	COMP_TMP_REG TmpReg1 TmpReg2

Input Argument	Type	Range/Bit	Description
TmpReg1	UINT	0...299	Temporary register number

Output Argument	Type	Range/Bit	Description
TmpReg2	UINT	Bit1	16-bit accumulator < TmpReg1
		Bit2	16-bit accumulator = TmpReg1
		Bit3	16-bit accumulator > TmpReg1

COMP_NV_REG

The COMP_NV_REG command compares the 16-bit accumulator content to the content of the non-volatile register defined by Argument 1 and sets the result of the comparison in one bit of the Argument 2 temporary register.

Arguments	Representation
2	COMP_NV_REG NVReg TmpReg

Input Argument	Type	Range/Bit	Description
NVReg	UINT	0...63	Non-volatile register number

Output Argument	Type	Range/Bit	Description
TmpReg	UINT	Bit1	16-bit accumulator < NVReg
		Bit2	16-bit accumulator = NVReg
		Bit3	16-bit accumulator > NVReg

AND_K

The AND_K command makes a logical AND link between a 16-bit constant value and the 16-bit accumulator content in logic memory. The result is saved in the 16-bit accumulator.

The AND process compares each bit in the 16-bit accumulator with the corresponding bit in the linked 16-bit constant value:

- If both bits equal 1, the result of the AND process for that bit number is also 1.
- In all other cases the result of the AND process for that bit number is 0.

Arguments	Representation
1	AND_K KValue

Input Argument	Type	Range	Description
KValue	UINT	0...65,535	A constant value

No output arguments.

AND_REG

The AND_REG command makes a logical AND link between the register value and the 16-bit accumulator content in logic memory. The result is saved in the 16-bit accumulator.

The AND process compares each bit in the 16-bit accumulator with the corresponding bit in the linked register:

- If both bits equal 1, the result of the AND process for that bit number is also 1.
- In all other cases the result of the AND process for that bit number is 0.

Arguments	Representation
1	AND_REG RegAddr

Input Argument	Type	Range	Description
RegAddr	UINT	0...1399	The register address

No output arguments.

AND_TMP_REG

The AND_TMP_REG command makes a logical AND link between the temporary register value and the 16-bit accumulator content in logic memory. The result is saved in the 16-bit accumulator.

The AND process compares each bit in the 16-bit accumulator with the corresponding bit in the linked temporary register:

- If both bits equal 1, the result of the AND process for that bit number is also 1.
- In all other cases the result of the AND process for that bit number is 0.

Arguments	Representation
1	AND_TMP_REG TmpReg

Input Argument	Type	Range	Description
TmpReg	UINT	0...299	The temporary register number

No output arguments.

AND_NV_REG

The AND_NV_REG command makes a logical AND link between the non-volatile register value and the 16-bit accumulator content in logic memory. The result is saved in the 16-bit accumulator.

The AND process compares each bit in the 16-bit accumulator with the corresponding bit in the linked non-volatile register:

- If both bits equal 1, the result of the AND process for that bit number is also 1.
- In all other cases the result of the AND process for that bit number is 0.

Arguments	Representation
1	`AND_NV_REG NVReg`

Input Argument	Type	Range	Description
`NVReg`	`UINT`	0...63	The non-volatile register number

No output arguments.

OR_K

The `OR_K` command makes a logical `OR` link between a 16-bit constant value and the 16-bit accumulator content in logic memory. The result is saved in the 16-bit accumulator.

The `OR` process compares each bit in the 16-bit accumulator with the corresponding bit in the linked 16-bit constant value:

- If any compared bit equals 1, the result of the `OR` process for that bit number is also 1.
- If all compared bits equal 0, the result of the `OR` process for that bit number is 0.

Arguments	Representation
1	`OR_K KValue`

Input Argument	Type	Range	Description
`KValue`	`UINT`	0...65,535	A constant value

No output arguments.

OR_REG

The `OR_REG` command makes a logical `OR` link between the register value and the 16-bit accumulator content in logic memory. The result is saved in the 16-bit accumulator.

The `OR` process compares each bit in the 16-bit accumulator with the corresponding bit in the linked register:

- If any compared bit equals 1, the result of the `OR` process for that bit number is also 1.
- If all compared bits equal 0, the result of the `OR` process for that bit number is 0.

Arguments	Representation
1	`OR_REG RegAddr`

Input Argument	Type	Range	Description
`RegAddr`	`UINT`	0...1399	The register address

No output arguments.

OR_TMP_REG

The OR_TMP_REG command makes a logical OR link between the temporary register value and the 16-bit accumulator content in logic memory. The result is saved in the 16-bit accumulator.

The OR process compares each bit in the 16-bit accumulator with the corresponding bit in the linked temporary register:

- If any compared bit equals 1, the result of the OR process for that bit number is also 1.
- If all compared bits equal 0, the result of the OR process for that bit number is 0.

Arguments	Representation
1	OR_TMP_REG TmpReg

Input Argument	Type	Range	Description
TmpReg	UINT	0...299	The temporary register number

No output arguments.

OR_NV_REG

The OR_NV_REG command makes a logical OR link between the non-volatile register value and the 16-bit accumulator content in logic memory. The result is saved in the 16-bit accumulator.

The OR process compares each bit in the 16-bit accumulator with the corresponding bit in the linked non-volatile register:

- If any compared bit equals 1, the result of the OR process for that bit number is also 1.
- If all compared bits equal 0, the result of the OR process for that bit number is 0.

Arguments	Representation
1	OR_NV_REG NVReg

Input Argument	Type	Range	Description
NVReg	UINT	0...63	The non-volatile register number

No output arguments.

XOR_K

The XOR_K command makes a logical exclusive OR link between a 16-bit constant value and the 16-bit accumulator content in logic memory. The result is saved in the 16-bit accumulator.

The XOR process compares each bit in the 16-bit accumulator with the corresponding bit in the linked 16-bit constant value and yields these results:

- If one bit equals 1 and the other equals 0, the result of the XOR process is 1.
- In all other cases, the result of the XOR process is 0.

Arguments	Representation
1	XOR_K KValue

Input Argument	Type	Range	Description
KValue	UINT	0...65,535	A constant value

No output arguments.

XOR_REG

The XOR_REG command makes a logical exclusive OR link between the register value and the 16-bit accumulator content in logic memory. The result is saved in the 16-bit accumulator.

The XOR process compares each bit in the 16-bit accumulator with the corresponding bit in the linked register and yields these results:

- If one bit equals 1 and the other equals 0, the result of the XOR process is 1.
- In all other cases, the result of the XOR process is 0.

Arguments	Representation
1	XOR_REG RegAddr

Input Argument	Type	Range	Description
RegAddr	UINT	0...1399	The register address

No output arguments.

XOR_TMP_REG

The XOR_TMP_REG command makes a logical exclusive OR link between the temporary register value and the 16-bit accumulator content in logic memory. The result is saved in the 16-bit accumulator.

The XOR process compares each bit in the 16-bit accumulator with the corresponding bit in the linked temporary register and yields these results:

- If one bit equals 1 and the other equals 0, the result of the XOR process is 1.
- In all other cases, the result of the XOR process is 0.

Arguments	Representation
1	XOR_TMP_REG TmpReg

Input Argument	Type	Range	Description
TmpReg	UINT	0...299	The temporary register number

No output arguments.

XOR_NV_REG

The XOR_NV_REG command makes a logical exclusive OR link between the non-volatile register value and the 16-bit accumulator content in logic memory. The result is saved in the 16-bit accumulator.

The XOR process compares each bit in the 16-bit accumulator with the corresponding bit in the linked non-volatile register and yields these results:

- If one bit equals 1 and the other equals 0, the result of the XOR process is 1.
- In all other cases, the result of the XOR process is 0.

Arguments	Representation
1	`XOR_NV_REG NVReg`

Input Argument	Type	Range	Description
`NVReg`	`UINT`	0...63	The non-volatile register number

No output arguments.

ON_SET_REG

The `ON_SET_REG` command copies the value of the 16-bit accumulator to a specified register on a rising edge of the 1-bit accumulator.

Arguments	Representation
2	`ON_SET_REG RegAddr TmpReg`

No input argument.

Output Argument	Type	Range/Bit	Description
`RegAddr`	`UINT`	0...1399	The address of the register to be set
`TmpReg`	`UINT`	Bit3	1-bit accumulator history bit

ON_SET_TMP_REG

The `ON_SET_TMP_REG` command copies the value of the 16-bit accumulator to a specified temporary register on a rising edge of the 1-bit accumulator.

Arguments	Representation
2	`ON_SET_TMP_REG TmpReg1 TmpReg2`

No input argument.

Output Argument	Type	Range/Bit	Description
`TmpReg1`	`UINT`	0...299	The address of the temporary register to be set
`TmpReg2`	`UINT`	Bit3	1-bit accumulator history bit

ON_SET_NV_REG

The `ON_SET_NV_REG` command copies the value of the 16-bit accumulator to a specified non-volatile register on a rising edge of the 1-bit accumulator.

Arguments	Representation
1	`ON_SET_NV_REG NVReg1 NVReg2`

No input argument.

Output Argument	Type	Range/Bit	Description
`NVReg1`	`UINT`	0...63	The address of the non-volatile register to be set
`NVReg2`	`UINT`	Bit3	1-bit accumulator history bit

Timer Logic Commands

Overview

The custom logic editor uses the following timer commands:

- `TIMER_SEC`
- `TIMER_TENTHS`
- `TIMER_K_SEC`
- `TIMER_K_TENTHS`

TIMER_SEC

The `TIMER_SEC` command:

- counts time in seconds, up to the number of counts specified by a temporary register
- calculates the end time in a second temporary register
- is enabled by, and reports its counting status to, a third temporary register

Arguments	Representation
3	`TIMER_SEC TmpReg1 TmpReg2 TmpReg3`

Input Argument	Type	Range/Bit	Description
`TmpReg1`	`UINT`	0...65,535	Timer preset value
`TmpReg3`	`UINT`	Bit0	• Starts the timer on a rising edge • Stops the timer on a falling edge

Output Argument	Type	Range/Bit	Description
`TmpReg2`	`UINT`	0...65,535	Calculated end time
`TmpReg3`	`UINT`	Bit1	Timer done: • bit set when timer reaches `TmpReg2` • bit reset when: ◦ `TmpReg3.Bit0` is reset ◦ power is cycled
		Bit2	Timer execution in progress Bit reset when timer reaches `TmpReg2`
		Bit3	`TmpReg3.Bit0` history bit
		Bit4	Reserved

TIMER_TENTHS

The `TIMER_TENTHS` command:

- counts time in tenths of seconds, up to the number of counts specified by a temporary register
- calculates the end time in a second temporary register
- is enabled by, and reports its counting status to, a third temporary register

Arguments	Representation
3	`TIMER_TENTHS TmpReg1 TmpReg2 TmpReg3`

Input Argument	Type	Range/Bit	Description
TmpReg1	UINT	0...65,535	Timer preset value
TmpReg3	UINT	Bit0	• Starts the timer on a rising edge • Stops the timer on a falling edge

Output Argument	Type	Range/Bit	Description
TmpReg2	UINT	0...65,535	Calculated end time
TmpReg3	UINT	Bit1	Timer done: • bit set when timer reaches TmpReg2 • bit reset when: ◦ TmpReg3.Bit0 is reset ◦ power is cycled
		Bit2	Timer execution in progress Bit reset when timer reaches TmpReg2
		Bit3	TmpReg3.Bit0 history bit
		Bit4	Reserved

TIMER_K_SEC

The TIMER_K_SEC command:

- counts time in seconds, up to the number of counts specified by a constant value
- calculates the end time in a temporary register
- is enabled by, and reports its counting status to, a second temporary register

Arguments	Representation
3	TIMER_K_SEC KValue TmpReg1 TmpReg2

Input Argument	Type	Range/Bit	Description
KValue	UINT	0...65,535	Timer preset value
TmpReg2	UINT	Bit0	• Starts the timer on a rising edge • Stops the timer on a falling edge

Output Argument	Type	Range/Bit	Description
TmpReg1	UINT	0...65,535	Calculated end time
TmpReg2	UINT	Bit1	Timer done: • bit set when timer reaches TmpReg1 • bit reset when: ◦ TmpReg2.Bit0 is reset ◦ power is cycled
		Bit2	Timer execution in progress Bit reset when timer reaches TmpReg1
		Bit3	TmpReg2.Bit0 history bit
		Bit4	Reserved

TIMER_K_TENTHS

The TIMER_K_TENTHS command:

- counts time in tenths of seconds, up to the number of counts specified by a constant value
- calculates the end time in a temporary register
- is enabled by, and reports its counting status to, a second temporary register

Arguments	Representation
3	TIMER_K_TENTHS KValue TmpReg1 TmpReg2

Input Argument	Type	Range/Bit	Description
KValue	UINT	0...65,535	Timer preset value
TmpReg2	UINT	Bit0	• Starts the timer on a rising edge • Stops the timer on a falling edge

Output Argument	Type	Range/Bit	Description
TmpReg1	UINT	0...65,535	Calculated end time
TmpReg2	UINT	Bit1	Timer done: • bit set when timer reaches TmpReg1 • bit reset when: ◦ TmpReg2.Bit0 is reset ◦ power is cycled
		Bit2	Timer execution in progress Bit reset when timer reaches TmpReg1
		Bit3	TmpReg2.Bit0 history bit
		Bit4	Reserved

Latch Logic Commands

Overview

The Custom Logic Editor uses the following latch commands:

- LATCH
- LATCH_NV

LATCH

The LATCH command:

- stores a Boolean value (0 or 1) in a temporary register
- provides a method for setting and resetting the stored value
- saves the clear and set status from the previous scan

Arguments	Representation
1	LATCH TmpReg

Input Argument	Type	Bit	Description
TmpReg	UINT	Bit1	Sets the TmpReg.Bit0 to 1 on a rising edge
		Bit2	Resets the TmpReg.Bit0 to 0 on a rising edge

Output Argument	Type	Bit	Description
TmpReg	UINT	Bit0	State of the latch
		Bit3	TmpReg.Bit1 history bit
		Bit4	TmpReg.Bit2 history bit

LATCH_NV

The LATCH_NV command:

- stores a Boolean value (0 or 1) in a non-volatile register
- provides a method for setting and resetting the stored value
- saves the clear and set status from the previous scan

Use the LATCH_NV command, instead of the LATCH command, to retain the latch state during a power cycle.

