Modicon M241 Logic Controller

System Functions and Variables

PLCSystem Library Guide

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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.

About the Book

Document Scope

This document will acquaint you with the system functions and variables offered within the Modicon M241 Logic Controller. The M241 PLCSystem library contains functions and variables to get information from and send commands to the controller system.

This document describes the data type functions and variables of the M241 PLCSystem library.

The following knowledge is required:

- Basic information on the functionality, structure, and configuration of the M241 Logic Controller.
- Programming in the FBD, LD, ST, IL, or CFC language.
- System variables (global variables).

Validity Note

This document has been updated for the release of EcoStruxure™ Machine Expert V2.0.1.

Related Documents

Title of Documentation	Reference Number
EcoStruxure Machine Expert Programming Guide	EIO0000002854 (ENG); EIO0000002855 (FRE); EIO0000002856 (GER); EIO0000002858 (SPA); EIO0000002857 (ITA); EIO0000002859 (CHS)
Modicon M241 Logic Controller Hardware Guide	EIO0000003083 (ENG); EIO0000003084 (FRE); EIO0000003085 (GER); EIO0000003086 (SPA); EIO0000003087 (ITA); EIO0000003088 (CHS)
Modicon M241 Logic Controller Programming Guide	EIO0000003059 (ENG); EIO0000003060 (FRE); EIO0000003061 (GER); EIO0000003062 (SPA); EIO0000003063 (ITA); EIO0000003064 (CHS)

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

Product Related Information

⚠WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop and overtravel stop, power outage and restart.
- 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 unanticipated transmission delays or failures of the link.
- Observe all accident prevention regulations and local safety guidelines.[1]
- Each implementation of this equipment 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" and to NEMA ICS 7.1 (latest edition), "Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems" or their equivalent governing your particular location.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- Only use software approved by Schneider Electric for use with this equipment.
- Update your application program every time you change the physical hardware configuration.

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

M241 System Variables

Overview

This chapter:

- gives an introduction to the system variables, page 10
- describes the system variables, page 13 included with the M241 PLCSystem library

System Variables: Definition and Use

Overview

This section defines system variables and how to implement them in the Modicon M241 Logic Controller.

Understanding System Variables

Introduction

This section describes how system variables are implemented. System variables:

- allow you to access general system information, perform system diagnostics, and command simple actions.
- are structured variables conforming to IEC 61131-3 definitions and naming conventions. You can access the system variables using the IEC symbolic name *PLC_GVL*. Some of the *PLC_GVL* variables are read-only (for example, *PLC_R*) and some are read/write (for example, *PLC_W*).
- are automatically declared as global variables. They have system-wide scope and can be accessed by any Program Organization Unit (POU) in any task.

Naming Convention

The system variables are identified by:

- a structure name that represents the category of system variable. For example, represents a structure name of read-only variables used for the controller diagnostic.
- a set of component names that identifies the purpose of the variable. For example, *i_wVendorID* represents the controller vendor ID.

You can access the system variables by typing the structure name of the variables followed by the name of the component.

Here is an example of system variable implementation:

```
VAR
myCtr_Serial : DWORD;
myCtr_ID : DWORD;
myCtr_FramesRx : UDINT;
END_VAR
myCtr_Serial := PLC_GVL.PLC_R.i_dwSerialNumber;
myCtr_ID := PLC_GVL.PLC.R.i_wVendorID;
myCtr_FramesRx := SERIAL_R[0].i_udiFramesReceivedOK
```

NOTE: The fully-qualified name of the system variable in the example above is *PLC_GVL.PLC_R*. The *PLC_GVL* is implicit when declaring a variable using the **Input Assistant**, but it may also be entered with the prefix. Good programming practice often dictates the use of the fully-qualified variable name in declarations.

System Variables Location

Two system variables are defined for use when programming the controller:

- located variables
- unlocated variables

They are used in EcoStruxure Machine Expert programs according to the *structure_name.component_name* %MW addresses from 0 to 59999 can be accessed directly. Addresses greater than this are considered out of range by EcoStruxure Machine Expert and can only be accessed through the *structure_name.component_name* convention.

The located variables:

- have a fixed location in a static %MW area: %MW60000 to %MW60199 for read-only system variables.
- are accessible through Modbus TCP, Modbus serial, and EtherNet/IP requests both in RUNNING and STOPPED states.

The unlocated variables:

- are not physically located in the %MW area.
- are not accessible through any fieldbus or network requests unless you locate them in the relocation table, and only then these variables can be accessed in RUNNING and STOPPED states. The relocation table uses the following dynamic %MW areas:
  - %MW60200 to %MW61999 for read-only variables
  - %MW62200 to %MW63999 for read/write variables

Using System Variables

Introduction

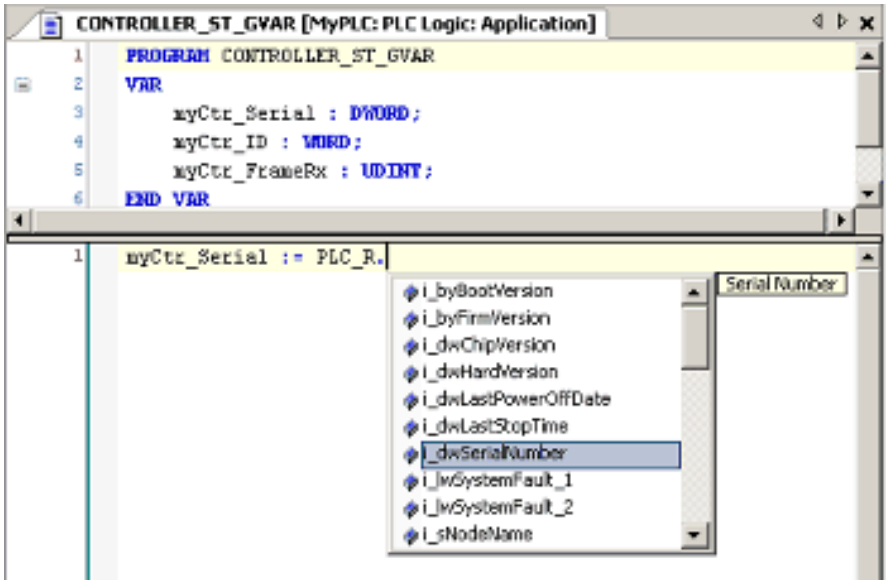
This section describes the steps required to program and to use system variables in EcoStruxure Machine Expert.

System variables are global in the application scope, and you can use them in all the Program Organization Units (POUs) of the application.

System variables do not need to be declared in the Global Variable List (GVL). They are automatically declared from the controller system library.

Using System Variables in a POU

EcoStruxure Machine Expert has an auto-completion feature. In a **POU**, start by entering the system variable structure name (*PLC_R*, *PLC_W*...) followed by a dot. The system variables are displayed in the **Input Assistant**. You can select the desired variable or enter the full name manually.



NOTE: In the example above, after you type the structure name `PLC_R.`, EcoStruxure Machine Expert offers a pop-up menu of possible component names/variables.

Example

The following example shows the use of some system variables:

```
VAR
myCtr_Serial : DWORD;
myCtr_ID : WORD;
myCtr_FramesRx : UDINT;
END_VAR
myCtr_Serial := PLC_R.i_dwSerialNumber;
myCtr_ID := PLC_R.i_wVendorID;
myCtr_FramesRx := SERIAL_R[0].i_udiFramesReceivedOK;
```

PLC_R and *PLC_W* Structures

Overview

This section lists and describes the different system variables included in the *PLC_R* and *PLC_W* structures.

PLC_R: Controller Read-Only System Variables

Variable Structure

This table describes the parameters of the *PLC_R* system variable (*PLC_R_STRUCT* type):

Modbus Address (1)	Variable Name	Type	Comment
60000	*i_wVendorID*	WORD	Controller Vendor ID. 101A hex = Schneider Electric
60001	*i_wProductID*	WORD	Controller Reference ID. **NOTE:** Vendor ID and Reference ID are the components of the Target ID of the controller displayed in the communication settings view (Target ID = 101A XXXX hex).
60002	*i_dwSerialNumber*	DWORD	Controller Serial Number
60004	*i_byFirmVersion*	ARRAY[0..3] OF BYTE	Controller Firmware Version `[aa.bb.cc.dd]`: • i_byFirmVersion[0] = aa • ... • i_byFirmVersion[3] = dd
60006	*i_byBootVersion*	ARRAY[0..3] OF BYTE	Controller Boot Version `[aa.bb.cc.dd]`: • i_byBootVersion[0] = aa • ... • i_byBootVersion[3] = dd
60008	*i_dwHardVersion*	DWORD	Controller Hardware Version.
60010	*i_dwChipVersion*	DWORD	Controller Coprocessor Version.
60012	*i_wStatus*	*PLC_R_STATUS*, page 43	State of the controller.
60013	*i_wBootProjectStatus*	*PLC_R_BOOT_PROJECT_STATUS*, page 42	Returns information about the boot application stored in non-volatile memory.
60014	*i_wLastStopCause*	*PLC_R_STOP_CAUSE*, page 44	Cause of the last transition from *RUN* to another state.
60015	*i_wLastApplicationError*	*PLC_R_APPLICATION_ERROR*, page 41	Cause of the last controller exception.
60016	*i_lwSystemFault_1*	LWORD	Bit field `FFFF FFFF FFFF FFFF` hex indicates no error detected. A bit at low level means that an error has been detected: • bit 0 = Expert I/O error detected • bit 1 = TM3 error detected • bit 2 = Ethernet IF1 error detected • bit 3 = Ethernet IF2 error detected • bit 4 = Serial 1 in overcurrent error detected • bit 5 = Serial 2 error detected • bit 6 = CAN 1 error detected • bit 7 = Cartridge 1 error detected • bit 8 = Cartridge 2 error detected • bit 9 = TM4 error detected • bit 10 = SD Card error detected • bit 11 = Firewall error detected • bit 12 = DHCP server error detected • bit 13 = OPC UA server error detected