Arguments	Representation
1	LATCH_NV NVReg

Input Argument	Type	Bit	Description
NVReg	UINT	Bit1	Sets the TmpReg.Bit0 to 1 on a rising edge
		Bit2	Resets the TmpReg.Bit0 to 0 on a rising edge

Output Argument	Type	Bit	Description
NVReg	UINT	Bit0	State of the latch
		Bit3	TmpReg.Bit1 history bit
		Bit4	TmpReg.Bit2 history bit

Counter Logic Commands

Overview

The custom logic editor uses the following counter logic commands:

- COUNTER
- COUNTER_NV

COUNTER

The COUNTER command:

- increments or decrements a count value
- provides a method for setting the count value to a preset value
- indicates when the count value equals 0

- indicates the relationship between the count value and the preset value - equal to, greater than or less than
- saves the increment, decrement and set status from the previous scan

Arguments	Representation
3	`COUNTER TmpReg1 KValue TmpReg2`

Input Argument	Type	Range/Bit	Description
`KValue`	`UINT`	0...65,535	Counter preset value
`TmpReg2`	`UINT`	Bit4	Increments the counter current value on a rising edge. Counter current value shall roll over from 65,535 to 0.
		Bit5	Decrements the counter current value on a rising edge. Counter current value shall roll over from 0 to 65,535.
		Bit6	Sets the current counter value to the preset value on a rising edge

Output Argument	Type	Range/Bit	Description
`TmpReg1`	`UINT`	0...65,535	Counter current value
`TmpReg2`	`UINT`	Bit0	The counter current value is 0: `TmpReg1=0`
		Bit1	The counter current value is lower than the preset value: `TmpReg1<KValue`
		Bit2	The counter current value is equal to the preset value: `TmpReg1=KValue`
		Bit3	The counter current value is greater than the preset value: `TmpReg1>KValue`
		Bit7	`TmpReg2.Bit4` history bit
		Bit8	`TmpReg2.Bit5` history bit
		Bit9	`TmpReg2.Bit6` history bit

COUNTER_NV

The `COUNTER_NV` command:

- increments or decrements a count value
- provides a method for setting the count value to a preset value
- indicates when the count value equals 0
- indicates the relationship between the count value and the preset value - equal to, greater than or less than
- saves the increment, decrement and set status from the previous scan

Use the `COUNTER_NV` command, instead of the `COUNTER` command, to retain the count during a power cycle.

Arguments	Representation
3	`COUNTER NVReg1 KValue NVReg2`

Input Argument	Type	Range/Bit	Description
`KValue`	`UINT`	0...65,535	Counter preset value
`NVReg2`	`UINT`	Bit4	Increments the counter current value on a rising edge
		Bit5	Decrements the counter current value on a rising edge
		Bit6	Sets the current counter value to the preset value on a rising edge

Output Argument	Type	Range/Bit	Description
NVReg1	UINT	0...65,535	Counter current value
NVReg2	UINT	Bit0	The counter current value is 0: NVReg1=0
		Bit1	The counter current value is lower than the preset value: NVReg1<KValue
		Bit2	The counter current value is equal to the preset value: NVReg1=KValue
		Bit3	The counter current value is greater than the preset value: NVReg1>KValue
		Bit7	NVReg2.Bit4 history bit
		Bit8	NVReg2.Bit5 history bit
		Bit9	NVReg2.Bit6 history bit

Math Logic Commands

Overview

The custom logic editor uses the following math commands:

- ON_ADD
- ON_SUB
- ON_MUL
- ON_DIV

ON_ADD

The ON_ADD command performs unsigned addition when the 1-bit accumulator transitions from 0 to 1. It adds the value from Argument 1 to the 16-bit accumulator value, then posts the result back to the value in Argument 1.

A status register:

- indicates an overflow if the result of the addition process exceeds 65,535
- indicates the status of the 1-bit-accumulator from the previous scan

Arguments	Representation
2	ON_ADD TmpReg1 TmpReg2

Input Argument	Type	Range/Bit	Description
TmpReg1	UINT	0...65,535	Value to add to the 16-bit accumulator

Output Argument	Type	Range/Bit	Description
TmpReg1	UINT	0...65,535	Result of the addition operation
TmpReg2	UINT	Bit0	Overflow: the result of the addition is greater than 65,535. In this case, the result of the addition is equal to Argument 1 + 65,536.
		Bit3	1-bit accumulator history bit

ON_SUB

The ON_SUB command performs unsigned subtraction when the 1-bit accumulator transitions from 0 to 1. It subtracts the 16-bit accumulator value from the value in Argument 1, then posts the result back to the value in Argument 1.

A status register:

- indicates an underflow if the result of the subtraction process is less than 0
- indicates the status of the 1-bit-accumulator from the previous scan

Arguments	Representation
2	`ON_SUB TmpReg1 TmpReg2`

Input Argument	Type	Range/Bit	Description
`TmpReg1`	`UINT`	0...65,535	Value to subtract from the 16-bit accumulator

Output Argument	Type	Range/Bit	Description
`TmpReg1`	`UINT`	0...65,535	Result of the subtraction operation
`TmpReg2`	`UINT`	Bit0	Underflow: the result of the subtraction is less than 0. In this case, the true result of the operation equals the value output to Argument 1 - 65,536.
		Bit3	1-bit accumulator history bit

ON_MUL

The `ON_MUL` command performs unsigned multiplication when the 1-bit accumulator transitions from 0 to 1. The `ON_MUL` procedure multiplies the value from Argument 2 against the 16-bit accumulator value, then posts the result back to Argument 1 (most significant word) and Argument 2 (least significant word).

A status register indicates the status of the 1-bit accumulator from the previous scan.

Arguments	Representation
3	`ON_MUL TmpReg1 TmpReg2 TmpReg3`

Input Argument	Type	Range/Bit	Description
`TmpReg2`	`UINT`	0...65,535	Value to be multiply with the 16-bit accumulator

Output Argument	Type	Range/Bit	Description
`TmpReg1` and `TmpReg2`	`UINT`	0...65,535	Result of the multiplication operation: • `TmpReg1` holds the most significant word • `TmpReg2` holds the least significant word
`TmpReg3`	`UINT`	Bit3	1-bit accumulator history bit

ON_DIV

The `ON_DIV` command performs unsigned division when the 1-bit accumulator transitions from 0 to 1. The `ON_DIV` procedure divides the combined value of Argument 1 and Argument 2 by the 16-bit accumulator value, then posts the result back to Argument 1 (most significant word) and Argument 2 (least significant word).

A status register indicates:

- an overflow if division is by 0
- the status of the 1-bit-accumulator from the previous scan

Arguments	Representation
3	`ON_DIV TmpReg1 TmpReg2 TmpReg3`

Input Argument	Type	Range/Bit	Description
`TmpReg1` and `TmpReg2`	`UINT`	0...65,535	Value to be divided by the 16-bit accumulator

Output Argument	Type	Range/Bit	Description
`TmpReg1` and `TmpReg2`	`UINT`	0...65,535	Result of the division operation: • `TmpReg1` holds the most significant word • `TmpReg2` holds the least significant word
`TmpReg3`	`UINT`	Bit0	Division by 0
		Bit3	1-bit accumulator history bit

Structured Text Program Examples

Summary

This section shows the structured text program of 2 typical situations which you may need to use in your applications:

- Checking timers and multiply commands
- Creating a truth table

How to Check Timers and Multiply Commands

Overview

When customizing your application you may need to check timers and multiply commands.

Checking Timers and Multiply Commands with a Structured Text Program

The following diagram gives the structured text program in Text View of how to check timers and multiply commands:

```
 LOGIC_ID 356
// A very simple test that checks timers and MUL (multiply command)
// It should switch LO1 and LO2 ON OFF if OK !!
//
 LOAD_K_BIT 1
 SET_TMP_BIT 115 3
 LOAD_TMP_REG 115
 ON_SET_TMP_REG 105 111
 ON_SET_TMP_REG 108 112
 LOAD_NOT_TMP_BIT 110 2     //  timer 2 not timing
 SET_TMP_BIT 107 0
 TIMER_TENTHS 105 106 107
 LOAD_NOT_TMP_BIT 107 2      //  timer 1 not timing
 SET_TMP_BIT 110 0
 TIMER_TENTHS 108 109 110
 LOAD_TMP_BIT 107 2
 SET_BIT 1200 12            //  Switch LO1 if timer 1 is working
 LOAD_K_REG 50              //  Load value of 50
 LOAD_K_BIT 1
 SET_NOT_TMP_BIT 123 3      //  Clear history bit
 ON_SET_TMP_REG 122 123      //  Save the 50 in temporary register 22
 LOAD_K_REG 2               //  Load value of 2
 SET_NOT_TMP_BIT 123 3
 ON_MUL 121 122 123           //  Multiply 50x2
 LOAD_TMP_REG 122
 COMP_K_REG 100 101          //  Is result 100?
 LOAD_TMP_BIT 110 2         //  timer 2 timing
 AND_TMP_BIT 101 2           //  =100?
 SET_BIT 1200 13          // Don't switch LO2 if MUL did not work OK
```

How to Create a Truth Table

Overview

When customizing your application you may need to create a truth table.

Creating a Truth Table with a Structured Text Program

The following diagram gives the structured Text program in Text View of the creation of a truth table:

```
LOGIC_ID 444
//
//
// Truth table example
//
//    I1  I2  I3    Output
//     0   0   0      0      (0)
//     0   0   1      1      (1)
//     0   1   0      1      (2)
//     0   1   1      0      (3)
//     1   0   0      1      (4)
//     1   0   1      0      (5)
//     1   1   0      0      (6)
//     1   1   1      0      (7)

LOAD_BIT 457.0        //SET INPUTS
SET_TMP_BIT 1.1
LOAD_BIT 457.1
SET_TMP_BIT 1.2
LOAD_BIT 457.2
SET_TMP_BIT 1.3


//
//**** 3x1 TRUTH TABLE TEMPLATE
//**** Inputs defined as bits 1.1 through 1.3)
//**** Output defined as bit 1.15
//
LOAD_K_BIT 0             //default output OFF
SET_TMP_BIT 1.15         //save partial result

//***************0**  Inputs 1-2-3 are OFF OFF OFF
//
LOAD_NOT_TMP_BIT 1.1  //include this SECTION
AND_NOT_TMP_BIT 1.2   //if output is to be ON
AND_NOT_TMP_BIT 1.3   //REMOVE if output to be OFF
SET_TMP_BIT 1.15      //save partial result
//
```

Creating a Truth Table with a Structured Text Program (cont'd)

```
LOAD_NOT_TMP_BIT 1.1  //include this SECTION
AND_NOT_TMP_BIT 1.2   //if output is to be ON
AND_TMP_BIT 1.3       //REMOVE if output to be OFF
OR_TMP_BIT 1.15       //include previous result
SET_TMP_BIT 1.15      //save partial result
//
//***************2**  Inputs 1-2-3 are OFF ON OFF
//
LOAD_NOT_TMP_BIT 1.1  //include this SECTION
AND_TMP_BIT 1.2       //if output is to be ON
AND_NOT_TMP_BIT 1.3   //REMOVE if output to be OFF
OR_TMP_BIT 1.15       //include previous result
SET_TMP_BIT 1.15      //save partial result
//
//***************3**  Inputs 1-2-3 are OFF ON ON
//
LOAD_NOT_TMP_BIT 1.1  //include this SECTION
AND_TMP_BIT 1.2       //if output is to be ON
AND_TMP_BIT 1.3       //REMOVE if output to be OFF
OR_TMP_BIT 1.15       //include previous result
SET_TMP_BIT 1.15      //save partial result
//
//***************4**  Inputs 1-2-3 are ON OFF OFF
//
LOAD_TMP_BIT 1.1      //include this SECTION
AND_NOT_TMP_BIT 1.2   //if output is to be ON
AND_NOT_TMP_BIT 1.3   //REMOVE if output to be OFF
OR_TMP_BIT 1.15       //include previous result
SET_TMP_BIT 1.15      //save partial result
//
//***************5**  Inputs 1-2-3 are ON OFF ON
//
LOAD_TMP_BIT 1.1      //include this SECTION
AND_NOT_TMP_BIT 1.2   //if output is to be ON
AND_TMP_BIT 1.3       //REMOVE if output to be OFF
OR_TMP_BIT 1.15       //include previous result
SET_TMP_BIT 1.15      //save partial result
```

Creating a Truth Table with a Structured Text Program (cont'd)

```
//
//***************6**  Inputs 1-2-3 are ON ON OFF
//
LOAD_TMP_BIT 1.1      //include this SECTION
AND_TMP_BIT 1.2       //if output is to be ON
AND_NOT_TMP_BIT 1.3   //REMOVE if output to be OFF
OR_TMP_BIT 1.15       //include previous result
SET_TMP_BIT 1.15      //save partial result
//
//***************7**  Inputs 1-2-3 are ON ON ON
//
LOAD_TMP_BIT 1.1      //include this SECTION
AND_TMP_BIT 1.2       //if output is to be ON
AND_TMP_BIT 1.3       //REMOVE if output to be OFF
OR_TMP_BIT 1.15       //include previous result
SET_TMP_BIT 1.15      //save partial result


LOAD_TMP_BIT 1.15     //SET OUTPUT
SET_BIT 1200.14
```

Function Block Diagram Language

Overview

The function block diagram editor enables you to create a custom logic program based on the function block diagram programming language.

Overview of FBD Language

Summary

This section provides a general description of FBD language. Use the FBD language to customize a pre-defined operating mode or to create a new program to suit the requirements of a specific application created using FBD.

Introduction to the FBD Editor

Overview

The FBD editor is a feature of the TeSys T DTM. Use the FBD editor to view an existing FBD file or to create an FBD file using FBD language, rather than an instruction-based text programming language.

Creating an FBD Program

To open the FBD editor, select **Device** → **FB diagram** → **New FB diagram** or click the **FB diagram** tab. The FBD editor appears in the main window.