Modbus Address (1)	Variable Name	Type	Comment
60020	*i_lwSystemFault_2*	LWORD	Bit field FFFF hex indicates no error detected. If *i_wIOStatus1* = *PLC_R_IO_SHORTCUT_FAULT*, the meaning of *i_lwSystemFault_2* is: • bit 0 = 0: short-circuit detected in output group 0 (Q0...Q1) • bit 1 = 0: short-circuit detected in output group 1 (Q2...Q3) • bit 2 = 0: short-circuit detected in output group 2 (Q4...Q7) • bit 3 = 0: short-circuit detected in output group 3 (Q8...Q11) • bit 4 = 0: short-circuit detected in output group 4 (Q12...Q15)
60024	*i_wIOStatus1*	*PLC_R_IO_STATUS*, page 42	Embedded Expert I/O status.
60025	*i_wIOStatus2*	*PLC_R_IO_STATUS*, page 42	TM3 I/O status.
60026	*i_wClockBatterystatus*	WORD	Status of the battery of the RTC: • 0 = Battery change needed • 100 = Battery fully charged Other values (1...99) represents the percentage of charge. For example, if the value is 75, it represents that the battery charge is 75%.
60028	*i_dwAppliSignature1*	DWORD	First DWORD of 4 DWORD signature (16 bytes total). The application signature is generated by the software during build.
60030	*i_dwAppliSignature2*	DWORD	Second DWORD of 4 DWORD signature (16 bytes total). The application signature is generated by the software during build.
60032	*i_dwAppliSignature3*	DWORD	Third DWORD of 4 DWORD signature (16 bytes total). The application signature is generated by the software during build.
60034	*i_dwAppliSignature4*	DWORD	Fourth DWORD of 4 DWORD signature (16 bytes total). The application signature is generated by the software during build.
n/a	*i_sVendorName*	STRING(31)	Name of the vendor: “Schneider Electric”.
n/a	*i_sProductRef*	STRING(31)	Reference of the controller.
n/a	*i_sNodeName*	STRING(99)	Node name on EcoStruxure Machine Expert Network.
n/a	*i_dwLastStopTime*	DWORD	The time of the last detected *STOP* in seconds beginning with January 1, 1970 at 00:00 UTC.
n/a	*i_dwLastPowerOffDate*	DWORD	The date and time of the last detected power off in seconds beginning with January 1, 1970 at 00:00 UTC. **NOTE:** Convert this value into date and time by using the function *SysTimeRtcConvertUtcToDate*. For more information about Time and Date conversion, refer to the Systime Library Guide (see EcoStruxure Machine Expert, Getting & Setting Real Time Clock, SysTimeRtc and SysTimeCore Library Guide).
n/a	*i_uiEventsCounter*	UINT	Number of external events detected on inputs configured for external event detection since the last cold start. Reset by a Cold Start or by the PLC_W.q_wResetCounterEvent command.
n/a	*i_wTerminalPortStatus*	*PLC_R_TERMINAL_PORT_STATUS*, page 45	Status of the USB Programming Port (USB Mini-B).
n/a	*i_wSdCardStatus*	*PLC_R_SDCARD_STATUS*, page 42	Status of the SD card.
n/a	*i_wUsrFreeFileHdl*	WORD	Number of available File Handles. A File Handle is the resource allocated by the system when you open a file.

Modbus Address (1)	Variable Name	Type	Comment
n/a	*i_udiUsrFsTotalBytes*	UDINT	User FileSystem total memory size (in bytes). It is the size of the non-volatile memory for the directory `/usr/`.
n/a	*i_udiUsrFsFreeBytes*	UDINT	User FileSystem free memory size (in bytes).
n/a	*i_uiTM3BusState*	*PLC_R_TM3_BUS_STATE*, page 45	TM3 bus state. *i_uiTM3BusState* can have the following values: • 1: TM3_CONF_ERROR Configuration mismatch between physical configuration and EcoStruxure Machine Expert configuration. • 3: TM3_OK Physical configuration matches EcoStruxure Machine Expert configuration. • 4: TM3_POWER_SUPPLY_ERROR TM3 bus is not powered (for example when the Logic Controller is powered by USB).
n/a	*i_ExpertIO_RunStop_Input*	BYTE	Run/Stop input location is: • 16...FF hex if the expert I/O is not configured • 0 for `%IX0.0` • 1 for `%IX0.1` • 2 for `%IX0.2` • ...and so on.
n/a	*i_x10msClk*	BOOL	TimeBase bit of 10 ms. This variable is toggling On/Off with period = 10 ms. The value toggles when the logic controller is in Stop and in Run state.
n/a	*i_x100msClk*	BOOL	TimeBase bit of 100 ms. This variable is toggling On/Off with period = 100 ms. The value toggles when the logic controller is in Stop and in Run state.
n/a	*i_x1sClk*	BOOL	TimeBase bit of 1 s. This variable is toggling On/Off with period = 1 s. The value toggles when the logic controller is in Stop and in Run state.
(1) means that the Modbus Address is not accessible through the application. **n/a** means there is no pre-defined Modbus address mapping for this system variable.			

PLC_W: Controller Read/Write System Variables

Variable Structure

This table describes the parameters of the *PLC_W* system variable (*PLC_W_STRUCT* type):

%MW	Variable Name	Type	Comment
n/a	*q_wResetCounterEvent*	WORD	Transition from 0 to 1 resets the events counter (*PLC_R.i_uiEventsCounter*). To reset the counter again, it is necessary to write 0 to this variable before another transition from 0 to 1 can take place.
n/a	*q_uiOpenPLCControl*	UINT	When the value of the variable passes from 0 to 6699, the command previously written in the following *PLC_W.q_wPLCControl* is executed.
n/a	*q_wPLCControl*	*PLC_W_COMMAND*, page 45	Controller RUN / STOP command executed when the system variable *PLC_W.q_uiOpenPLCControl* value passes from 0 to 6699.
n/a means that there is no pre-defined %MW mapping for this system variable			

SERIAL_R and *SERIAL_W* Structures

Overview

This section lists and describes the different system variables included in the *SERIAL_R* and *SERIAL_W* structures.

SERIAL_R[0...1]: Serial Line Read-Only System Variables

Introduction

SERIAL_R is an array of two *SERIAL_R_STRUCT* type. Each element of the array returns diagnostic system variables for the corresponding serial line.

For the M241 Logic Controller:

- *Serial_R[0]* refers to the serial line 1
- *Serial_R[1]* refers to the serial line 2

Variable Structure

This table describes the parameters of the *SERIAL_R[0...1]* system variables:

%MW	Variable Name	Type	Comment
Serial Line			
n/a	*i_udiFramesTransmittedOK*	UDINT	Number of frames successfully transmitted.
n/a	*i_udiFramesReceivedOK*	UDINT	Number of frames received without any errors detected.
n/a	*i_udiRX_MessagesError*	UINT	Number of frames received with errors detected (checksum, parity).
Modbus Specific			
n/a	*i_uiSlaveExceptionCount*	UINT	Number of Modbus exception responses returned by the logic controller.
n/a	*i_udiSlaveMsgCount*	UINT	Number of messages received from the Master and addressed to the logic controller.
n/a	*i_uiSlaveNoRespCount*	UINT	Number of Modbus broadcast requests received by the logic controller.
n/a	*i_uiSlaveNakCount*	UINT	Not used
n/a	*i_uiSlaveBusyCount*	UINT	Not used
n/a	*i_uiCharOverrunCount*	UINT	Number of character overruns.
n/a means that there is no predefined %MW mapping for this system variable **Not used** means that the variable is not maintained by the system, and that if the value of the variable is non-zero, it should be considered extraneous			

The *SERIAL_R* counters are reset on:

- Download.
- Controller reset.
- *SERIAL_W[x].q_wResetCounter* command.
- Reset command by Modbus request function code number 8.

SERIAL_W[0...1]: Serial Line Read/Write System Variables

Introduction

SERIAL_W is an array of two *SERIAL_W_STRUCT* type. Each element of the array resets the *SERIAL_R* system variables for the corresponding serial line to be reset.

For the M241 Logic Controller:

- *Serial_W[0]* refers to the serial line 1
- *Serial_W[1]* refers to the serial line 2

Variable Structure

This table describes the parameters of the *SERIAL_W[0...1]* system variable:

%MW	Variable Name	Type	Comment
n/a	*q_wResetCounter*	WORD	Transition from 0 to 1 resets all *SERIAL_R[0...1]* counters. To reset the counters again, it is necessary to write 0 to this variable before another transition from 0 to 1 can take place.
n/a means that there is no predefined %MW mapping for this system variable.			

ETH_R and *ETH_W* Structures

Overview

This section lists and describes the different system variables included in the *ETH_R* and *ETH_W* structures.

ETH_R: Ethernet Port Read-Only System Variables

Variable Structure

This table describes the parameters of the *ETH_R* system variable (*ETH_R_STRUCT* type):

%MW	Variable Name	Type	Comment
60050	*i_byIPAddress*	ARRAY[0..3] OF BYTE	IP address `[aaa.bbb.ccc.ddd]`: • i_byIPAddress[0] = aaa • ... • i_byIPAddress[3] = ddd
60052	*i_bySubNetMask*	ARRAY[0..3] OF BYTE	Subnet Mask `[aaa.bbb.ccc.ddd]`: • i_bySub-netMask[0] = aaa • ... • i_bySub-netMask[3] = ddd
60054	*i_byGateway*	ARRAY[0..3] OF BYTE	Gateway address `[aaa.bbb.ccc.ddd]`: • i_byGateway[0] = aaa • ... • i_byGateway[3] = ddd
60056	*i_byMACAddress*	ARRAY[0..5] OF BYTE	MAC address `[aa.bb.cc.dd.ee.ff]`: • i_byMACAddress[0] = aa • ... • i_byMACAddress[5] = ff
60059	*i_sDeviceName*	STRING(15)	Name used to get IP address from server.
n/a	*i_wIpMode*	*ETH_R_IP_MODE*, page 47	Method used to obtain an IP address.
n/a	*i_byFDRServerIPAddress*	ARRAY[0..3] OF BYTE	The IP address `[aaa.bbb.ccc.ddd]` of the DHCP or BootP server: • i_byFDRServerIPAddress[0] = aaa • ... • i_byFDRServerIPAddress[3] = ddd Equals 0.0.0.0 if Stored IP or Default IP used.
n/a	*i_udiOpenTcpConnections*	UDINT	Number of open TCP connections.
n/a	*i_udiFramesTransmittedOK*	UDINT	Number of frames successfully transmitted. Reset at Power ON or with reset command `ETH_W.q_wResetCounter`.
n/a	*i_udiFramedReceivedOK*	UDINT	Number of frames successfully received. Reset at Power ON or with reset command `ETH_W.q_wResetCounter`.
n/a	*i_udiTransmitBufferErrors*	UDINT	Numbers of frames transmitted with detected errors. Reset at Power ON or with reset command `ETH_W.q_wResetCounter`.
n/a	*i_udiReceiveBufferErrors*	UDINT	Numbers of frames received with detected errors. Reset at Power ON or with reset command `ETH_W.q_wResetCounter`.
n/a	*i_wFrameSendingProtocol*	*ETH_R_FRAME_PROTOCOL*, page 47	Ethernet protocol configured for frames sending (IEEE 802.3 or Ethernet II).
n/a	*i_wPortALinkStatus*	*ETH_R_PORT_LINK_STATUS*, page 48	Link of the Ethernet Port (0 = No Link, 1 = Link connected to another Ethernet device).
n/a	*i_wPortASpeed*	*ETH_R_PORT_SPEED*, page 48	Ethernet Port network speed (10Mb/s, 100Mb/s).
n/a	*i_wPortADuplexStatus*	*ETH_R_PORT_DUPLEX_STATUS*, page 47	Ethernet Port duplex status (0 = Half or 1 = Full duplex).
n/a	*i_udiPortACollisions*	UDINT	Number of frames involved in one or more collisions and subsequently transmitted successfully. Reset at Power ON or with reset command `ETH_W.q_wResetCounter`.
n/a	*i_byIPAddress_If2*	ARRAY[0..3] OF BYTE	IP address of the TM4 expansion module.
n/a	*i_bySubNetMask_If2*	ARRAY[0..3] OF BYTE	Subnet Mask of the TM4 expansion module.
n/a	*i_byGateway_If2*	ARRAY[0..3] OF BYTE	Gateway address of the TM4 expansion module.

%MW	Variable Name	Type	Comment
n/a	*i_byMACAddress_If2*	ARRAY[0..3] OF BYTE	MAC address of theTM4 expansion module.
n/a	*i_sDeviceName_If2*	STRING(15)	Name used to get IP address of the TM4 expansion module.
n/a	*i_wIpMode_If2*	*ETH_R_IP_MODE*, page 47	Method used to obtain the IP address of the TM4 expansion module.
n/a	*i_wPortALinkStatus_If2*	*ETH_R_PORT_LINK_STATUS*, page 48	Link of the TM4 expansion module Ethernet Port: • 0: No link • 1: Link connected to another Ethernet device
n/a	*i_wPortASpeed_If2*	*ETH_R_PORT_SPEED*, page 48	Ethernet Port network speed of the TM4 expansion module (10Mb/s or 100Mb/s).
n/a	*i_wPortADuplexStatus_If2*	*ETH_R_PORT_DUPLEX_STATUS*, page 47	Ethernet Port duplex status of the TM4 expansion module: • 0: Half • 1: Full duplex
n/a	*i_wPortAIpStatus_If2*	*ETH_R_PORT_IP_STATUS*, page 48	Ethernet TCP/IP port stack status of the TM4 expansion module.
Modbus TCP/IP Specific			
n/a	*i_udiModbusMessageTransmitted*	UDINT	Number of Modbus messages transmitted. Reset at Power ON or with reset command `ETH_W.q_wResetCounter`.
n/a	*i_udiModbusMessageReceived*	UDINT	Number of Modbus messages received. Reset at Power ON or with reset command `ETH_W.q_wResetCounter`.
n/a	*i_udiModbusErrorMessage*	UDINT	Modbus detected error messages transmitted and received. Reset at Power ON or with reset command `ETH_W.q_wResetCounter`.
EtherNet/IP Specific			
n/a	*i_udiETHIP_IOMessagingTransmitted*	UDINT	EtherNet/IP Class 1 frames transmitted. Reset at Power ON or with reset command `ETH_W.q_wResetCounter`.
n/a	*i_udiETHIP_IOMessagingReceived*	UDINT	EtherNet/IP Class 1 frames received. Reset at Power ON or with reset command `ETH_W.q_wResetCounter`.
n/a	*i_udiUCMM_Request*	UDINT	EtherNet/IP Unconnected Messages received. Reset at Power ON or with reset command `ETH_W.q_wResetCounter`.
n/a	*i_udiUCMM_Error*	UDINT	EtherNet/IP invalid Unconnected Messages received. Reset at Power ON or with reset command `ETH_W.q_wResetCounter`.
n/a	*i_udiClass3_Request*	UDINT	EtherNet/IP Class 3 requests received. Reset at Power ON or with reset command `ETH_W.q_wResetCounter`.
n/a	*i_udiClass3_Error*	UDINT	EtherNet/IP invalid class 3 requests received. Reset at Power ON or with reset command `ETH_W.q_wResetCounter`.
n/a	*i_uiAssemblyInstanceInput*	UINT	Input Assembly Instance number. See the appropriate Programming Guide of your controller for more information.
n/a	*i_uiAssemblyInstanceInputSize*	UINT	Input Assembly Instance size. See the appropriate Programming Guide of your controller for more information.
n/a	*i_uiAssemblyInstanceOutput*	UINT	Output Assembly Instance number. See the appropriate Programming Guide of your controller for more information.
n/a	*i_uiAssemblyInstanceOutputSize*	UINT	Output Assembly Instance size. See the appropriate Programming Guide of your controller for more information.
n/a	*i_uiETHIP_ConnectionTimeouts*	UINT	Number of connection timeouts. Reset at Power ON or with reset command `ETH_W.q_wResetCounter`.
n/a	*i_ucEipRunIdle*	*ETH_R_RUN_IDLE*, page 48	Run (value = 1)/Idle(value = 0) flag for EtherNet/IP class 1 connection.

%MW	Variable Name	Type	Comment
n/a	*i_byMasterIpTimeouts*	BYTE	Ethernet Modbus TCP Master timeout events counter. Reset at Power ON or with reset command `ETH_W.q_wResetCounter`.
n/a	*i_byMasterIpLost*	BYTE	Ethernet Modbus TCP Master link status: 0 = link OK, 1 = link lost.
n/a	*i_wPortAIpStatus*	*ETH_R_PORT_IP_STATUS*, page 48	Ethernet TCP/IP port stack status.
n/a means that there is no predefined %MW mapping for this system variable.			

ETH_W: Ethernet Port Read/Write System Variables

Variable Structure

This table describes the parameters of the *ETH_W* system variable (*ETH_W_STRUCT* type):

%MW	Variable Name	Type	Comment
n/a	*q_wResetCounter*	WORD	Transition from 0 to 1 resets all *ETH_R* counters. To reset again, it is necessary to write 0 to this variable before another transition from 0 to 1 can take place.
n/a means that there is no predefined %MW mapping for this system variable.			

TM3_MODULE_R Structure

Overview

This section lists and describes the different system variables included in the *TM3_MODULE_R* structure.

TM3_MODULE_R[0...13]: TM3 Modules Read-Only System Variables

Introduction

The *TM3_MODULE_R* is an array of 14 *TM3_MODULE_R_STRUCT* type. Each element of the array returns diagnostic system variables for the corresponding TM3 expansion module.