Saving an FBD Program

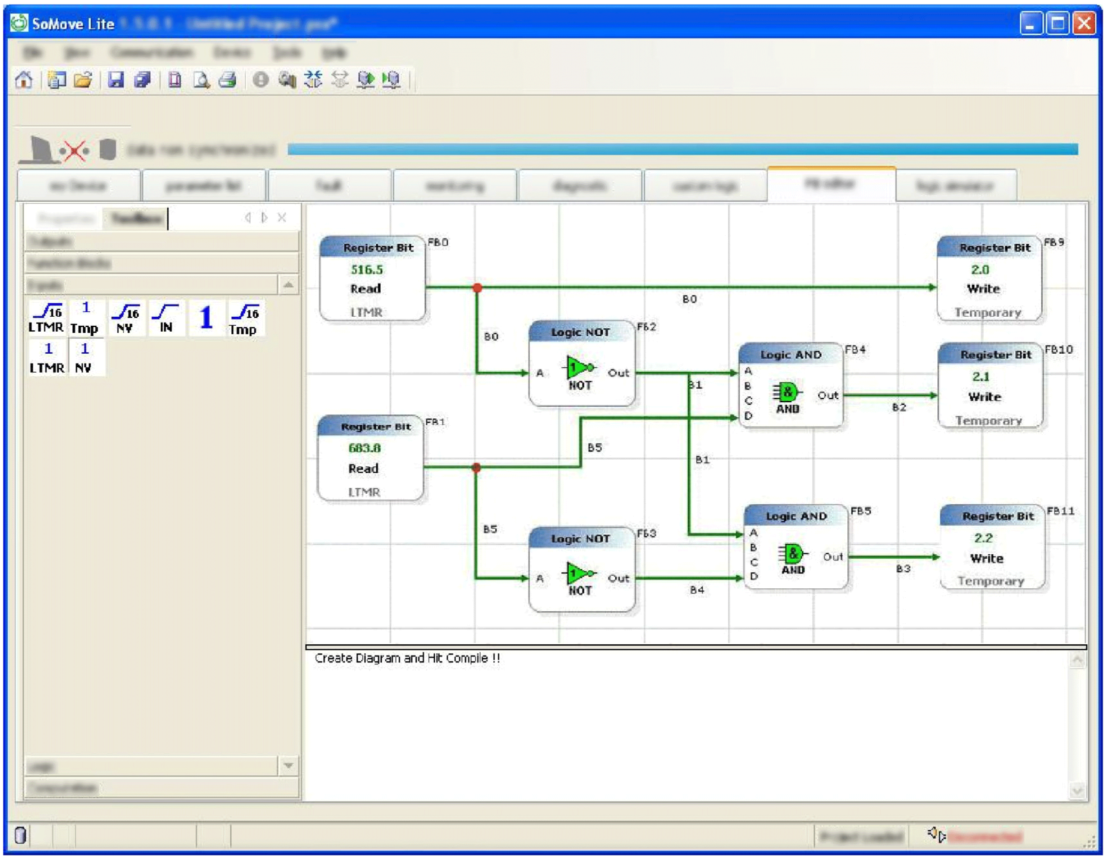
Before compiling the FBD program, you must save it. To save the program you created or edited, select **Device** → **FB diagram** → **Save FB diagram as**.

NOTE: The file is saved with the extension **.Gef*.

FBD Editor User Interface

The FBD editor is available even when the TeSys T DTM is in connected mode. However, many of the menu items are enabled only when an FBD program is open in the FBD editor.

When an FBD file is open the FBD editor looks like this:



Workspace

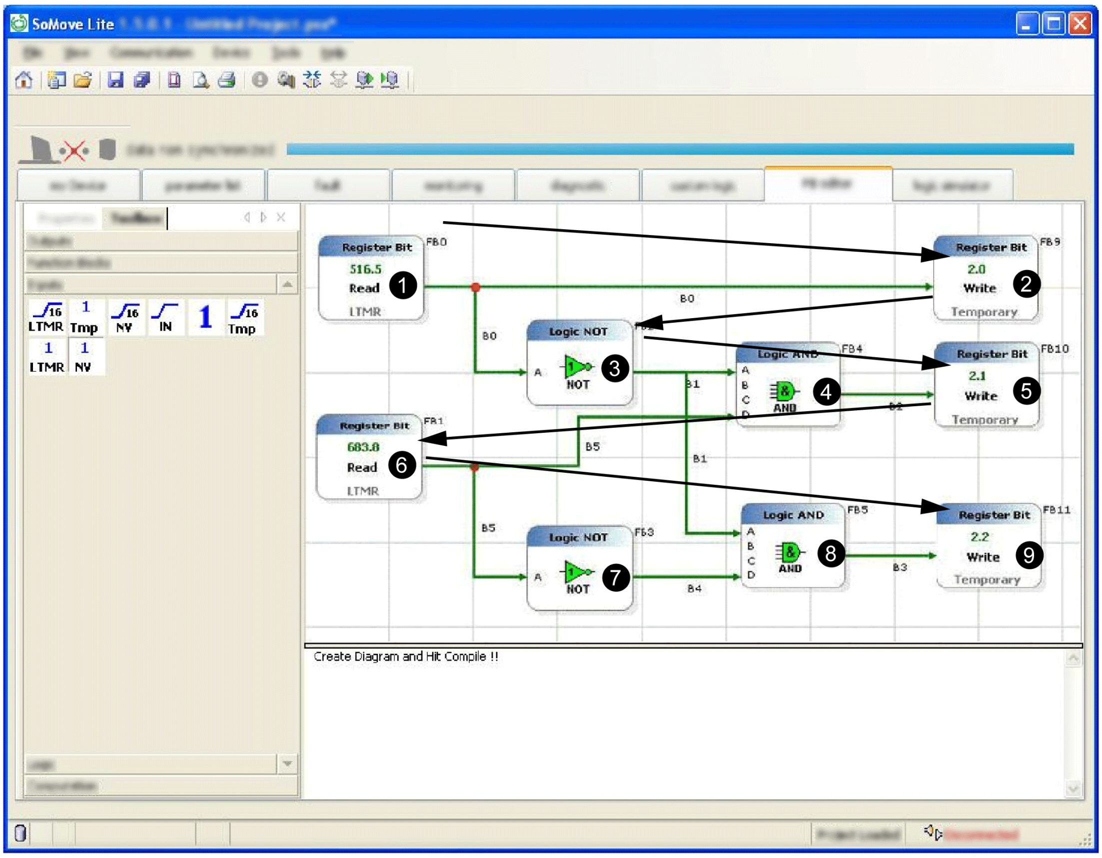
FBD programs are edited and created in the workspace.

The workspace is made up of 2 elements:

- blocks
- wires to link the blocks

Execution of FBD Programs

FBD programs are executed line by line, from the left to the right and from top to bottom. In the example below, the instructions are executed from instruction 1 to instruction 9, in the order indicated by the arrows.



FBD Elements

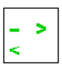
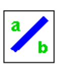
Summary

This section describes in detail the FBD elements provided by the FBD editor, and their arguments.

Computation Blocks

Overview

The FBD editor uses various Computation blocks accessible through the **Computation** bar in the Toolbox:

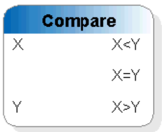
Block	Description
	Compare
	Add
	Division

Block	Description
	Multiplication
	Subtraction

NOTE: Placing cursor over the icon will reveal a tool tip defining the icon. This will help you distinguish which type of block is represented by that icon.

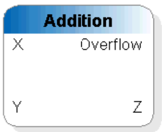
Compare Block

The  block compares two 16-bit register values.

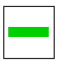
FBD Symbol	Arguments	Description
	Inputs	• X: 16-bit unsigned register value (0...65,535). • Y: 16-bit unsigned register value (0...65,535).
	Outputs	• X < Y: ON/OFF temporary bit that is ON if the value X is less than the value Y. • X = Y: ON/OFF temporary bit that is ON if the value X is equal to the value Y. • X > Y: ON/OFF temporary bit that is ON if the value X is greater than the value Y.

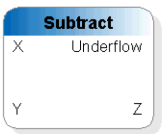
Add Block

The  block performs an unsigned addition of two 16-bit register values.

FBD Symbol	Arguments or Example	Description
	Inputs	• X: 16-bit unsigned register value (0...65,535). • Y: 16-bit unsigned register value (0...65,535).
	Outputs	• Z: 16-bit unsigned register result (Z = X + Y). • Overflow: ON or OFF value which when set ON caries a value of 65,536. The value is initialized to OFF.
	Example	Assuming X = 60,000 and Y = 7,000, the overflow will be ON because 60,000 + 7,000 = 67,000, which is superior to 65,536. The result Z is then equal to 1,464 (1,464 + 65,356 = 67,000).

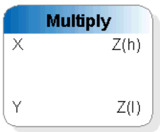
Subtraction Block

The  block performs an unsigned subtraction of two 16-bit register values.

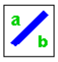
FBD Symbol	Arguments or Example	Description
	Inputs	• X: 16-bit unsigned register value (0...65,535). • Y: 16-bit unsigned register value (0...65,535).
	Outputs	• Z: 16-bit unsigned register result (Z = X – Y). • Underflow: ON or OFF value, which when set ON, caries a value of negative 65,536. The value is initialized to OFF.
	Example	Assuming X = 5 and Y = 10, the underflow will be ON because the result is negative. The result Z is then equal to 65,531 (65,531 – 65,536 = –5)

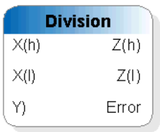
Multiplication Block

The  block performs an unsigned multiplication of two 16-bit register values.

FBD Symbol	Arguments or Example	Description
	Inputs	• X: 16-bit unsigned register value (0...65,535) • Y: 16-bit unsigned register value (0...65,535)
	Outputs	• Z(h): 16 most significant bits of the 32-bit result, Z(h) = (X * Y) / 65,536 • Z(l): 16 least significant bits of the 32-bit result, Z(l) = (X * Y) – Z(h) * 65,536
	Example	Assuming X = 20,000 and Y = 10, the result will be Z(h) = 3 and Z(l) = 3,392 because 200,000 = 3 * 65,536 + 3,392

Division Block

The  block performs an unsigned division of two 16-bit register values.

FBD Symbol	Arguments or Example	Description
	Inputs	• X(h): 16 most significant bits of an unsigned register value (0...65,535). • X(l): 16 least significant bits of an unsigned register value (0...65,535). • Y: 16-bit unsigned register divisor (0...65,535).
	Outputs	• Z(h): 16 most significant bits of the 32-bit quotient, Z(h) = (X / Y) / 65,536 • Z(l): 16 least significant bits of the 32-bit quotient, Z(l) = (X / Y) – Z(h) * 65,536 • Detected Error: ON or OFF value, which is set ON when a division by zero occurs. This value is initialized to OFF.
	Example	Assuming X(h) = 3, X(l) = 3,392 and Y = 40, the result will be Z(h) = 0 and Z(l) = 5,000 because X(h) * 65,536 + X(l) = 3 * 65,536 + 3,392 = 200,000 and 200,000 /Y = 5,000 = 0 * 65,536 + 5,000

Inputs Blocks

Overview

The FBD editor uses various inputs blocks accessible through the **Inputs** bar in the Toolbox:

Block	Description
	`Constant Bit`
	`Constant Word`
	`Register Bit In`

Block	Description
	`Register Word In`
	`Register NV Bit In`
	`Register NV Word In`
	`Register Temp Bit In`
	`Temp Word In`

NOTE: Placing cursor over the icon will reveal a tool tip defining the icon. This will help you distinguish which type of block is represented by that icon.

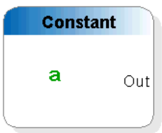
Constant Bit Block

The  block is used to set other blocks' inputs to 0 or 1.

FBD Symbol	Arguments	Description
	Properties	• a: Constant bit value 0 or 1 (ON=1 and OFF=0).
	Outputs	• Constant value 0 or 1 (ON=1 and OFF=0).

Constant Word Block

The  block is used to set other blocks' inputs values.

FBD Symbol	Arguments	Description
	Properties	• a: Constant value from 0 to 65,535.
	Outputs	• Constant value from 0 to 65,535.

Register Bit In Block

The  block enables the reading and use of a register bit value from the LTM R controller addresses from 0 to 1399.

FBD Symbol	Arguments	Description
	Properties	• a: Any register from 0 to 1399. • b: Bit number from 0 to 15.
	Outputs	• Value 0 or 1 (ON=1 and OFF=0).

Register Word In Block

The  block enables the reading and use of a register value from the LTM R controller addresses from 0 to 1399.

FBD Symbol	Arguments	Description
	Properties	• a: Any register from 0 to 1399.
	Outputs	• Value from 0 to 65,535.

Register NV Bit In Block

The  block enables the reading and use of a non-volatile register bit value.

FBD Symbol	Arguments	Description
	Properties	• a: Any non-volatile register from 0 to 63 • b: Bit number from 0 to 15.
	Outputs	• Value 0 or 1 (ON=1 and OFF=0).

Register NV Word In Block

The  block enables the reading and use of a non-volatile register value.

FBD Symbol	Arguments	Description
	Properties	• a: Any non-volatile register from 0 to 63.
	Outputs	• Value from 0 to 65,535.

Register Temp Bit In Block

The  block enables the reading and use of a temporary register bit value.

FBD Symbol	Arguments	Description
	Properties	• a: Any temporary register from 0 to 299. • b: Bit number from 0 to 15.
	Outputs	• Value 0 or 1 (ON=1 and OFF=0).

Temp Word In Block

The  block enables the reading and use of a temporary register value.

FBD Symbol	Arguments	Description
	Properties	• a: Any temporary register from 0 to 299.
	Outputs	• Value from 0 to 65,535.

Function Blocks

Overview

The FBD editor uses various functions blocks accessible through the **function** bar in the Toolbox:

Block	Description
	`CALL_EOM`
	`Counter`
	`Counter NV`
	`Volatile Latch`
	`Non Volatile Latch`
	`Multiplexer`
	`TimerSeconds`
	`TimerTenthSeconds`

NOTE: Placing cursor over the icon will reveal a tool tip defining the icon. This will help you distinguish which type of block is represented by that icon.

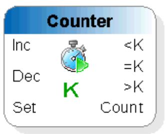
CALL_EOM Block

The  function executes a pre-defined operating mode in the customized program.

FBD Symbol	Arguments	Description
	Properties	Property 1 = Embedded operating mode (EOM): • Overload (1) • Independent (2) • Reverser (3) • 2-Step (4) • 2-Speed (5) Property 2 = Terminal strip control: • ON = 3-wire terminal strip control (3W) • OFF = 2-wire terminal strip control (2W)

Counter Block

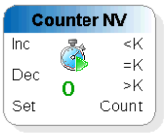
The  function performs a comparative count, saving both the counter current and counter preset values to temporary registers.