For the Modicon M241 Logic Controller:

- *TM3_MODULE_R[0]* refers to the TM3 expansion module 0
- ...
- *TM3_MODULE_R[13]* refers to the TM3 expansion module 13

Variable Structure

The following table describes the parameters of the *TM3_MODULE_R[0...13]* system variable:

%MW	Var Name	Type	Comment
n/a	*i_wProductID*	WORD	TM3 expansion module ID.
n/a	*i_wModuleState*	*TM3_MODULE_STATE*, page 49	Describes the state of the TM3 module.
n/a means that there is no predefined %MW mapping for this system variable.			

TM3_BUS_W Structure

Overview

This section lists and describes the different system variables included in the *TM3_BUS_W* structure.

TM3_BUS_W: TM3 Bus System Variables

Variable Structure

This table describes the parameters of the *TM3_BUS_W* system variable (*TM3_BUS_W_STRUCT* type):

Var Name	Type	Comment
q_wIOBusErrPassiv	*TM3_BUS_W_IOBUSERRMOD*	When set to *ERR_ACTIVE* (the default), bus errors detected on TM3 expansion modules stop I/O exchanges. When set to *ERR_PASSIVE*, passive I/O error handing is used: the controller attempts to continue data bus exchanges.
q_wIOBusRestart	*TM3_BUS_W_IOBUSINIT*	When set to 1, restarts the I/O expansion bus. This is only necessary when *q_wIOBusErrPassiv* is set to *ERR_ACTIVE* and at least one bit of *TM3_MODULE_R[i] .i_wModuleState* is set to *TM3_BUS_ERROR*.

For more information, refer to I/O Configuration General Description (see Modicon M241 Logic Controller, Programming Guide).

PROFIBUS_R Structure

PROFIBUS_R: PROFIBUS Read-Only System Variables

Variable Structure

This table describes the parameters of the *PROFIBUS_R* system variable (*PROFIBUS_R_STRUCT* type):

%MW	Variable Name	Type	Comment
n/a	*i_wPNOIdentifier*	WORD	Slave identification code (1...126).
n/a	*i_wBusAdr*	UINT	PROFIBUS slave address.
n/a	*i_CommState*	UDINT	Value representing the state of the PROFIBUS module: • 0x00: Undeterminable • 0x01: Not configured • 0x02: Stop • 0x03: Idle • 0x04: Operate
n/a	*i_CommError*	UDINT	If the value is non-zero, a communication error was detected by the Profibus Module indicated by an error code (see TM4 Expansion Modules - Programming Guide).
n/a	*i_ErrorCount*	UDINT	Communication error counter.
n/a means that there is no predefined %MW mapping for this system variable.			

CART_R Structure

CART_R_STRUCT: Cartridge Read-Only System Variables

Variable Structure

The following table describes the parameters of the *CART_R_STRUCT* system variable:

%MW	Var Name	Type	Comment
n/a	*i_uiModuleId*	CART_R_MODULE_ID, page 50	Module ID
n/a	*i_uifirmwareVersion*	UINT	Firmware version
n/a	*i_udiCartState*	CART_R_STATE, page 50	Cartridge state
n/a means that there is no predefined %MW mapping for this system variable.			

M241 System Functions

Overview

This chapter describes the system functions included in the M241 PLCSystem library.

M241 Read Functions

Overview

This section describes the read functions included in the M241 PLCSystem library.

GetImmediateFastInput: Read Input of an Embedded Expert I/O

Function Description

This function returns the value of the input, which may be different from the logical value of that input. The value is read directly from the hardware at function call time. Only I0 to I7 can be accessed through this function.

Graphical Representation

IL and ST Representation

To see the general representation in IL or ST language, refer to the chapter *Function and Function Block Representation*, page 54.

I/O Variable Description

The following table describes the input variables:

Input	Type	Comment
Block	INT	Not used.
Input	INT	Input Index to read from 0...7.

The following table describes the output variable:

Output	Type	Comment
GetImmediateFastInput	BOOL	Value of the input <*Input*> – FALSE/ TRUE.

The following table describes the input/output variables:

Input/Output	Type	Comment
Error	BOOL	FALSE= operation is successful. TRUE= operation error, the function returns an invalid value.
ErrID	*IMMEDIATE_ERR_TYPE*, page 50	Operation error code when Error is TRUE.

GetRtc: Get Real Time Clock

Function Description

This function returns RTC time in seconds in UNIX format (time expired in seconds since January 1, 1970 at 00:00 UTC).

Graphical Representation

IL and ST Representation

To see the general representation in IL or ST language, refer to the chapter *Function and Function Block Representation*, page 54.

I/O Variable Description

The following table describes the I/O variable:

Output	Type	Comment
GetRtc	DINT	RTC in seconds in UNIX format.

Example

The following example describes how to get the RTC value:

```
VAR
MyRTC : DINT := 0;
END_VAR
MyRTC := GetRtc();
```

IsFirstMastColdCycle: Indicate if this Cycle is the First MAST Cold Start Cycle

Function Description

This function returns TRUE during the first MAST cycle after a cold start (first cycle after download or reset cold).

Graphical Representation

IL and ST Representation

To see the general representation in IL or ST language, refer to the chapter *Function and Function Block Representation*, page 54.

I/O Variable Description

The table describes the output variable:

Output	Type	Comment
IsFirstMastColdCycle	BOOL	TRUE during the first MAST task cycle after a cold start.

Example

Refer to the function *IsFirstMastCycle*, page 25.

IsFirstMastCycle: Indicate if this Cycle is the First MAST Cycle

Function Description

This function returns TRUE during the first MAST cycle after a start.

Graphical Representation

IL and ST Representation

To see the general representation in IL or ST language, refer to the chapter *Function and Function Block Representation*, page 54.

I/O Variable Description

Output	Type	Comment
IsFirstMastCycle	BOOL	TRUE during the first MAST task cycle after a start.

Example

This example describes the three functions *IsFirstMastCycle*, *IsFirstMastColdCycle* and *IsFirstMastWarmCycle* used together.

Use this example in MAST task. Otherwise, it may run several times or possibly never (an additional task might be called several times or not called during 1 MAST task cycle):

```
VAR
MyIsFirstMastCycle : BOOL;
MyIsFirstMastWarmCycle : BOOL;
MyIsFirstMastColdCycle : BOOL;
END_VAR
MyIsFirstMastWarmCycle := IsFirstMastWarmCycle();
MyIsFirstMastColdCycle := IsFirstMastColdCycle();
MyIsFirstMastCycle := IsFirstMastCycle();
IF (MyIsFirstMastWarmCycle) THEN
```

```
(*This is the first Mast Cycle after a Warm Start: all
variables are set to their initialization values except the
Retain variables*)
(*=> initialize the needed variables so that your
application runs as expected in this case*)
END_IF;
IF (MyIsFirstMastColdCycle) THEN
(*This is the first Mast Cycle after a Cold Start: all
variables are set to their initialization values including
the Retain Variables*)
(*=> initialize the needed variables so that your
application runs as expected in this case*)
END_IF;
IF (MyIsFirstMastCycle) THEN
(*This is the first Mast Cycle after a Start, i.e. after a
Warm or Cold Start as well as STOP/RUN commands*)
(*=> initialize the needed variables so that your
application runs as expected in this case*)
END_IF;
```

IsFirstMastWarmCycle: Indicate if this Cycle is the First MAST Warm Start Cycle

Function Description

This function returns TRUE during the first MAST cycle after a warm start.

Graphical Representation

IL and ST Representation

To see the general representation in IL or ST language, refer to the chapter *Function and Function Block Representation*, page 54.

I/O Variable Description

This table describes the output variable:

Output	Type	Comment
IsFirstMastWarmCycle	BOOL	TRUE during the first MAST task cycle after a warm start.

Example

Refer to the function *IsFirstMastCycle*, page 25.

M241 Write Functions

Overview

This section describes the write functions included in the M241 PLCSystem library.

InhibitBatLed: Enables or Disable the Battery Led

Function Description

This function enables or disables the display of the battery LED indicator, regardless of its charge level.

Graphical Representation

IL and ST Representation

To see the general representation in IL or ST language, refer to the chapter *Function and Function Block Representation*, page 54.

I/O Variable Description

The following table describes the input variable:

Input	Type	Comment
Inhibit	BOOL	If *TRUE*, disables the display of the battery LED. If *FALSE*, enables the display of the battery LED.

The following table describes the output variable:

Output	Type	Comment
InhibitBatLed	INT	A value of 0 indicates that no error was detected while executing the function block. A non-zero indicates that an error was detected.

Example

This example describes how to disable the battery led display:

```
(* Disable Battery LED Information *)
SEC.InhibitBatLed(TRUE);
```

PhysicalWriteFastOutputs: Write Fast Output of an Embedded Expert I/O

Function Description

This function writes a state to the Q0 to Q3 outputs at function call time.

Graphical Representation

IL and ST Representation

To see the general representation in IL or ST language, refer to the chapter *Function and Function Block Representation*, page 54.

I/O Variable Description

The following table describes the input variables:

Input	Type	Comment
Q0Value	BOOL	Requested value for the output 0.
Q1Value	BOOL	Requested value for the output 1.
Q2Value	BOOL	Requested value for the output 2.
Q3Value	BOOL	Requested value for the output 3.

The following table describes the output variable:

Output	Type	Comment
PhysicalWriteFastOutputs	WORD	Output value of the function.

NOTE: Only the first 4 bits of the output value are significant and used as a bit field to indicate if the output is written.

If the bit corresponding to the output is 1, the output is written successfully.

If the bit corresponding to the output is 0, the output is not written because it is already used by an expert function.

If the bit corresponding to the output is 1111 bin, all of the 4 outputs are written correctly.

If the bit corresponding to the output is 1110 bin, Q0 is not written because it is used by a frequency generator.

SetRTCDrift: Set Compensation Value to the RTC

Function Description

This function accelerates or slows down the frequency of the RTC to give control to the application for RTC compensation, depending on the operating environment (temperature, …). The compensation value is given in seconds per week. It can be positive (accelerate) or negative (slow down).

NOTE: The *SetRTCDrift* function must be called only once. Each new call replaces the compensation value by the new one. The value is kept in the controller hardware while the RTC is powered by the main supply or by the battery. If both battery and power supply are removed, the RTC compensation value is not available.

Graphical Representation

IL and ST Representation

To see the general representation in IL or ST language, refer to the chapter *Function and Function Block Representation*, page 54.

I/O Variables Description

This table describes the input parameters:

Inputs	Type	Comment
RtcDrift	SINT(-36...+73)	Correction in seconds per week (-36 ... +73).

NOTE: The parameters *Day*, *Hour*, and *Minute* are used only to ensure backwards compatibility.

NOTE: If the value entered for *RtcDrift* exceeds the limit value, the controller firmware sets the value to its maximum value.

This table describes the output variable:

Output	Type	Comment
SetRTCDrift	*RTCSETDRIFT_ERROR*, page 51	Returns `RTC_OK` (00 hex) if command is correct otherwise returns the ID code of the detected error.

Example

In this example, the function is called only once during the first MAST task cycle. It accelerates the RTC by 4 seconds a week (18 seconds a month).

```
VAR
MyRTCDrift : SINT (-36...+73) := 0;
MyDay : DAY_OF_WEEK;
MyHour : HOUR;
MyMinute : MINUTE;
END_VAR
IF IsFirstMastCycle() THEN
MyRTCDrift := 4;
MyDay := 0;
MyHour := 0;
MyMinute := 0;
SetRTCDrift(MyRTCDrift, MyDay, MyHour, MyMinute);
END_IF
```

M241 User Functions

Overview

This section describes the *FB_Control_Clone*, *DataFileCopy* and *ExecuteScript* functions included in the M241 PLCSystem library.

FB_ControlClone: Clone the Controller

Function Block Description

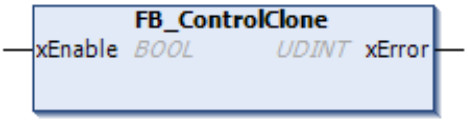
Cloning is by default possible by SD card or **Controller Assistant**. When user rights are enabled and the View right **ExternalCmd** is denied for the **ExternalMedia** group, the cloning function is not allowed. In this case, the function block enables cloning functionality one time on the next controller power on.

NOTE: You can choose whether user rights are included in the clone on the **Clone Management** page of the Web server (see Modicon M241 Logic Controller, Programming Guide).

This table shows how to set the function block and the user rights:

Function block setting	When user rights enabled	When user rights disabled
xEnable = 1	Cloning is allowed	Cloning is allowed
xEnable = 0	Cloning is not allowed	Cloning is not allowed

Graphical Representation



IL and ST Representation

To see the general representation in IL or ST language, refer to the chapter *Function and Function Block Representation*, page 54.

I/O Variable Description

The following table describes the input variables:

Input	Type	Comment
xEnable	BOOL	If *TRUE*, enables the cloning functionality one time. If *FALSE*, disables the cloning functionality.

The following table describes the output variables:

Output	Type	Comment
xError	UDINT	A value of 0 indicates that no error was detected while executing the function block. A non-zero indicates that an error was detected.

DataFileCopy: Copy File Commands

Function Block Description

This function block copies memory data to a file and vice versa. The file is located either within the internal file system or an external file system (SD card).

The *DataFileCopy* function block can:

- Read data from a formatted file or
- Copy data from memory to a formatted file. For further information, refer to Non-Volatile Memory Organization (see Modicon M241 Logic Controller, Programming Guide).

Graphical Representation

IL and ST Representation

To see the general representation in IL or ST language, refer to the chapter *Function and Function Block Representation*, page 54.

I/O Variable Description

This table describes the input variables:

Input	Type	Comment
xExecute	BOOL	On rising edge, starts the function block execution. On falling edge, resets the outputs of the function block when any ongoing execution terminates. **NOTE:** With the falling edge, the function continues until it concludes its execution and updates its outputs. The outputs are retained for one cycle and reset.
sFileName	STRING	File name without extension (the extension *.DTA* is automatically added). Use only a...z, A...Z, 0...9 alphanumeric characters.
xRead	BOOL	TRUE: copy data from the file identified by *sFileName* to the internal memory of the controller. FALSE: copy data from the internal memory of the controller to the file identified by *sFileName*.
xSecure	BOOL	TRUE: The MAC address is always stored in the file. Only a controller with the same MAC address can read from the file. FALSE: Another controller with the same type of memory can read from the file.
iLocation	INT	0: the file location is */usr/DTA* in internal file system. 1: the file location is */usr/DTA* in external file system (SD card). **NOTE:** If the file does not already exist in the directory, the file is created.

uiSize	UINT	Indicates the size in bytes. Maximum is 65534 bytes.
		Only use addresses of variables conforming to IEC 61131-3 (variables, arrays, structures), for example:
		`Variable : int;`
		`uiSize := SIZEOF (Variable);`

dwAdd	DWORD	Indicates the address in the memory that the function will read from or write to.
		Only use addresses of variables conforming to IEC 61131-3 (variables, arrays, structures), for example:
		`Variable : int;`
		`dwAdd := ADR (Variable);`

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

Verify that the memory location is of the correct size and the file is of the correct type before copying the file to memory.

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

This table describes the output variables:

Output	Type	Comment
xDone	BOOL	`TRUE` = indicates that the action is successfully completed.
xBusy	BOOL	`TRUE` = indicates that the function block is running.
xError	BOOL	`TRUE` = indicates that an error is detected and the function block aborted the action.
eError	*DataFileCopyError*, page 46	Indicates the type of the data file copy detected error.

NOTE: If you modify data within the memory (variables, arrays, structures) used to write the file, a CRC integrity error results.

Example

This example describes how to copy file commands:

```
VAR
LocalArray : ARRAY [0..29] OF BYTE;
myFileName: STRING := 'exportfile';
EXEC_FLAG: BOOL;
DataFileCopy: DataFileCopy;
END_VAR
DataFileCopy(
xExecute:= EXEC_FLAG,
sFileName:= myFileName,
xRead:= FALSE,
xSecure:= FALSE,
iLocation:= DFCL_INTERNAL,
uiSize:= SIZEOF(LocalArray),
dwAdd:= ADR(LocalArray),
xDone=> ,
xBusy=> ,
xError=> ,
eError=> );
```

ExecuteScript: Run Script Commands

Function Block Description

This function block can run the following SD card script commands:

- *Download*
- *Upload*
- *SetNodeName*
- *Delete*
- *Reboot*
- *ChangeModbusPort*

For information on the required script file format, refer to Script Files for SD Cards (see Modicon M241 Logic Controller, Programming Guide).

Graphical Representation

IL and ST Representation

To see the general representation in IL or ST language, refer to the chapter *Function and Function Block Representation*, page 54.

I/O Variable Description

This table describes the input variables:

Input	Type	Comment
xExecute	BOOL	On detection of a rising edge, starts the function block execution. On detection of a falling edge, resets the outputs of the function block when any on-going execution terminates. **NOTE:** With the falling edge, the function continues until it concludes its execution and updates its outputs. The outputs are retained for one cycle and reset.
sCmd	STRING	SD card script command syntax. Simultaneous command executions are not allowed: if a command is being executed from another function block or from an SD card script then the function block queues the command and does not execute it immediately. **NOTE:** An SD card script executed from an SD card is considered as being executed until the SD card has been removed.

This table describes the output variables:

Output	Type	Comment
xDone	BOOL	`TRUE` indicates that the action is successfully completed.
xBusy	BOOL	`TRUE` indicates that the function block is running.
xError	BOOL	`TRUE` indicates error detection; the function block aborts the action.
eError	ExecuteScrip-tError, page 46	Indicates the type of the execute script detected error.

Example

This example describes how to execute an *Upload* script command:

```
VAR
EXEC_FLAG: BOOL;
ExecuteScript: ExecuteScript;
END_VAR
ExecuteScript(
xExecute:= EXEC_FLAG,
sCmd:= 'Upload "/usr/Syslog/*"',
xDone=> ,
xBusy=> ,
xError=> ,
eError=> );
```

M241 Disk Space Functions

Overview

This section describes the disk space functions included in this library.

FC_GetFreeDiskSpace: Gets the Free Memory Space

Function Description

This function retrieves the amount of free memory space of a memory medium (user disk, system disk, SD card) in bytes.

The name of the memory medium is transferred:

- User disk = “/usr”
- System disk = “/sys”
- SD card = “/sd0”

The free memory space of a remote device cannot be accessed. If a remote device is specified as parameter, then the function returns "-1".