FBD Symbol	Arguments	Description
	Properties	K: Counter preset value (UINT 0...65,535).
	Inputs	• Inc: Increments the counter current value on a rising edge. Counter current value shall roll over from 65,535 to 0. • Dec: Decrements the counter current value on a rising edge. Counter current value shall roll over from 0 to 65,535. • Set: Sets the current counter value to the preset value on a rising edge.
	Outputs	• Count: Counter current value (UINT 0...65,535). Count is initialized to zero on power-up. • <K: The counter current value is lower than the preset value K. • =K: The counter current value is equal to the preset value K. • >K: The counter current value is greater than the preset value K.

NOTE: The Counter preset value range is from 0 to 65,535. Cascading counters and compare functions can be used if you need larger values or multiple preset values.

Counter NV Block

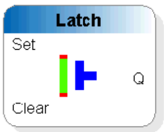
The  function performs a comparative count, saving both the counter current and counter preset values to non-volatile registers.

FBD Symbol	Arguments	Description
	Properties	K: Counter preset value (UINT 0...65,535).
	Inputs	• Inc: Increments the counter current value on a rising edge. Counter current value shall roll over from 65,535 to 0. • Dec: Decrements the counter current value on a rising edge. Counter current value shall roll over from 0 to 65,535. • Set: Sets the current counter value to the preset value on a rising edge.
	Outputs	• Count: Counter current value (UINT 0...65,535). This value is saved in non-volatile memory and initialized to the previous value on power-up. • <K: The counter current value is lower than the preset value K. • =K: The counter current value is equal to the preset value K. • >K: The counter current value is greater than the preset value K.

NOTE: The Counter preset value range is from 0 to 65,535. Cascading counters and compare functions can be used if you need larger values or multiple preset values

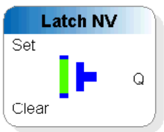
Volatile Latch Block

The  function records and retains signal history in a temporary register.

FBD Symbol	Arguments	Description
	Inputs	• Set: ON/OFF input value. The latch value is set ON when this input transitions from OFF to ON. • Clear: ON/OFF input value. The latch value is set OFF when this input transitions from OFF to ON.
	Outputs	• Q: ON or OFF latch value which represents the state of this latch. This value remains ON/OFF until the next rising edge of Set or Clear. This value is initialized to OFF.

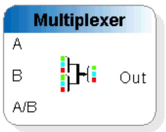
Non Volatile Latch Block

The  function records and retains signal history in a non-volatile register.

FBD Symbol	Arguments	Description
	Inputs	• Set: ON/OFF input value. The latch value is set ON when this input transitions from OFF to ON. • Clear: ON/OFF input value. The latch value is set OFF when this input transitions from OFF to ON.
	Outputs	• Q: ON or OFF non-volatile register bit value that represents the state of this latch. This value remains ON/OFF until the next rising edge of Set or Clear. This value is saved in non-volatile memory and initialized to previous state on power-up.

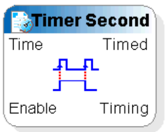
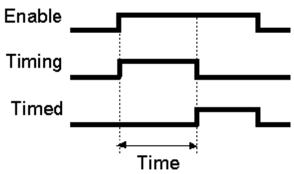
Multiplexer Block

The  function enables you to choose between two 16-bit unsigned values.

FBD Symbol	Arguments	Description
	Inputs	• A: 16-bit unsigned value (0...65,535). • B: 16-bit unsigned value (0...65,535). • A/B: ON/OFF input value that selects value A or B.
	Outputs	• Out: Selected 16-bit value: ◦ If A/B is ON then Out = A. ◦ If A/B is OFF then Out = B.

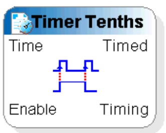
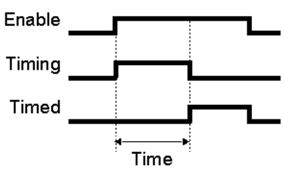
Timer Seconds Block

The  function measures time in intervals of seconds.

FBD Symbol	Timing Diagram	Argu-ments	Description
		Inputs	• Time: 16-bit unsigned value (0...65,535) that specifies time period in seconds. • Enable: ON/OFF input value. The time period is loaded on the rising edge of the Enable input. Time measuring continues while Enable is ON. Timing stops and outputs are OFF when Enable is OFF.
		Outputs	• Timed: ON/OFF value which turns ON while Enable is ON and time period expires. It is OFF while measuring time or while Enable is OFF. • Timing: ON/OFF value that is ON while Enable is ON and while measuring time. It is OFF after time period expires or Enable is OFF. Note: Both outputs can never be simultaneously ON.

Timer TenthSeconds Block

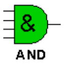
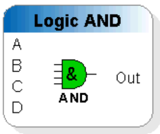
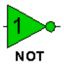
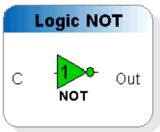
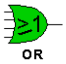
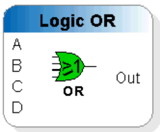
The  function measures time in intervals of tenths of seconds.

FBD Symbol	Timing Diagram	Argu-ments	Description
		Inputs	• Time: 16-bit unsigned value (0...65,535) that specifies time periods in tenths of seconds. • Enable: ON/OFF input value. The time period is loaded on the rising edge of the Enable input. Time measuring continues while Enable is ON. Timing stops and outputs are OFF when Enable is OFF.
		Outputs	• Timed: ON/OFF value that turns ON while Enable is ON and time period expires. It is OFF while measuring time or while Enable is OFF. • Timing: ON/OFF value which is ON while Enable is ON and while measuring time. It is OFF after time period expires or Enable is OFF. Note: Both outputs can never be simultaneously ON.

Logic Blocks

Overview

The FBD editor uses various logic blocks accessible through the **Logic blocks** bar in the Toolbox:

Function	Icon	FBD Symbol	Description
AND			If all the inputs (ON or OFF values, respectively 1 or 0) are ON or not connected, the output is ON. If at least one input is OFF, the output is OFF. **NOTE:** unconnected inputs are assumed to be ON.
NOT			If the input (ON or OFF values, respectively 1 or 0) is ON, the output is OFF. If the input is OFF, the output is ON.
OR			If at least one input (ON or OFF values, respectively 1 or 0) is ON, the output is ON. If all the inputs are OFF or not connected, the output is OFF. **NOTE:** unconnected inputs are assumed to be OFF.

NOTE: Placing cursor over the icon will reveal a tool tip defining the icon. This will help you distinguish which type of block is represented by that icon.

Outputs Blocks

Overview

The FBD editor uses various outputs blocks accessible through the **Outputs** bar in the Toolbox:

Block	Description
	Register Bit Out
	Register Word Out
	Register NV Bit Out
	Register NV Word Out
	Register Temp Bit Out
	Temp Word Out

NOTE: Placing cursor over the icon will reveal a tool tip defining the icon. This will help you distinguish which type of block is represented by that icon.

Register Bit Out Block

The  block is used to set an LTM R controller register bit value to 0 or 1 from the LTM R controller addresses from 0 to 1399.

FBD Symbol	Arguments	Description
	Properties	• a: Any register from 0 to 1399. • b: Bit number from 0 to 15.
	Inputs	• 0 or 1 (ON=1 and OFF=0)

Register Word Out Block

The  block is used to set an LTM R controller register value from the LTM R controller addresses from 0 to 1399.

FBD Symbol	Arguments	Description
	Properties	• a: Any register from 0 to 1399.
	Inputs	• 16-bit unsigned value from 0 to 65,535.

Register NV Bit Out Block

The  block is used to set a non-volatile register bit value to 0 or 1.

FBD Symbol	Arguments	Description
	Properties	• a: Any non-volatile register from 0 to 63. • b: Bit number from 0 to 15.
	Inputs	• 0 or 1 (ON=1 and OFF=0)

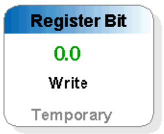
Register NV Word Out Block

The  block is used to set a non-volatile register value.

FBD Symbol	Arguments	Description
	Properties	• a: Any non-volatile register from 0 to 63.
	Inputs	• 16-bit unsigned value from 0 to 65,535

Register Temp Bit Out Block

The  block is used to set a temporary register bit value to 0 or 1.

FBD Symbol	Arguments	Description
	Properties	• a: Any temporary register from 0 to 299. • b: Bit number from 0 to 15.
	Inputs	• 0 or 1 (ON=1 and OFF=0)

Temp Word Out Block

The  block is used to set a temporary register value.

FBD Symbol	Arguments	Description
	Properties	• a: Any temporary register from 0 to 299.
	Inputs	• 16-bit unsigned value from 0 to 65,535

Programming with the FBD Language

Summary

This section describes how to create and modify a program using the FBD language.

Inserting FBD Blocks

Overview

To create an FBD program, insert blocks into the workspace, then link them together. All types of blocks can be placed in the workspace.

Inserting Blocks from the Toolbox

The following procedure describes how to insert a block from the toolbox into the workspace:

Step	Action
1	Select **Device > FB diagram > View > Toolbox** or click the **Toolbox** tab on the left side.
2	Select the type of block to insert: • Computation • Inputs • Function Blocks • Logic • Outputs
3	Left-click on the icon corresponding to the block to insert.
4	Drag and drop the block from the toolbox to the workspace.

Step	Action
5	Position the block in the required location on the workspace.
6	Repeat steps 2 to 5 to insert all the blocks required for the program.

Inserting Blocks from the Workspace

The following procedure describes how to insert a block directly from the workspace:

Step	Action
1	Right-click anywhere on a blank space in the workspace. **Result**: A menu opens and enables you to select the type of block you wish to insert.
2	Select the type of block to insert: • Computation • Inputs • Function Blocks • Logic • Outputs
3	Left-click on the block you wish to insert.
4	Position the block in the required location in the workspace.
5	Repeat steps 1 to 5 to insert all the blocks required for the program.

Creation of Links between Blocks

Overview

After you have positioned the blocks in the workspace, you can link them together. To do this, you link a block's output to the input of another block. You can also loop an output back to the input of the same block.

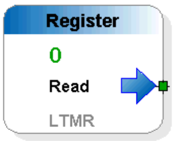
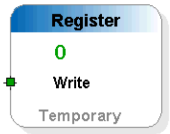
General Rules

There are some basic rules that apply when placing and connecting blocks:

- One or more connecting wires attached together form a "wire node". This is indicated in the workspace by a red dot. If wires cross without a red connection dot, it means they are not connected.
- Only one output can be attached to each wire node.
- Connections between boolean and register data are prohibited.
- Data typically flows from left to right.

Link between Blocks

The following procedure describes how to link blocks together:

Step	Action
1	Place the mouse over the first block. **Result**: One or more squares become visible on the block border, and the type of output (analog or boolean) is indicated. 
2	Click the left mouse button and hold it down.
3	With the button held down, move the cursor over the input of the block you want to link to. **Result**: One or more squares become visible on the block border. If the square is green, a connection between the 2 blocks is possible. A red square indicates that a connection is not possible. The type of output (analog or boolean) is also indicated.  Note: Inputs and outputs have to be of the same type: a boolean output is linked to another boolean output. If the inputs or outputs are not the same, the FBD editor will display a pop-up window to indicate that origins and destinations are not of the same type.
4	Release the mouse button. **Result**: A line and a number are shown between the 2 linked blocks.
5	Repeat steps 1 to 4 to link all the blocks.

Link Number

There are 2 types of wires:

- The boolean wire, which will have a number beginning with B.
- The register wire, which will have a number beginning with R.

The wire number is automatically incremented in chronological order.

FBD Blocks Properties

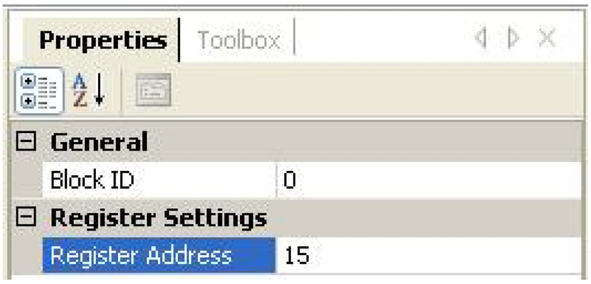
Overview

Each of the blocks has a properties window. To display this window, left-click on a block.

The Properties window consists of several tabs, separated in 1 or 2 categories, depending on the type of block:

- General settings, which contain the block ID and comments (common to all types of blocks.
- Specific settings, depending on the type of block (register settings for registers, counter settings for counters, etc.).

For example, if you wish to display non-volatile register properties, select a non-volatile register block and left-click on it. The following window is displayed:



Comments

In the Comment zone, in the white box on the right of Comments, you can enter a comment. Select any object or any free location in the workspace to save the comment.

Settings

Most blocks have a specific settings tab. In this tab, Set the specific settings of blocks. These settings are described in detail in the help for each of the FBD blocks.

Properties Display

The properties of each block can be displayed in 2 different ways:

- by category, clicking  or
- by alphabetical order, clicking .

FBD Resource Management

Overview

The LTM R controller memory is equipped with the following resources:

- Logic memory space size equal to 8,192 words
- 300 temporary registers
- 64 non-volatile registers

Reserved Resources

When a custom logic program is developed using the structured text editor, all resources are available, whereas, when using the FBD editor, some temporary and non-volatile registers are reserved for use by the FBD compiler.

Register Allocation

The following table lists all reserved registers and their allocation. It also indicates how these registers are controlled:

Register Type	Address Range	Controlled by	Description
Temporary	0...69	The user	Temporary storage of bit and registers assigned by the user when creating an FBD program.
Temporary	70...299	The FBD compiler	Reserved temporary registers for use by the compiler.
Non-volatile	0...31	The user	Non-volatile bits or registers assigned by the user when creating an FBD program.
Non-volatile	32...63	The FBD compiler	Reserved non-volatile registers for use by the compiler.

Manipulating FBD Blocks

Summary

This section describes the manner in which blocks in the workspace can be manipulated, including how to select, move, duplicate or delete blocks.

How to Select Blocks

Overview

When you add blocks to the workspace, you can select them to reposition them within the workspace.

How to Select One or More Blocks

The following table describes how to select one or more blocks:

If you would like to select...	Then
An isolated block	Click block.
Several contiguous blocks	Frame the blocks to be selected by defining a selection zone. **Result**: All of the selected blocks are highlighted with an orange outline. 
Several blocks in different areas of the workspace	Press the SHIFT key, then click the blocks to be selected while continuing to hold down the SHIFT key. **Result**: All of the selected blocks are highlighted with an orange outline.
All objects including wires	Select **Device** > **FB diagram** > **FBD editor** > **Select all** **Note:** The keyboard shortcut CTRL+A can also be used to select all objects.

How to Delete and Duplicate Objects

Overview

Sometimes it may be necessary to delete a block or duplicate a block in the workspace.

How to Delete Blocks

The following table describes how to delete one or more blocks:

Step	Action
1	Select the block(s) to be deleted **Result**: The selected blocks are highlighted with an orange outline. 
2	Press the DELETE or BACKSPACE key or select **Device > FB diagram > FBD editor > Delete**. **Result**: The selected blocks are deleted.

How to Cut, Copy or Paste Blocks

The following table describes how to cut, copy, or paste one or more blocks:

Step	Action
1	Select the block(s) to be manipulated. **Result**: The selected blocks are highlighted with an orange outline. 
2	Click **Device > FB diagram > FBD editor** and select one of the following commands: • **Copy** • **Cut** • **Paste** **Result**: **Cut** deletes the selected blocks and stores them in the clipboard. **Copy** duplicates the selected blocks in the clipboard and **Paste** duplicates the clipboard contents on the workspace. **Note:** The keyboard shortcuts CTRL+C, CTRL+V, and CTRL+X can also be used to copy the selected blocks, and either paste or delete them.

FBD Editor Display Options

Summary

The following section describes the different FBD editor display options.

Other Display Options

Summary

You can customize the following display options to suit your requirements:

- Zoom
- Links
- Arguments

Zoom Display Options

To access zoom options, click **Device > FB diagram > View**.

3 options are offered:

- zoom out to see more of the program at once.
- zoom in to focus on the program in more detail.
- zoom to 50 %, 75 %, 100 %, 150 %, 200 %, or 400 % to have a customized view of the program.

Links Display Options

To access links display options, click **Device > FB diagram > Tools**.

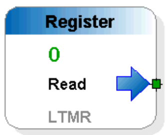
3 options are offered. You can:

- renumber links, to aid in understanding the execution of the program.
- show all links, to see which blocks are linked together.
- hide all links, to have a better overall view of the blocks.

When you click a link, its properties window opens and enables you to customize the text that appears next to the link.

Arguments Display Options

The following procedure describes how to access and change argument display options:

Step	Action
1	Position the mouse over a block. **Result**: One or more squares become visible on the block border. It also indicates if the argument is analog or boolean. 
2	Click on this square. **Result:** The display options appear.
3	Choose if you want the label to be displayed and what text should appear.

Workspace Appearance and Graph Options

Summary

The FBD editor enables you to customize the workspace by changing its appearance and graph options.

Appearance and Graph Options

To access appearance and graph options, left-click anywhere in the workspace, except on an object.

Appearance Options

The following table lists all the possible appearance customization options:

Appearance Option	Description	Possible Choices
Background Color	Enables you to set the background color of the workspace by clicking the box where the color is displayed.	Choose between the colors available in the **Custom**, **Web**, and **System** tabs.
Background Image Path	Enables you to insert an image from your hard disk drive or any removable device and to define it as the background.	Any image you select as the background. **Note:** Only possible when the background type is set to image.
Background Type	Enables you to set the background type.	Choose between a flat color, gradient, or image background.
Enable Context Menu	Shows or hides the context menu.	True or false
Enable Tooltip	Shows or hides tooltips.	True or false
Gradient Bottom	Enables you to set the color of the bottom of the gradient.	Choose between the colors available in the Custom, Web, and System tabs. **Note:** Only possible when the background type is set to gradient.
Gradient Top	Enables you to set the color of the top of the gradient.	Choose between the colors available in the Custom, Web, and System tabs. **Note:** Only possible when the background type is set to gradient.
Gradient Mode	Enables you to set the type of gradient	Choose between horizontal, vertical, forward diagonal, and backward diagonal modes. **Note:** Only possible when the background type is set to gradient.
Restrict to Canvas	Enables you to choose whether the FBD program should be kept inside the canvas.	True or false
Show Grid	Enables you to choose whether the accurate grid is visible.	True or false **Note:** This grid must not be confused with the grid line, which is accessed from the top-level **View** menu bar.
Snap	Enables you to choose whether the objects are snapped with the grid. When set to true, if you move objects, they will move along the grid step.	True or false

Graph Options

The following table lists all the possible graph customization options:

Graph option	Description	Possible choices
Allow Add Connection	Enables you to choose whether connections can be added to the workspace.	True or false
Allow Add Shape	Enables you to choose whether blocks can be added to the workspace.	True or false
Allow Delete Shape	Enables you to choose whether blocks can be deleted.	True or false
Allow Move Shape	Enables you to choose whether blocks can be moved in the workspace.	True or false
Locked	Enables you to choose whether the FBD program can be edited.	True or false

Display Grid

You may wish to display the grid lines. In order to do so, click **Device > FB diagram > View > Show grid**.

Compiling, Simulating, and Transferring a Program

Overview

This chapter describes how to compile a structured text and a Function Block Diagram language program. It also describes the user interface windows involved in compiling the program, simulating it with the logic simulator, and transferring it to the LTM R controller.

Introduction

Compiling Overview

The customized program must be compiled before being downloaded to the LTM R controller:

- The programs in structured text language can be compiled directly.
- The programs in FBD language must be first converted in structured text language programs before compilation as structured text programs.

Compiling includes a check for program errors, such as:

- syntax and structure errors
- symbols without corresponding addresses
- resources used by the program that are not available
- whether the program fits in available controller memory

Converting FBD to Structured Text

To compile into structured text the FBD program you created or edited, select **Device > FB diagram > Compile FB diagram to ST program**.

The program is automatically copied into the structured text editor if there is no detected error.

NOTE: Remember to save the FBD program in the FBD editor before converting it, because it is not possible to convert a structured text program file into an FBD file.

Compiling Structured Text

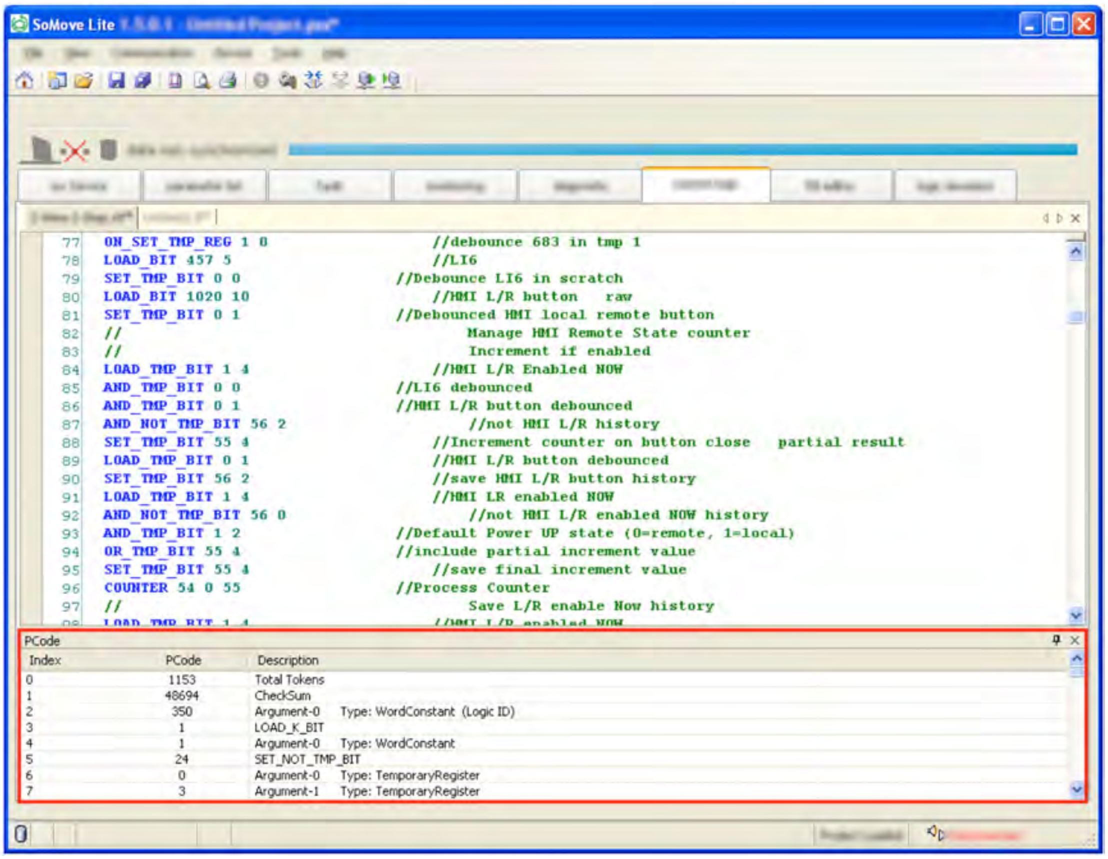
Follow these steps in order to compile the structured text program just created into PCode:

Step	Action
1	Select **Device > custom logic**.
2	Click **Compile custom program**. **NOTE:** If no errors are detected, the PCode window is displayed. Otherwise, the Detected Error window is displayed.

PCode Window

Overview

When a custom logic program is compiled successfully, the **PCode** (Pseudo Code) window is displayed:



PCode Window Elements

The following table lists the different elements which make up the **PCode** window:

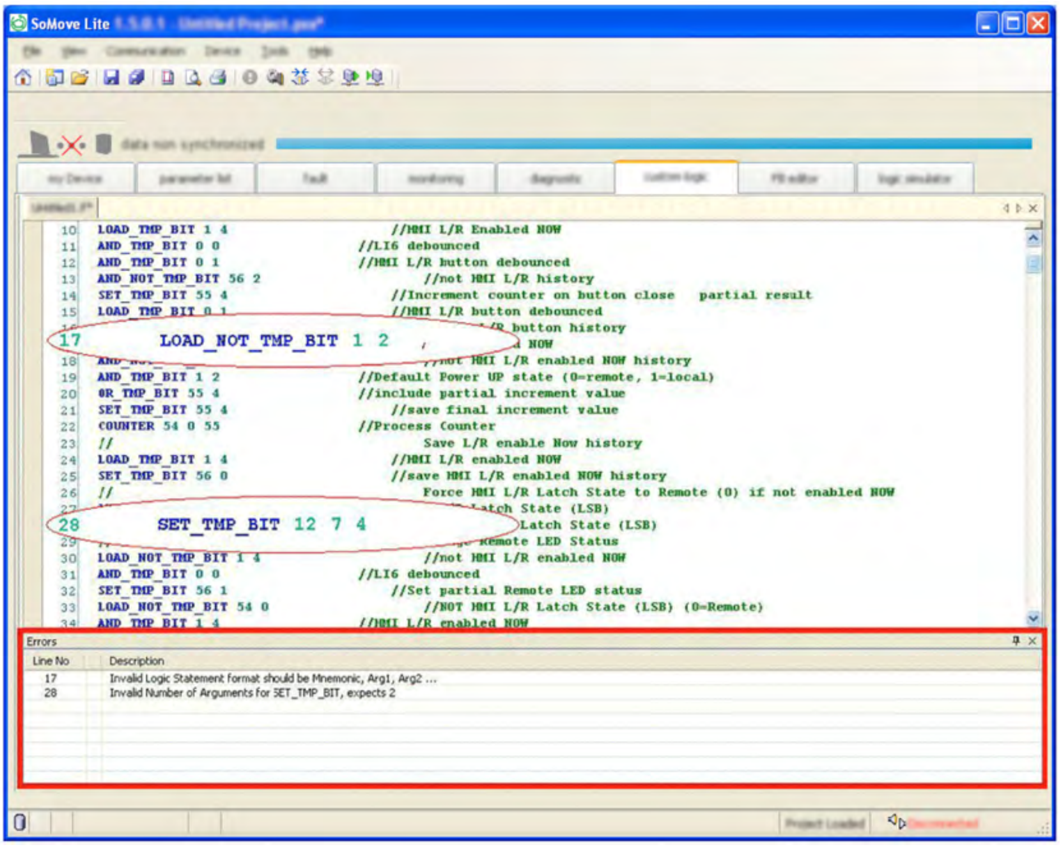
Item	Description
Total tokens	Size of PCode (in 16-bits word). Count including checksum, logic ID, and all logic commands and arguments.
Checksum	Module 16 summation of all logic commands and arguments.
Logic command	Each logic command in the program and its related PCode.
Argument	Each argument in the program, and the type of register (temporary, non-volatile, or data) that it refers to or affects.

NOTE: Logic commands and arguments are listed in the same order as in the structured text language program.

Error Window

Overview

When a structured text language program is compiled, it may contain errors. In this case, the **Error** window is displayed:



Error Window Elements

In the example above, 2 mistakes were made.

The Error window indicates:

- the line numbers with detected errors, and
- a description of the detected error.

Detected Error Types

The following list describes the different types of detected coding errors that may occur:

- syntax and structure errors
- logic commands without corresponding addresses
- resources used by the program that are not available
- program size is too large

LTM R Controller Logic Simulator

Overview

SoMove with the TeSys T DTM comes with the LTM R controller logic simulator. It enables to test the functioning of a structured text custom logic program before transferring it into the LTM R controller.