Graphical Representation

IL and ST Representation

To see the general representation in IL or ST language, refer to the chapter *Function and Function Block Representation*, page 54.

I/O Variable Description

This table describes the input variables:

Input	Data type	Description
i_sVolumeName	STRING[80]	Name of the device whose free memory space must be accessed
iq_uliFreeDiskSpace	ULINT	Free memory space in bytes

This table describes the output variables:

Output	Data type	Description
FC_GetFreeDiskSpace	DINT	0: The amount of free memory space was retrieved successfully -1: Error when attempting to access the amount of free memory. For example, an invalid device or remote device was selected -318: Invalid parameter (*i_sVolumeName*)

FC_GetLabel: Gets the Label of Memory

Function Description

This function retrieves the label of a memory medium. If a device has no label, then an empty string is returned.

The name of the memory medium (user disk, system disk, SD card) is transferred:

- User disk = “/usr”
- System disk = “/sys”
- SD card = “/sd0”

Graphical Representation

IL and ST Representation

To see the general representation in IL or ST language, refer to the chapter *Function and Function Block Representation*, page 54.

I/O Variable Description

This table describes the input variables:

Input	Data type	Description
i_sVolumeName	STRING[80]	Name of the device whose label must be accessed
iq_sLabel	STRING[11]	Label of the device

This table describes the output variables:

Output	Data type	Description
FC_GetLabel	DINT	0: The label was retrieved successfully -1: Error when accessing the label -318: Invalid parameter

FC_GetTotalDiskSpace: Gets the Size of Memory

Function Description

This function retrieves the size of a memory medium (user disk, system disk, SD card) in bytes.

The name of the memory medium is transferred:

- User disk = “/usr”
- System disk = “/sys”
- SD card = “/sd0”

The size of a remote device cannot be accessed. If a remote device is specified as parameter, then the function returns "-1".

Graphical Representation

IL and ST Representation

To see the general representation in IL or ST language, refer to the chapter *Function and Function Block Representation*, page 54.

I/O Variable Description

This table describes the input variables:

Input	Data type	Description
i_sVolumeName	STRING[80]	Name of the device whose memory size must be accessed
iq_uliTotalDiskSpace	ULINT	Size of the memory medium in byte

This table describes the output variables:

Output	Data type	Description
FC_GetTotalDiskSpace	DINT	0: Size was retrieved successfully -1: Error when reading the size -318: At least one of the parameters is invalid

TM3 Read Functions

Overview

This section describes the TM3 read functions included in the M241 PLCSystem library.

TM3_GetModuleBusStatus: Get TM3 Module Bus Status

Function Description

This function returns the bus status of the module. The index of the module is given as an input parameter.

Graphical Representation

IL and ST Representation

To see the general representation in IL or ST language, refer to the chapter *Function and Function Block Representation*, page 54.

I/O Variable Description

The following table describes the input variable:

Input	Type	Comment
ModuleIndex	BYTE	Index of the module (0 for the first expansion, 1 for the second, and so on).

The following table describes the output variable:

Output	Type	Comment
TM3_GetModuleBusStatus	*TM3_ERR_CODE*, page 49	Returns `TM3_OK` (00 hex) if command is correct otherwise returns the ID code of the detected error.

TM3_GetModuleFWVersion: Get TM3 Module Firmware Version

Function Description

This function returns the firmware version of a specified TM3 module.

Graphical Representation

IL and ST Representation

To see the general representation in IL or ST language, refer to the chapter *Function and Function Block Representation*, page 54.

I/O Variable Description

The following table describes the input variables:

Input	Type	Comment
ModuleIndex	BYTE	Index of the module (0 for the first expansion, 1 for the second, and so on).

The following table describes the output variable:

Output	Type	Comment
TM3_GetModuleFWVersion	UINT	Returns the firmware version of the module, or `FFFF hex` if the information cannot be read. For example, `001A hex` indicates firmware version 26.

TM3_GetModuleInternalStatus: Get TM3 Module Internal Status

Function Description

This function selectively reads the I/O channel status of a TM3 analog or temperature module, indicated by *ModuleIndex*. The function block writes the status for each requested channel starting at the memory location pointed to by *pStatusBuffer*.

NOTE: This function block is intended to be used with analog and temperature I/O modules. To get status information for digital I/O modules, see *TM3_GetModuleBusStatus*, page 36.

Graphical Representation

IL and ST Representation

To see the general representation in IL or ST language, refer to the chapter *Function and Function Block Representation*, page 54.

I/O Variable Description

Each analog/temperature I/O channel of the requested module requires one byte of memory. If there is not sufficient memory allocated to the buffer for the number of I/O module channel statuses requested, it is possible that the function will overwrite memory allocated for other purposes, or perhaps attempt to overwrite a restricted area of memory.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

Ensure that *pStatusBuffer* is pointing to a memory area that has been sufficiently allocated for the number of channels to be read.

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

The following table describes the input variables:

Input	Type	Comment
ModuleIndex	*BYTE*	Index of the expansion module (0 for the module closest to the controller, 1 for the second closest, and so on)
StatusOffset	*BYTE*	Offset of the first status to be read in the status table.
StatusSize	*BYTE*	Number of bytes to be read in the status table.
pStatusBuffer	*POINTER TO BYTE*	Buffer containing the read status table.

The following table describes the output variable:

Output	Type	Comment
TM3_GetModuleInternalStatus	*TM3_ERR_CODE*, page 49	Returns `TM3_NO_ERR` (00 hex) if command is correct otherwise returns the ID code of the error. For the purposes of this function block, any returned value other than zero indicates that the module is not compatible with the status request, or that the module has other communication issues.

Example

The following examples describe how to get the module internal status:

```
VAR
TM3AQ2_Channel_0_Output_Status: BYTE;
END_VAR
TM3AQ2 is on position 1
Status of channel 0 is at offset 0
We read 1 channel
TM3_GetModuleInternalStatus(1, 0, 1, ADR(TM3AQ2_Channel_0_
Output_Status));
status of channel 0 is in TM3AQ2_Channel_0_Output_Status
```

TM3AQ2 module (2 outputs)

Getting the status of first output QW0

- *StatusOffset* = 0 (0 inputs x 2)
- *StatusSize* = 1 (1 status to read)
- *pStatusBuffer* needs to be at least 1 byte

```
VAR
TM3AM6_Channels_1_2_Input_Status: ARRAY[1..2] OF BYTE;
```

```
END_VAR
TM3AM6 is on position 1
Status of channel 1 is at offset 9
We read 2 consecutive channels
TM3_GetModuleInternalStatus(1, 9, 2, ADR(TM3AM6_Channels_1_
2_Input_Status));
status of channel 1 is in TM3AM6_Channels_1_2_Input_Status
[1]
status of channel 2 is in TM3AM6_Channels_1_2_Input_Status
[2]
```

TM3AM6 module (4 inputs, 2 outputs)

Getting the status of input IW1 & IW2 (IW0 being the first one)

- *StatusOffset* = 9 (4 inputs x 2 + 1 to skip IW0 status)
- *StatusSize* = 2 (2 statuses to read)
- *pStatusBuffer* needs to be at least 2 bytes

M241 PLCSystem Library Data Types

Overview

This chapter describes the data types of the M241 PLCSystem library.

There are 2 kinds of data types available:

- System variable data types are used by the system variables, page 10 of the M241 PLCSystem Library (*PLC_R*, *PLC_W*,...).
- System function data types are used by the read/write system functions, page 23 of the M241 PLCSystem Library.

PLC_RW System Variables Data Types

Overview

This section lists and describes the system variable data types included in the *PLC_R* and *PLC_W* structures.

PLC_R_APPLICATION_ERROR: Detected Application Error Status Codes

Enumerated Type Description

The *PLC_R_APPLICATION_ERROR* enumeration data type contains the following values:

Enumerator	Value	Comment	What to do
PLC_R_APP_ERR_UNKNOWN	FFFF hex	Undefined error detected.	Contact your Schneider Electric service representative.
PLC_R_APP_ERR_NOEXCEPTION	0000 hex	No error detected.	–
PLC_R_APP_ERR_WATCHDOG	0010 hex	Task watchdog expired.	Check your application. A reset is needed to enter Run mode.
PLC_R_APP_ERR_HARDWAREWATCHDOG	0011 hex	System watchdog expired.	If the problem is reproducible, verify that there are no configured but disconnected communication ports. Otherwise, update the firmware. If the problem still persists, contact your Schneider Electric service representative.
PLC_R_APP_ERR_IO_CONFIG_ERROR	0012 hex	Incorrect I/O configuration parameters detected.	Your application might be corrupted. To resolve this issue, use one of the methods: 1. **Build > Clean All** 2. Export/Import your application. 3. Upgrade EcoStruxure Machine Expert to the latest version.
PLC_R_APP_ERR_UNRESOLVED_EXTREFS	0018 hex	Undefined functions detected.	Delete the unresolved functions from the application.
PLC_R_APP_ERR_IEC_TASK_CONFIG_ERROR	0025 hex	Incorrect Task configuration parameters detected.	Your application might be corrupted. To resolve this issue, use one of the methods: 1. **Build > Clean All** 2. Export/Import your application. 3. Upgrade EcoStruxure Machine Expert to the latest version.
PLC_R_APP_ERR_ILLEGAL_INSTRUCTION	0050 hex	Undefined instruction detected.	Debug your application to resolve the problem.
PLC_R_APP_ERR_ACCESS_VIOLATION	0051 hex	Attempted access to reserved memory area.	Debug your application to resolve the problem.
PLC_R_APP_ERR_DIVIDE_BY_ZERO	0102 hex	Integer division by zero detected.	Debug your application to resolve the problem.
PLC_R_APP_ERR_PROCESSORLOAD_WATCHDOG	0105 hex	Processor overloaded by Application Tasks.	Reduce the application workload by improving the application architecture. Increase the task cycle duration. Reduce event frequency.
PLC_R_APP_ERR_DIVIDE_REAL_BY_ZERO	0152 hex	Real division by zero detected.	Debug your application to resolve the problem.
PLC_R_APP_ERR_EXPIO_EVENTS_COUNT_EXCEEDED	4E20 hex	Too many events on expert I/Os are detected.	Reduce the number of event tasks.
PLC_R_APP_ERR_APPLICATION_VERSION_MISMATCH	4E21 hex	Mismatch in the application version detected.	The application version in the logic controller does not match the version in EcoStruxure Machine Expert. Refer to Applications (see EcoStruxure Machine Expert, Programming Guide).