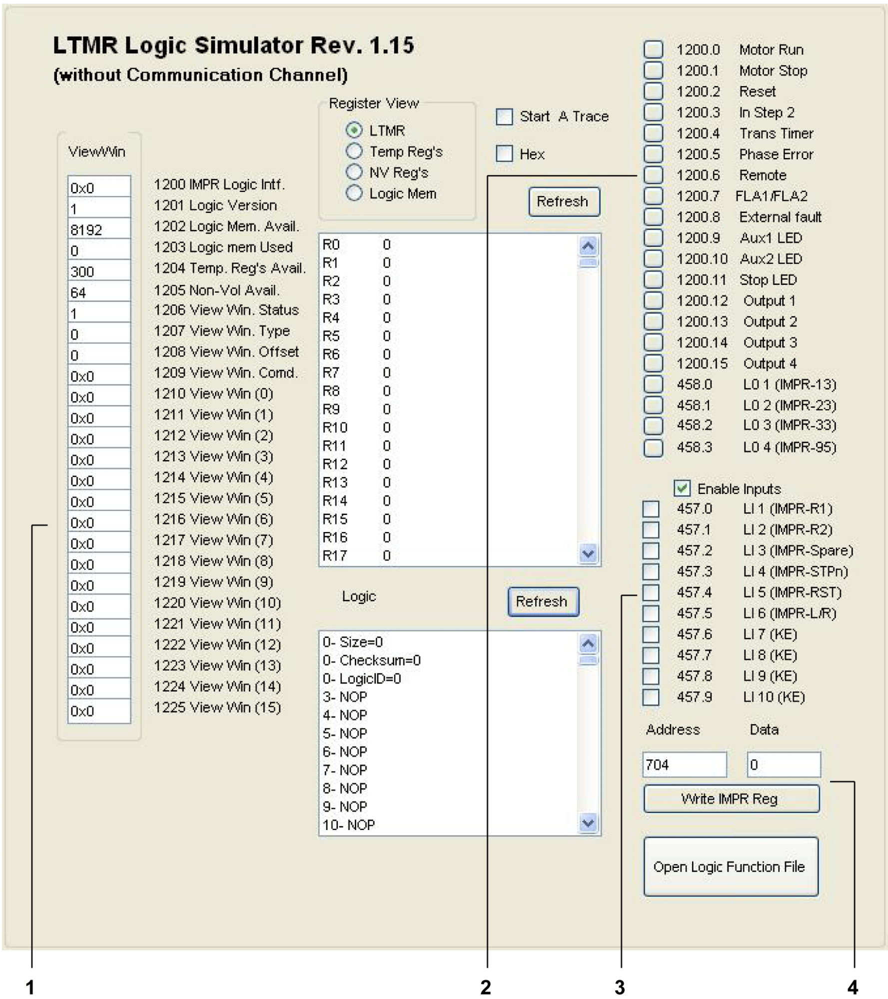
NOTE: To simulate an FBD program, it must be first converted and saved as a structured text program with the extension **.lf*.

Logic Simulator Interface

To open the logic simulator, click the **logic simulator** tab. The logic simulator is then displayed. In the right bottom corner, click **Open Logic Function File** to import your previously saved structured text program.

NOTE: When you import a program with syntax errors, an information window appears: correct all detected errors in the structure text editor and compile the program after corrections before starting the simulation.

The logic simulator with a loaded custom logic file is then displayed:



1 View window: used to display register 1200...1225.

2 Used to display the status of registers 1200 and 458.

3 Used to writes values to register 457.

4 Used to write data in decimal format to any register address.

Register View

4 kinds of registers are displayed by the logic simulator:

- LTM R controller registers
- Temporary registers
- Non-volatile registers
- Logic memory

Those registers cannot be displayed at the same time. The Register View enables you to choose which ones you wish to monitor. In the example above, the content of the logic memory is displayed.

NOTE: By default, registers values are displayed in decimal code. Tick the **Hex** box if you would prefer them to be in hexadecimal code.

Logic Primitives Window

The Logic Primitives window displays the compiled PCode, page 294.

NOTE: The PCode may read or write to any READ/WRITE register that is accessible by serial port communications.

View Window

The logic simulator displays the content of LTM R controller registers 1200...1225 in hexadecimal code (see part 1 on the illustration above). Registers 1200...1205 are the custom logic registers.

Registers 1200 and 458

The logic simulator displays the status of registers 1200 and 458 (See part 2 on the illustration above). The LTM R controller firmware then reads those PCode register values to direct device functions and physical outputs. For more information about those registers see the sections on Communication Variables in the *Use* chapter of the *TeSys T LTM R Motor Management Controller User Manual*.

The logic simulator displays an X in each output status checkbox to indicate that a bit value of ‘1’ exists in the output status register.

Register 457

The logic simulator enables to write values to register 457 bits (see part 3 on the illustration above). For more information about this register see the sections on Communication Variables in the *Use* chapter of the *TeSys T LTM R Motor Management Controller User Manual*. To be allowed to write to register 457, tick the **Enables Inputs** box.

Ticking a box on the left of a register bit will assign a value of 1 to this bit. Untick this box to assign 0 to this bit.

Example: If you tick the 3 first boxes, bits 457.0, 457.1, and 457.2 will get the value of 1. Click on the upper refresh button, and then check the value of register 457. You can see that it has the value of 7, which is in binary code 0000000000000111.

Writing to a Register Address

The logic simulator enables to write data in decimal format to any register address (see part 4 on the illustration above). Follow these steps to assign a value to a register:

Step	Action
1	Specify to which register you wish write data in the **Address** box.
2	Specify which value in decimal format you wish to assign in the **Data** box.
3	Click **Write IMPR Reg**.

Start a Trace

The **Start a Trace** box is an integrated debugging tool which captures the 1-bit and the 16-bit accumulator content.

Refresh

When you load your **.lf* file into the logic simulator, it emulates the LTM R controller behavior. However, values are assigned when you load the file, regardless of changes you made in the logic simulator. Click the upper refresh button to take into accounts the changes made to registers' values. Click the bottom refresh button to refresh the displayed PCode.

Initialization and Connection

Initialization

When you connect the LTM R controller to the PC, the controller automatically initializes. This initialization process enables the controller and the PC to exchange identification information.

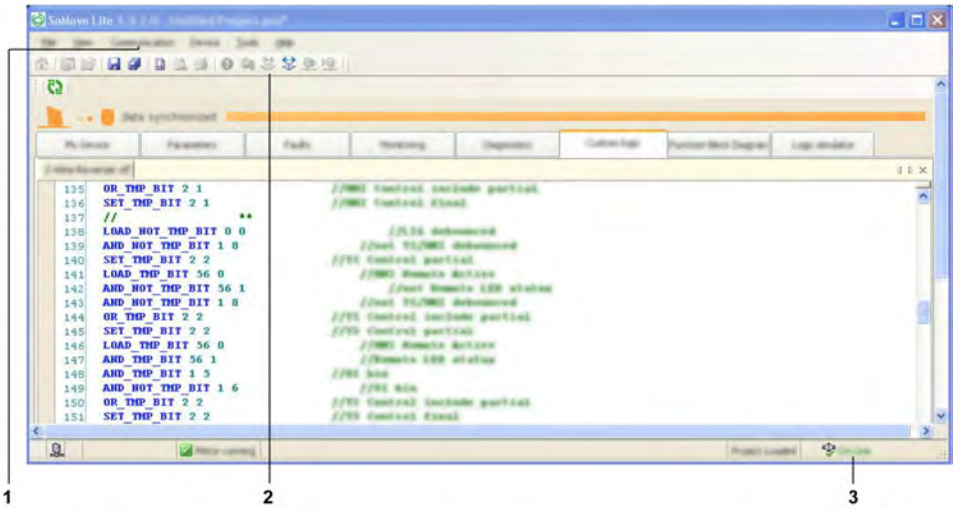
During this process, the custom logic editor indicates "Wait" until initialization is complete.

Connection

After initialization, the LTM R controller should automatically connect to the PC.

To verify that the controller is connected, check the status bar in the custom logic editor.

If the status bar reads **Disconnected**, then click **Communication > Connect to Device** or click the **Connect to Device** icon.



1 Communication menu

2 Connect to Device icon

3 Connection status

A progress bar briefly appears as your PC connects to the controller, and the word **Connected** appears in the status bar when the connection process successfully completes.

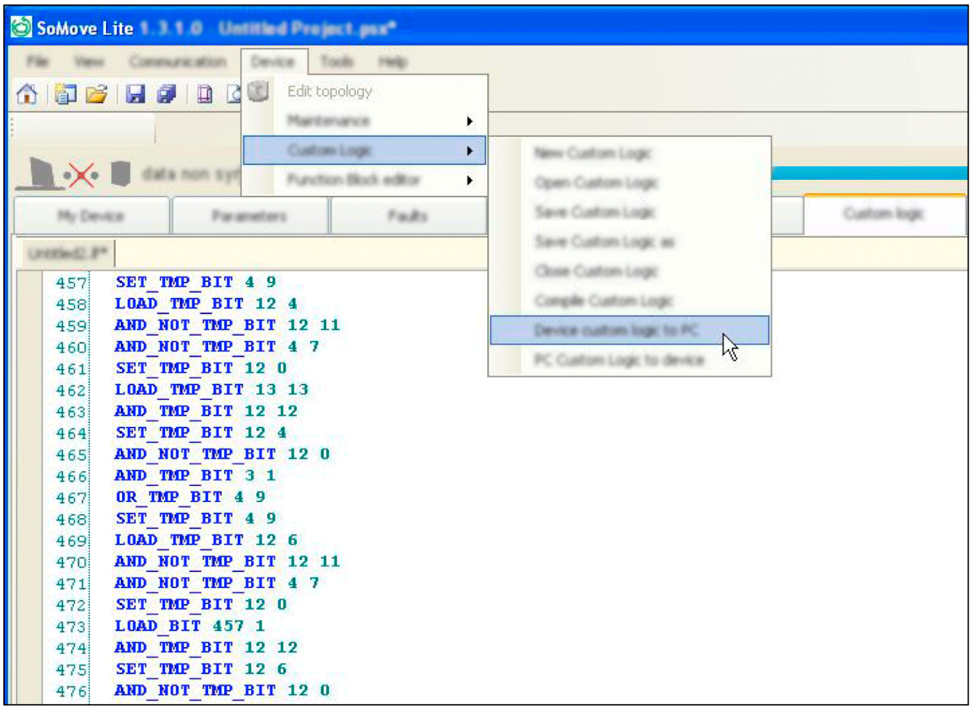
When the LTM R controller is connected, you can

- upload custom logic files from the controller to SoMove with the TeSys T DTM for editing,
- download edited custom logic files from SoMove with the TeSys T DTM to the controller.

Transferring Logic Files between the LTM R Controller and Custom Logic Editor

File Transfer - Device Custom Logic to PC

To transfer the custom logic file from the LTM R controller to the custom logic editor:

Step	Action
1	Ensure that the LTM R controller is connected to the PC, page 298.
2	Select **Device > custom logic > Device custom program to PC** or click the  icon to transfer the custom logic file from the LTM R controller to the custom logic editor. 
3	When the custom logic file has been transferred, you can use the custom logic editor to edit it as a structured text program. **NOTE:** Programs retrieved from LTM R controllers are in structured text only without comments. Programs such as FBD programs cannot be retrieved from the LTM R controller.
4	After your logic file edits are complete, save your work to a file. Select the **Save** command in either the icon bar or the **File** menu, browse to the correct location and click **Save**.

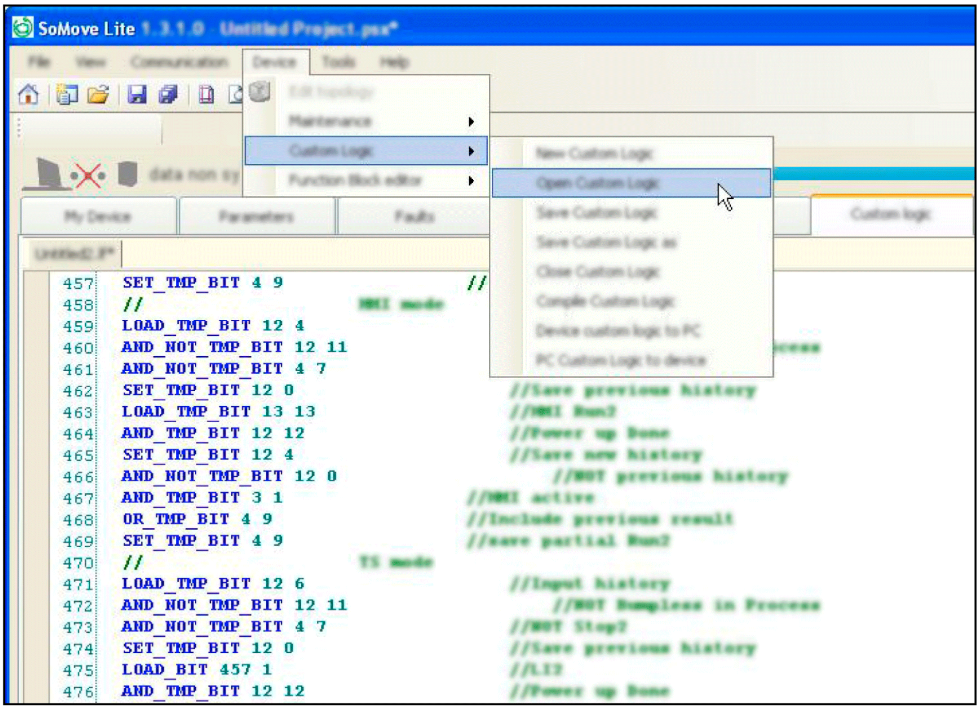
File Transfer Procedure - PC Custom Logic to Device

After you have edited and compiled your custom logic file, you can transfer the file to the LTM R controller. Before SoMove with the TeSys T DTM makes this transfer, the following conditions must be met:

- The custom logic file to transfer must be different than the logic file present in the LTM R controller, i.e., the software does not transfer the same program.
- Current must not be detected, that is, online current must be less than 10% of FLC.

If these conditions are not met, the file cannot be transferred to the controller.

To transfer a logic file from the custom logic editor to the LTM R controller:

Step	Action
1	Ensure that the LTM R controller is connected to the PC, page 298.
2	Ensure that the file to be transferred is in the main window. To open a file, select **Open custom program** from the **custom logic** submenu of the **Device** menu. Then, browse to the correct location and click **Open**. 
3	Select **Device > custom logic > Compile custom program** to compile the structured text program.
4	After the compilation of the program, select **Device > custom logic > PC custom program to device** or click the  icon to transfer the logic file from the custom logic editor to the controller.
5	The transfer is now successful. A new window appears, click **Ok** to close it.

Custom Logic Program Transfer and Execution

Overview

Custom logic programs may be uploaded to or downloaded from the LTM R controller via SoMove with the TeSys T DTM. Only one custom logic program can be loaded into the LTM R controller at a time.

Transfer Validity Check

During the upload or download of a custom logic program, outputs are turned off and logic execution is stopped.

A specific mechanism is used to upload or download a custom logic file. This mechanism uses a size register, checksum, and custom logic ID code to help detect an incomplete or corrupt logic function. SoMove with the TeSys T DTM does not allow a logic file to be uploaded with a bad checksum. However, an interruption to the connection during the upload is detected by the checksum mechanism.

Custom Logic Program Selection

When a custom logic file is uploaded to the LTM R controller, that program can be selected by choosing "Custom" from the motor controller mode selection menu or by writing its logic ID code to register 540.

Custom Logic Program Replacement

In the situation where a custom logic program is replaced by another one with a different logic ID code and the installed custom program is selected, when the new program is uploaded, the value in register 540 is automatically changed to the new logic ID code. In cases, when a standard motor controller mode is currently active (i.e. Logic ID = 2 through 11) the value in register 540 does not change.

Invalid Program

If the custom logic program that is stored in memory has a bad checksum, an invalid size or invalid logic ID, or if there is no program stored in memory, it is impossible to select "Custom" from the motor controller mode selection menu. Writing a logic ID value to register 540 that does not match one of the pre-defined operating modes or the logic ID of the valid, checksummed custom logic program in memory is blocked by the LTM R controller.

Corrupted Program

If the custom logic program in memory is already selected and becomes corrupted (either by loading a corrupt function over it or by data loss in the memory) then the LTM R controller issues a minor internal trip as soon as the corruption is detected.

Maintenance

Updating the LTM R Controller Firmware

Overview

As newer firmware versions become available, you can upgrade the firmware in the LTM R controller. This action can be performed from the TeSys T DTM **Device** menu, page 25.

The LTM R controller firmware update process is broken has 3 parts:

- checking the version of the LTM R controller firmware present in the device
- downloading the latest version of the LTM R controller firmware
- installing the latest version of the LTM R controller firmware in the device

Installation of a newer firmware stops the LTM R if it is running and erases all users configurations.

Safety Instructions

⚠ CAUTION

RISK OF FIRMWARE CORRUPTION

- Once programming has begun, do not close TeSys T programmer until the process is complete.
- Do not interrupt power to the device.
- Do not disconnect the communication cable if programming is in progress.
- Remove I/O scanner for Ethernet TeSys T.
- Close all other programs before starting programming.

Failure to follow these instructions can result in injury or equipment damage.

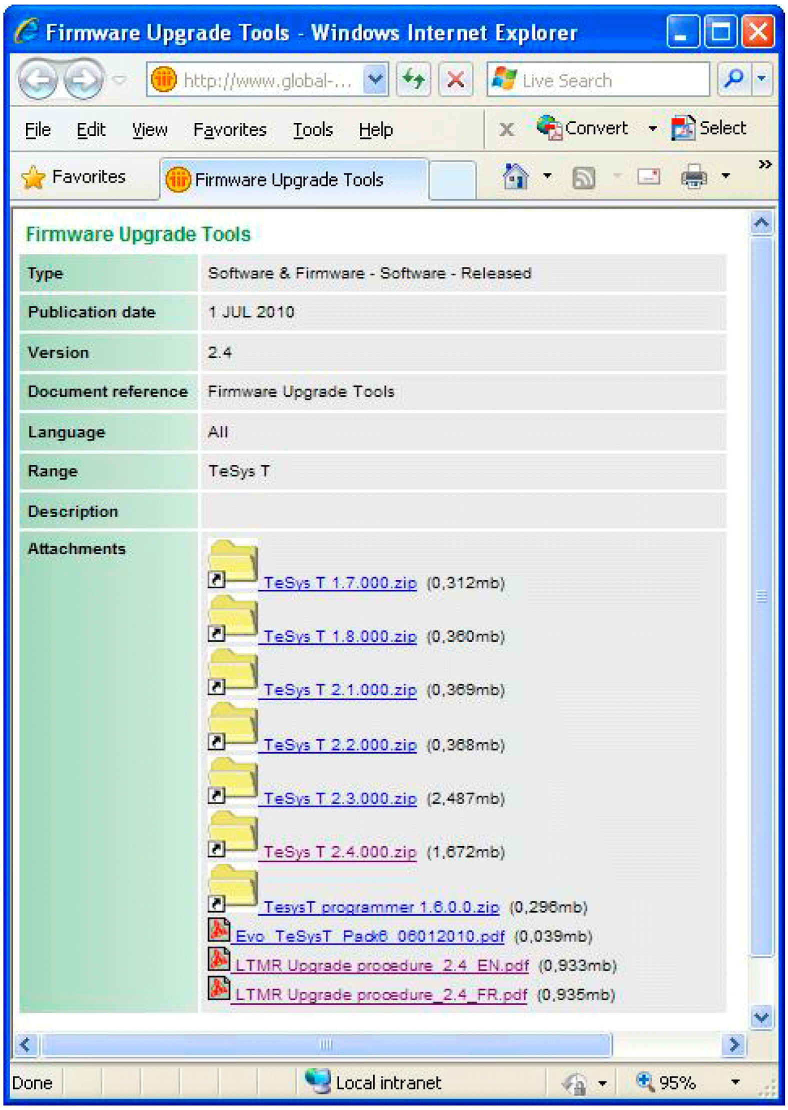
Checking the Current LTM R Controller Firmware Version

Step	Action
1	Click **my Device** tab.
2	In the display area, locate the LTM R firmware version which is displayed in the **structure** section, page 33.

Downloading the Latest Version of the LTM R Controller Firmware

Step	Action
1	Open the Schneider Electric website: www.se.com.
2	Type *TeSys T* in the Search field.
3	In the list to the right, select **Software/Firmware**.

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>4</td><td>Click Firmware Upgrade Tools file. A new window opens.


</td></tr>
<tr><td>5</td><td>If the version of the LTM R controller firmware currently installed in the device is not the latest version available for download, it is recommended to download and update the LTM R controller firmware in the device.

If this is not the case, it is not necessary to continue this procedure.</td></tr>
<tr><td>6</td><td>Click the .zip file corresponding to the latest version of the firmware update. It contains all LTM R controller firmware protocols.
Click Save in the dialog box that opens.</td></tr>
<tr><td>7</td><td>Browse to download the .zip file on your hard disk.</td></tr>
<tr><td>8</td><td>Unzip the downloaded file: all LTM R controller firmware protocol are unzipped in a folder named TeSys T X.X.XXX (where X.X.XXX is the version number).</td></tr>
</table>

LTM R Controller Connection

The LTM R controller must be connected to a PC running SoMove with the TeSys T DTM.

For all LTM R controller types a USB connection is establish between the LTM R controller and the PC to update the firmware, page 311.

For the LTM R Modbus/TCP, an additional Ethernet connection is necessary.

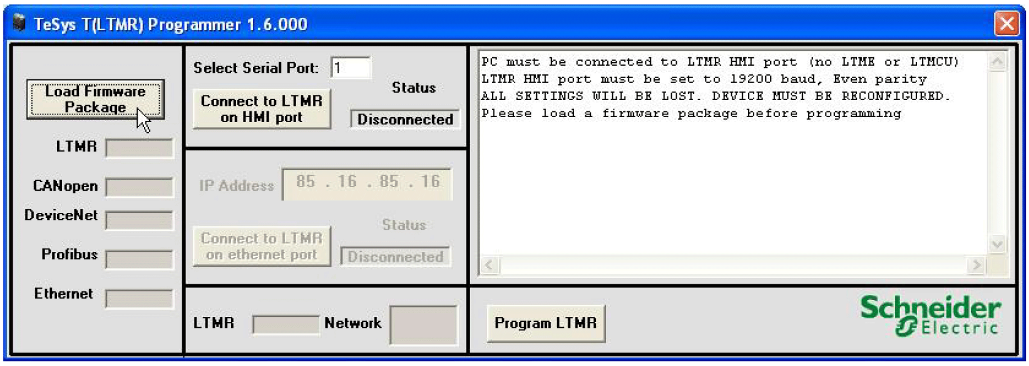
Updating the LTM R Controller Firmware

Prerequisites:

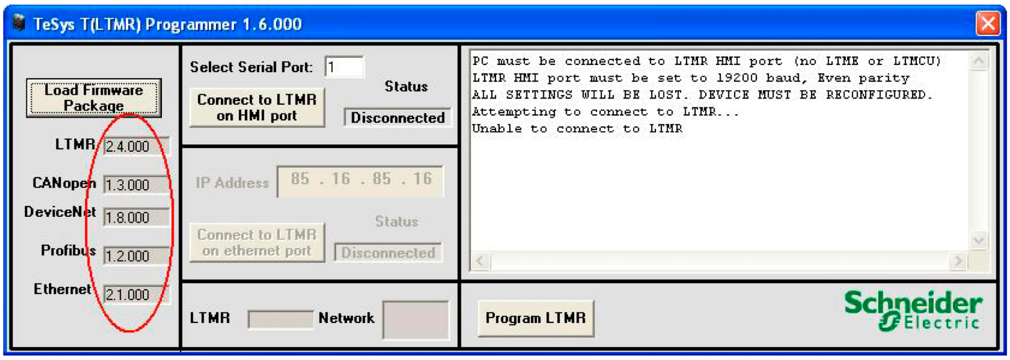
- The specific hardware connection for the firmware update between the PC and the LTM R must be done, page 310.
- The LTM R HMI port must be set to 19,200 Baud, even parity.

NOTE: The firmware update clears all existing settings, the LTM R controller must be reconfigured after the update.

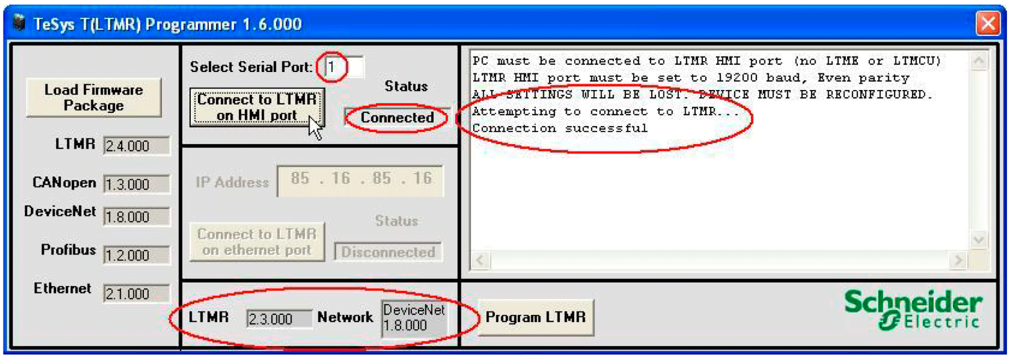
<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>In the Device menu, point to the Maintenance submenu, and then click Firmware update to open the TeSys T(LTMR) Programmer window.



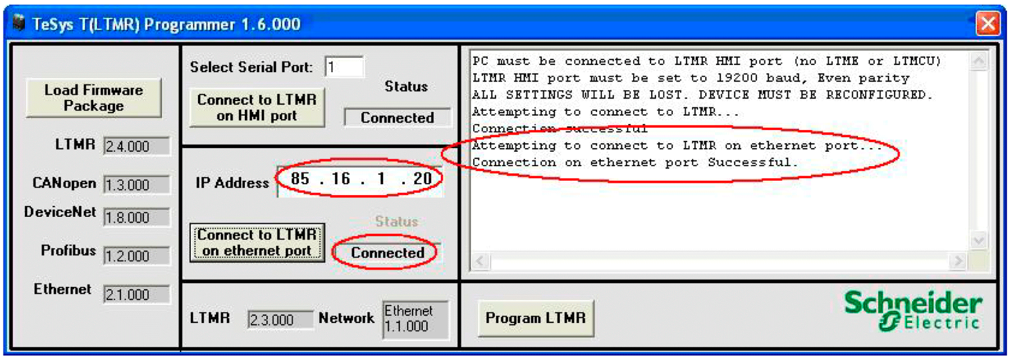
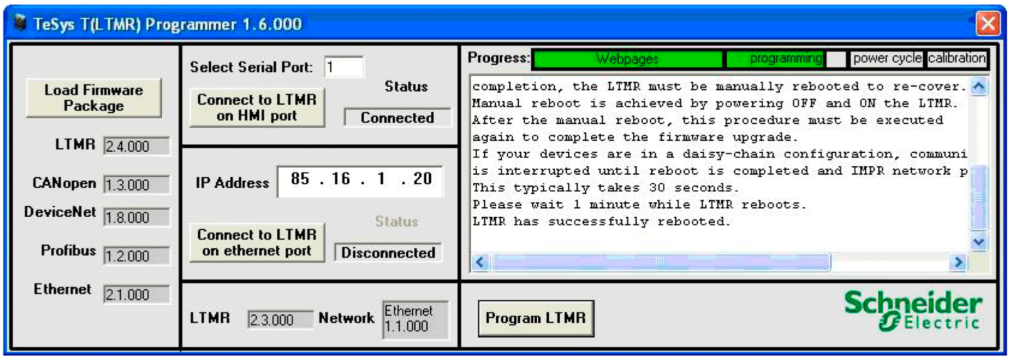
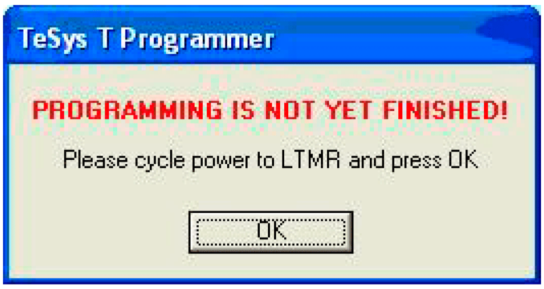
</td></tr>
<tr><td>2</td><td>Click Load Firmware Package. A new window opens.</td></tr>
<tr><td>3</td><td>Browse to the TeSys T X.X.XXX folder (where X.X.XXX is the version number) and double-click the latest version of the .fw file. All firmware releases ready to be updated are displayed.



</td></tr>
<tr><td>4</td><td>Set the serial port number according to your configuration and click Connect to LTMR on HMI port. The serial connection status is updated, the firmware version and type are displayed, and a message confirms the connection.



</td></tr>
</table>

Step	Action
5	Follow this step only with an LTM R Modbus/TCP. Go to the next step if another type of LTM R controller is used. Enter the TeSys T default IP address (in our example 85.16.1.20) and click **Connect to LTMR on ethernet port**. The Ethernet connection status is updated and a message confirms the connection to the Ethernet port. 
6	Click **Program LTMR**. A new window appears with safety instructions, page 303. After carefully reading the safety message, click **Proceed** to install the new firmware.
7	During the installation of the new firmware, a progress bar is displayed and the LEDs on the LTM R controller blink. The installation process takes about 8 minutes. 
8	At the end of the installation, a window opens to give the final instructions: 
9	Restart the LTM R controller and click **OK**. A message displays **Programming finished successfully** and the updated firmware version is displayed.

Self Test with Motor On

Description

Use the self test command to check the internal operation of both the LTM R controller and the LTM E expansion module. The self test command can be performed from the **Device** menu in the connected mode, page 26.