PLC_R_BOOT_PROJECT_STATUS: Boot Project Status Codes

Enumerated Type Description

The *PLC_R_BOOT_PROJECT_STATUS* enumeration data type contains the following values:

Enumerator	Value	Comment
PLC_R_NO_BOOT_PROJECT	0000 hex	Boot project does not exist in non-volatile memory.
PLC_R_BOOT_PROJECT_CREATION_IN_PROGRESS	0001 hex	Boot project is being created.
PLC_R_DIFFERENT_BOOT_PROJECT	0002 hex	Boot project in non-volatile memory is different from the project loaded in memory.
PLC_R_VALID_BOOT_PROJECT	FFFF hex	Boot project in non-volatile memory is the same as the project loaded in memory.

PLC_R_IO_STATUS: I/O Status Codes

Enumerated Type Description

The *PLC_R_IO_STATUS* enumeration data type contains the following values:

Enumerator	Value	Comment
PLC_R_IO_OK	FFFF hex	Inputs/Outputs are operational.
PLC_R_IO_NO_INIT	0001 hex	Inputs/Outputs are not initialized.
PLC_R_IO_CONF_FAULT	0002 hex	Incorrect I/O configuration parameters detected.
PLC_R_IO_SHORTCUT_FAULT	0003 hex	Inputs/Outputs short-circuit detected.
PLC_R_IO_POWER_SUPPLY_FAULT	0004 hex	Inputs/Outputs power supply error detected.

PLC_R_SDCARD_STATUS: SD Card Slot Status Codes

Enumerated Type Description

The *PLC_R_SDCARD_STATUS* enumeration data type contains the following values:

Enumerator	Value	Comment
NO_SDCARD	0000 hex	No SD card detected in the slot or the slot is not connected.
SDCARD_READONLY	0001 hex	SD card is in read-only mode.
SDCARD_READWRITE	0002 hex	SD card is in read/write mode.
SDCARD_ERROR	0003 hex	Error detected in the SD card. More details on the error are written to the file FwLog.txt.

PLC_R_STATUS: Controller Status Codes

Enumerated Type Description

The *PLC_R_STATUS* enumeration data type contains the following values:

Enumerator	Value	Comment
PLC_R_EMPTY	0000 hex	Controller does not contain an application.
PLC_R_STOPPED	0001 hex	Controller is stopped.
PLC_R_RUNNING	0002 hex	Controller is running.
PLC_R_HALT	0004 hex	Controller is in a HALT state (see the controller state diagram in your controller programming guide (see Modicon M241 Logic Controller, Programming Guide)).
PLC_R_BREAKPOINT	0008 hex	Controller has paused at a breakpoint.

PLC_R_STOP_CAUSE: From RUN State to Other State Transition Cause Codes

Enumerated Type Description

The *PLC_R_STOP_CAUSE* enumeration data type contains the following values:

Enumerator	Value	Comment	What to do
PLC_R_STOP_REASON_UNKNOWN	00 hex	Initial value or stop cause is indeterminable.	Contact your local Schneider Electric representative.
PLC_R_STOP_REASON_HW_WATCHDOG	01 hex	Stopped after hardware watchdog timeout.	Contact your local Schneider Electric representative.
PLC_R_STOP_REASON_RESET	02 hex	Stopped after reset.	See reset possibilities in Controller State Diagram.
PLC_R_STOP_REASON_EXCEPTION	03 hex	Stopped after exception.	Verify your application, and correct if necessary. See System and Task Watchdogs (see Modicon M241 Logic Controller, Programming Guide). A reset is needed to enter Run mode.
PLC_R_STOP_REASON_USER	04 hex	Stopped after a user request.	Refer to Stop Command in Commanding State Transitions (see Modicon M241 Logic Controller, Programming Guide).
PLC_R_STOP_REASON_IECPROGRAM	05 hex	Stopped after a program command request (for example: control command with parameter *PLC_W.q_wPLCControl:=PLC_W_COMMAND.PLC_W_STOP;*).	–
PLC_R_STOP_REASON_DELETE	06 hex	Stopped after a remove application command.	See the **Applications** tab of the Controller Device Editor (see Modicon M241 Logic Controller, Programming Guide).
PLC_R_STOP_REASON_DEBUGGING	07 hex	Stopped after entering debug mode.	–
PLC_R_STOP_FROM_NETWORK_REQUEST	0A hex	Stopped after a request from the network, the controller Web server, or *PLC_W* command.	–
PLC_R_STOP_FROM_INPUT	0B hex	Stop required by a controller input.	–
PLC_R_STOP_FROM_RUN_STOP_SWITCH	0C hex	Stop required by the controller switch.	–
PLC_R_STOP_REASON_RETAIN_MISMATCH	0D hex	Stopped after an unsuccessful check context test during rebooting.	There are retained variables in non-volatile memory that do not exist in the executing application. Verify your application, correct if necessary, then reestablish the boot application.
PLC_R_STOP_REASON_BOOT_APPLI_MISMATCH	0E hex	Stopped after an unsuccessful compare between the boot application and the application that was in the memory before rebooting.	Create a valid boot application.
PLC_R_STOP_REASON_POWERFAIL	0F hex	Stopped after a power interruption.	–

For more information for reasons the controller has stopped, refer to the Controller State Description.

PLC_R_TERMINAL_PORT_STATUS: Programming Port Connection Status Codes

Enumerated Type Description

The *PLC_R_TERMINAL_PORT_STATUS* enumeration data type contains the following values:

Enumerator	Value	Comment
TERMINAL_NOT_CONNECTED	00 hex	No PC is connected to the programming port.
TERMINAL_CONNECTION_IN_PROGRESS	01 hex	Connection is in progress.
TERMINAL_CONNECTED	02 hex	PC is connected to the programming port.
TERMINAL_ERROR	0F hex	Error detected during connection.

PLC_R_TM3_BUS_STATE: TM3 Bus Status Codes

Enumerated Type Description

The *PLC_R_TM3_BUS_STATE* enumeration data type contains the following values:

Enumerator	Value	Comment
TM3_CONF_ERROR	01 hex	Error detected due to mismatch in the physical configuration and the configuration in EcoStruxure Machine Expert.
TM3_OK	03 hex	The physical configuration and the configuration in EcoStruxure Machine Expert match.
TM3_POWER_SUPPLY_ERROR	04 hex	Error detected in power supply.

PLC_W_COMMAND: Control Command Codes

Enumerated Type Description

The *PLC_W_COMMAND* enumeration data type contains the following values:

Enumerator	Value	Comment
PLC_W_STOP	0001 hex	Command to stop the controller.
PLC_W_RUN	0002 hex	Command to run the controller.
PLC_W_RESET_COLD	0004 hex	Command to initiate a Controller cold reset.
PLC_W_RESET_WARM	0008 hex	Command to initiate a Controller warm reset.

DataFileCopy System Variables Data Types

Overview

This section lists and describes the system variable data types included in the *DataFileCopy* structures.

DataFileCopyError: Detected Error Codes

Enumerated Type Description

The *DataFileCopyError* enumeration data type contains the following values:

Enumerator	Value	Description
ERR_NO_ERR	00 hex	No error detected.
ERR_FILE_NOT_FOUND	01 hex	The file does not exist.
ERR_FILE_ACCESS_REFUSED	02 hex	The file cannot be opened.
ERR_INCORRECT_SIZE	03 hex	The request size is not the same as size read from file.
ERR_CRC_ERR	04 hex	The CRC is not correct and the file is assumed to be corrupted.
ERR_INCORRECT_MAC	05 hex	The controller attempting to read from the file does not have the same MAC address as that contained in the file.

DataFileCopyLocation: Location Codes

Enumerated Type Description

The *DataFileCopyLocation* enumeration data type contains the following values:

Enumerator	Value	Description
DFCL_INTERNAL	00 hex	Data file with DTA extension is located in */usr/Dta* directory.
DFCL_EXTERNAL	01 hex	Data file with DTA extension is located in */sd0/usr/Dta* directory.
DFCL_TBD	02 hex	Not used.

ExecScript System Variables Data Types

Overview

This section lists and describes the system variable data types included in the *ExecScript* structures.