When the motor is On, performing a self test simulates a thermal trip to check if the logic output O.4 is working correctly. It triggers a thermal overload trip.

During a self test, the LTM R controller sets the self test command parameter to 1. When the self test finishes, this parameter is reset to 0.

Connection to the LTM R Controller

Overview

This chapter describes how to physically connect the PC running SoMove with the TeSys T DTM to the LTM R controller, including connection accessories that are used. It also describes how to connect the PC running the TeSys T (LTMR) Programmer to the LTM R Controller to update its firmware.

Hardware Connection for SoMove

Overview

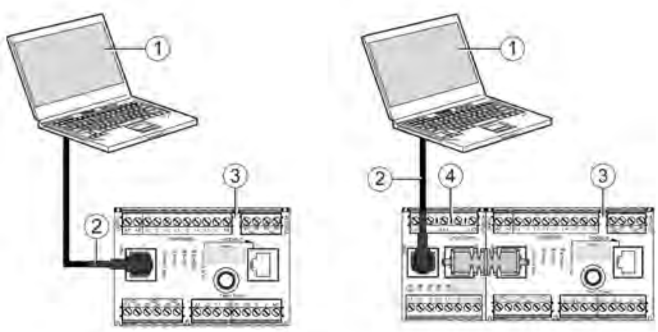
This section describes how to physically connect the LTM R controller to a PC running SoMove with the TeSys T DTM.

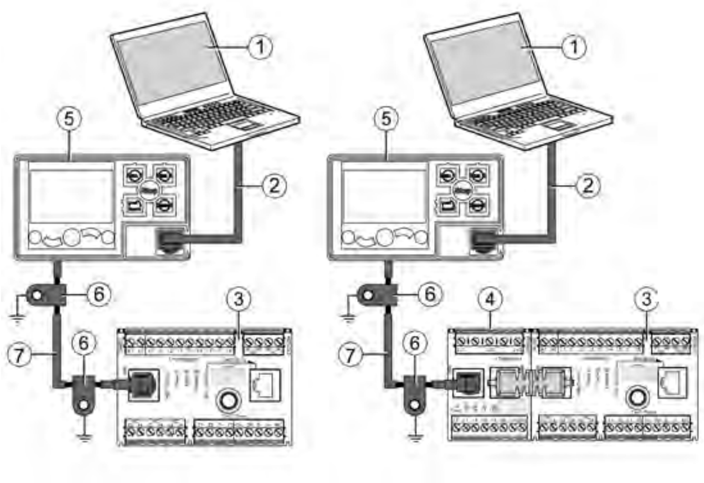
The PC requires its own power source and must be connected to the RJ45 port on the LTM R controller or the HMI interface port (RJ45) on the LTM E expansion module when attached to the LTM R controller.

The PC can be connected in a 1-to-1 configuration to a single LTM R controller, or in a 1-to-many configuration to multiple controllers.

Connecting to a PC Running SoMove with the TeSys T DTM in 1-to-1 Mode

The diagrams below show a 1-to-1 connection from a PC running SoMove with the TeSys T DTM to the LTM R controller, with and without the LTM E expansion module and the LTM CU control operator unit:





1 PC running SoMove with the TeSys T DTM

2 Cable kit TCSMCNAM3M002P

3 LTM R controller

4 LTM E expansion module

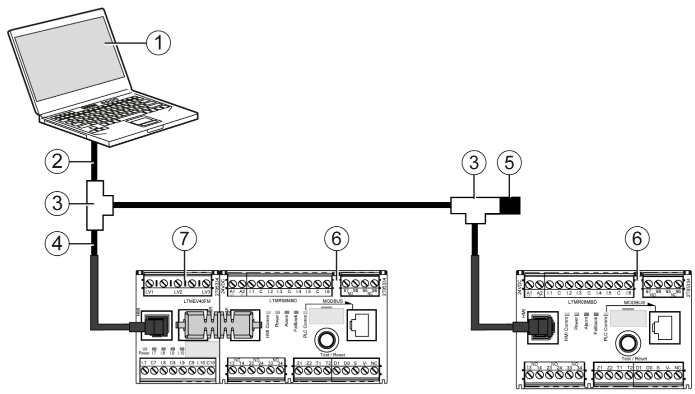
5 LTM CU control operator unit

6 Grounding collar

7 HMI device connection cable LTM9CU••

Connecting to a PC Running SoMove with the TeSys T DTM in 1-to-Many Mode

The diagram below shows a 1-to-many connection from a PC running SoMove with the TeSys T DTM with to up to 8 controllers (with or without the LTM E expansion module):



1 PC running SoMove with the TeSys T DTM

2 Cable kit TCSMCNAM3M002P

3 T-junction boxes VW3 A8 306 TF••

4 Shielded cable with 2 RJ45 connectors VW3 A8 306 R••

5 Line terminator VW3 A8 306 R

6 LTM R controller

7 LTM E expansion module

NOTE: This connection requires defining additional HMI communication addresses because the default address for each LTM R controller is 1.

Connection Accessories

The following table lists connection accessories:

Designation	Description	Reference
T-junction boxes	With 0.3 m (1 ft) integrated cable	VW3 A8 306 TF03
	With 1 m (3.2 ft) integrated cable	VW3 A8 306 TF10
Line terminator for RJ45 connector	R = 150 Ω	VW3 A8 306 R
Cable kit	Length = 2.5 m (8.2 ft) USB to RS-485 converter	TCSMCNAM3M002P
Communication cables	Length = 0.3 m (1 ft)	VW3 A8 306 R03
	Length = 1 m (3.2 ft)	VW3 A8 306 R10
	Length = 3 m (3.2 ft)	VW3 A8 306 R30
HMI device connection cable	Length = 1 m (3.2 ft)	LTM9CU10
	Length = 3 m (9.6 ft)	LTM9CU30

Hardware Connection for the Firmware Update

Overview

This section describes how to physically connect the LTM R controller to a PC running the TeSys T (LTMR) Programmer to update the LTM R controller firmware.

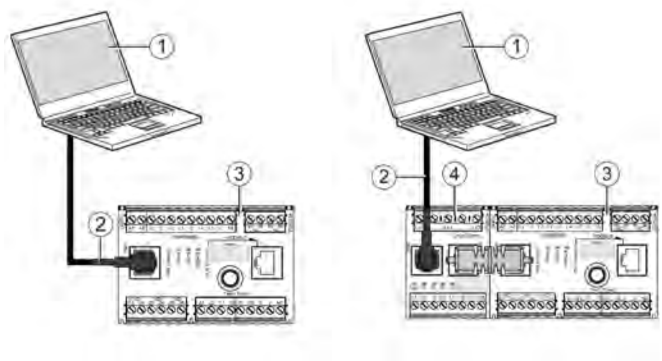
The PC must be connected in a 1-to-1 configuration to the HMI port of the LTM R controller with or without the LTM E expansion module.

An additional connection is necessary to update the LTM R Modbus/TCP firmware.

Do not connect the PC to the HMI port on the LTM CU control operator unit.

Connecting an LTM R controller to a PC Running SoMove with the TeSys T DTM

The diagram below shows the connection with or without the LTM E expansion module for all LTM R controller types except the LTM R Modbus/TCP:



1 PC running SoMove with the TeSys T DTM

2 Cable kit TCSMCNAM3M002P

3 LTM R controller

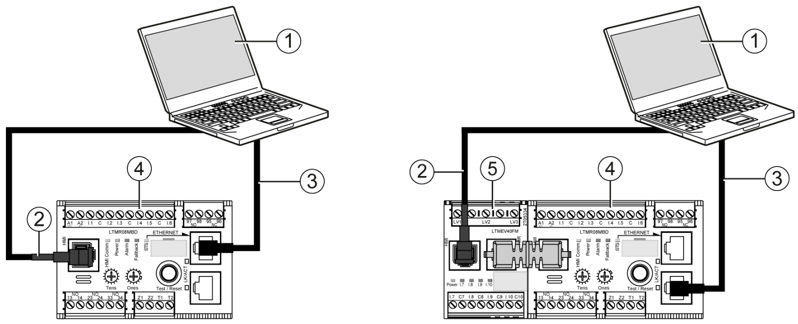
4 LTM E expansion module

To establish a USB connection, follow these steps:

Step	Action
1	Plug the USB connector of the TCSMCNAM3M002P cable into the PC USB port.
2	Plug the RJ45 connector of the TCSMCNAM3M002P cable into the LTM R controller HMI port.
3	Turn on the LTM R controller. The power LED is green.

Connecting an LTM R Modbus/TCP to a PC Running SoMove with the TeSys T DTM

The diagram below shows the connection with or without the LTM E expansion module for the LTM R Modbus/TCP:



1 PC running SoMove with the TeSys T DTM

2 Cable kit TCSMCNAM3M002P

3 Cat 5 shielded or unshielded twisted pair Ethernet cable

4 LTM R controller

5 LTM E expansion module

To establish an additional Ethernet connection, follow these steps:

Step	Action
1	Plug the USB connector of the TCSMCNAM3M002P cable into the PC USB port.
2	Plug the RJ45 connector of the TCSMCNAM3M002P cable into the LTM R controller HMI port.
3	Plug one end of the Ethernet cable into the TeSys T network port.
4	Plug the other end of the Ethernet cable into the Ethernet RJ45 port of the computer.
5	Turn on the LTM R controller. The power LED is green.

Connection Accessories

The following table lists connection accessories:

Designation	Description	Reference
Cable kit	Length = 2.5 m (8.2 ft) USB to RS-485 converter	TCSMCNAM3M002P
Communication cables	Length = 0.3 m (1 ft)	VW3 A8 306 R03
	Length = 1 m (3.2 ft)	VW3 A8 306 R10
	Length = 3 m (3.2 ft)	VW3 A8 306 R30
HMI device connection cable	Length = 1 m (3.2 ft)	VW3 A1 104 R10
	Length = 3 m (9.6 ft)	VW3 A1 104 R30

Establishing and Configuring a Connection for the LTM R Modbus/TCP Controller

Step	Action
1	On the PC, open the network status window and click **Properties**. The network properties window opens.
2	Select **Internet Protocol (TCP/IP)**, and then click **Properties**. The Internet Protocol (TCP/IP) properties window opens.
3	There are 2 possibilities: • If the LTM R controller is a part of a configured network and the IP address is known: configure your PC IP address according to the LTM R controller address. (1) • If the LTM R controller has an unknown or unconfigured IP address: click **Use the following IP address**. Then in the **IP address** field, enter the value **85.16.0.1** and in the **Subnet mask** field, enter **255.0.0.0**.
4	Click **OK** and close all the windows. Stop the procedure (without doing step 5) in the following cases: • The LTM R controller has never been put into service. • The LTM R controller is already configured on a network with a known IP address.
5	Configure the LTM R controller with the default IP address: • either by setting the **Ones** switch on the right to the **Disabled** position on the LTM R controller front panel and executing a power cycle, • or by setting the IP address to 0.0.0.0: ◦ either using a **Clear All** command. This action can be performed from the **Device** menu, ◦ or rotating the **Ones** switch to the **Clear IP** position and executing a power cycle
(1) The fixed and configurable part of an IP network address is defined by the subnet mask. Configure your PC IP address by changing the configurable part to obtain a different IP address than the LTM R controller. The subnet mask must be the same as the LTM R controller.	

NOTE:

- The steps of the procedure may be different depending on the operating system of the PC.
- The default address response starts with 85.16 and finishes with the last 2 bytes (converted in decimal format) of the product MAC address.
- The Ethernet connection can be set with other parameters as long as the configurations of the PC and LTM R controller are made correctly to establish a communication.

Checking the USB Connection

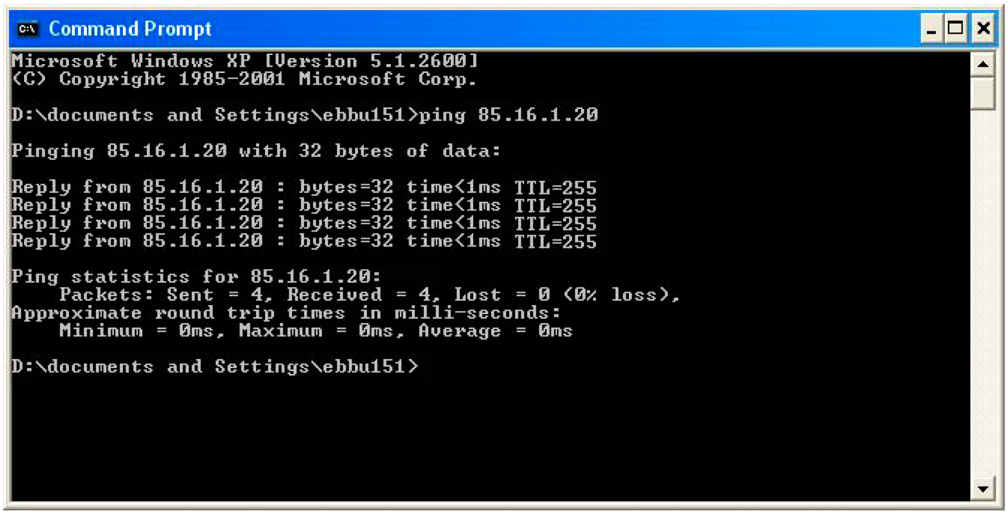
To check the port number of the serial or USB connection, follow these steps:

Step	Action
1	On the PC, open the device manager and expand the **Ports (COM & LPT)** line of the tree. (1)
2	In the expanded tree, the **Communication Port (COMX)** line corresponds to your serial connection and the **TSX C USB 485 (COMX)** line corresponds to the TCSMCNAM3M002P cable connection (where COMX is the number of your communication port).

NOTE: The steps of the procedure may be different depending on the operating system of the PC.

Checking the Ethernet Connection

To check the Ethernet connection of the LTM R Modbus/TCP, follow these steps:

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>On the PC, open a Command Prompt window. (1)</td></tr>
<tr><td>2</td><td>Execute a ping command to the TeSys T default IP address (in our example 85.16.1.20): ping 85.16.1.20.

</td></tr>
<tr><td>3</td><td>Check in the ping statistics that you have received all the packets sent.</td></tr>
</table>

NOTE: The steps of the procedure may be different depending on the operating system of the PC.

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Schneider Electric
800 Federal Street
Andover, MA 01810
USA

888–778–2733

www.se.com

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