ExecuteScriptError: Detected Error Codes

Enumerated Type Description

The *ExecuteScriptError* enumeration data type contains the following values:

Enumerator	Value	Description
CMD_OK	00 hex	No error detected.
ERR_CMD_UNKNOWN	01 hex	The command is invalid.
ERR_SD_CARD_MISSING	02 hex	SD card is not present.
ERR_SEE_FWLOG	03 hex	There was an error detected during command execution, see `FwLog.txt`. For more information, refer to File Type (see Modicon M241 Logic Controller, Programming Guide).
ERR_ONLY_ONE_COMMAND_ALLOWED	04 hex	An attempt was made to execute several scripts simultaneously.
CMD_BEING_EXECUTED	05 hex	A script is already in progress.

ETH_RW System Variables Data Types

Overview

This section lists and describes the system variable data types included in the *ETH_R* and *ETH_W* structures.

ETH_R_FRAME_PROTOCOL: Frame Transmission Protocol Codes

Enumerated Type Description

The *ETH_R_FRAME_PROTOCOL* enumeration data type contains the following values:

Enumerator	Value	Comment
ETH_R_802_3	00 hex	The protocol used for frame transmission is IEEE 802.3.
ETH_R_ETHERNET_II	01 hex	The protocol used for frame transmission is Ethernet II.

ETH_R_IP_MODE: IP Address Source Codes

Enumerated Type Description

The *ETH_R_IP_MODE* enumeration data type contains the following values:

Enumerator	Value	Comment
ETH_R_STORED	00 hex	Stored IP address is used.
ETH_R_BOOTP	01 hex	Bootstrap protocol (BOOTP) is used to get an IP address.
ETH_R_DHCP	02 hex	DHCP protocol is used to get an IP address.
ETH_DEFAULT_IP	FF hex	Default IP address is used.

ETH_R_PORT_DUPLEX_STATUS: Transmission Mode Codes

Enumerated Type Description

The *ETH_R_PORT_DUPLEX_STATUS* enumeration data type contains the following values:

Enumerator	Value	Comment
ETH_R_PORT_HALF_DUPLEX	00 hex	Half duplex transmission mode is used.
ETH_R_FULL_DUPLEX	01 hex	Full duplex transmission mode is used.
ETH_R_PORT_NA_DUPLEX	03 hex	No duplex transmission mode is used.

ETH_R_PORT_IP_STATUS: Ethernet TCP/IP Port Status Codes

Enumerated Type Description

The *ETH_R_PORT_IP_STATUS* enumeration data type contains the following values:

Enumerator	Value	Comment
WAIT_FOR_PARAMS	00 hex	Waiting for parameters.
WAIT_FOR_CONF	01 hex	Waiting for configuration.
DATA_EXCHANGE	02 hex	Ready for data exchange.
ETH_ERROR	03 hex	Ethernet TCP/IP port error detected (cable disconnected, invalid configuration, and so on).
DUPLICATE_IP	04 hex	IP address already used by another equipment.

ETH_R_PORT_LINK_STATUS: Communication Link Status Codes

Enumerated Type Description

The *ETH_R_PORT_LINK_STATUS* enumeration data type contains the following values:

Enumerator	Value	Comment
ETH_R_LINK_DOWN	00 hex	Communication link not available to another device.
ETH_R_LINK_UP	01 hex	Communication link available to another device.

ETH_R_PORT_SPEED: Communication Speed of the Ethernet Port Codes

Enumerated Type Description

The *ETH_R_PORT_SPEED* enumeration data type contains the following values:

Enumerator	Value	Comment
ETH_R_SPEED_NA	0 dec	Network speed is not available.
ETH_R_SPEED_10_MB	10 dec	Network speed is 10 megabits per second.
ETH_R_100_MB	100 dec	Network speed is 100 megabits per second.

ETH_R_RUN_IDLE: Ethernet/IP Run and Idle States Codes

Enumerated Type Description

The *ETH_R_RUN_IDLE* enumeration data type contains the following values:

Enumerator	Value	Comment
IDLE	00 hex	EtherNet/IP connection is idle.
RUN	01 hex	EtherNet/IP connection is running.

TM3_MODULE_RW System Variables Data Types

Overview

This section lists and describes the system variable data types included in the *TM3_MODULE_R* and *TM3_MODULE_W* structures.

TM3_ERR_CODE: TM3 Expansion Module Detected Error Codes

Enumerated Type Description

The *TM3_ERR_CODE* enumeration data type contains the following values:

Enumerator	Value	Comment
TM3_NO_ERR	00 hex	Last bus exchange with the expansion module was successful.
TM3_ERR_FAILED	01 hex	Error detected due to the last bus exchange with the expansion module was unsuccessful.
TM3_ERR_PARAMETER	02 hex	Parameter error detected in the last bus exchange with the module.
TM3_ERR_COK	03 hex	Temporary or permanent hardware error detected on one of the TM3 expansion modules.
TM3_ERR_BUS	04 hex	Bus error detected in the last bus exchange with the expansion module.

TM3_MODULE_R_ARRAY_TYPE: TM3 Expansion Module Read Array Type

Description

The *TM3_MODULE_R_ARRAY_TYPE* is an array of 0...13 *TM3_MODULE_R_STRUCT*.

TM3_MODULE_STATE: TM3 Expansion Module State Codes

Enumerated Type Description

The *TM3_MODULE_STATE* enumeration data type contains the following values:

Enumerator	Value	Comment
TM3_EMPTY	00 hex	No module.
TM3_CONF_ERROR	01 hex	Physical expansion module does not match with the one configured in EcoStruxure Machine Expert.
TM3_BUS_ERROR	02 hex	Bus error detected in the last exchange with the module.
TM3_OK	03 hex	Last bus exchange with this module was successful.
TM3_MISSING_OPT_MOD	05 hex	Optional module is not physically present.

TM3_BUS_W_IOBUSERRMOD: TM3 bus error mode

Enumerated Type Description

The *TM3_BUS_W_IOBUSERRMOD* enumeration data type contains the following values:

Enumerator	Value	Comment
IOBUS_ERR_ACTIVE	00 hex	Active mode. The logic controller stops all I/O exchanges on the TM3 bus on detection of a permanent error. Refer to I/O Configuration General Description (see Modicon M241 Logic Controller, Programming Guide).
IOBUS_ERR_PASSIVE	01 hex	Passive mode. I/O exchanges continue on the TM3 bus even if an error is detected.

Cartridge System Variables Data Types

Overview

This section lists and describes the system variable data types included in the *Cartridge* structure.

CART_R_ARRAY_TYPE: Cartridge Read Array Type

Description

The *CART_R_ARRAY_TYPE* is an array of 0..1 *CART_R_STRUCT*.

CART_R_MODULE_ID: Cartridge Read Module Identifier

Enumerated Type Description

The *CART_R_MODULE_ID* enumeration data type contains the following values:

Enumerator	Value	Description
CART_R_MODULE_ID	40 hex	TMC4AI2
CART_R_MODULE_ID	41 hex	TMC4AQ2
CART_R_MODULE_ID	42 hex	TMC4TI2
CART_R_MODULE_ID	48 hex	TMC4HOIS01
CART_R_MODULE_ID	49 hex	TMC4PACK01
CART_R_MODULE_ID	FF hex	None

CART_R_STATE: Cartridge Read State

Enumerated Type Description

The *CART_R_STATE* enumeration data type contains the following values:

Enumerator	Value	Comment
CONFIGURED	00 hex	Cartridge is configured.
INITIALIZED_NOT_CONFIGURED	01 hex	Cartridge is initialized but not configured.
NOT_INITIALIZED	02 hex	Cartridge is not initialized.

System Function Data Types

Overview

This section describes the different system function data types of the M241 PLCSystem library.

IMMEDIATE_ERR_TYPE: *GetImmediateFastInput* Read Input of Embedded Expert I/O Codes

Enumerated Type Description

The enumeration data type contains the following values:

Enumerator	Type	Comment
IMMEDIATE_NO_ERROR	Word	No errors detected.
IMMEDIATE_UNKNOWN	Word	The reference of *Immediate* function is incorrect or not configured.
IMMEDIATE_UNKNOWN_PARAMETER	Word	A parameter reference is incorrect.

RTCSETDRIFT_ERROR: *SetRTCDrift* Function Detected Error Codes

Enumerated Type Description

The *RTCSETDRIFT_ERROR* enumeration data type contains the following values:

Enumerator	Value	Comment
RTC_OK	00 hex	RTC drift correctly configured.
RTC_BAD_DAY	01 hex	Not used.
RTC_BAD_HOUR	02 hex	Not used.
RTC_BAD_MINUTE	03 hex	Not used.
RTC_BAD_DRIFT	04 hex	RTC Drift parameter out of range.
RTC_INTERNAL_ERROR	05 hex	RTC Drift settings rejected on internal error detected.

Appendices

What's in This Part

Overview

This appendix extracts parts of the programming guide for technical understanding of the library documentation.

Function and Function Block Representation

What's in This Chapter

Overview

Each function can be represented in the following languages:

- IL: Instruction List
- ST: Structured Text
- LD: Ladder Diagram
- FBD: Function Block Diagram
- CFC: Continuous Function Chart

This chapter provides functions and function blocks representation examples and explains how to use them for IL and ST languages.

Differences Between a Function and a Function Block

Function

A function:

- is a POU (Program Organization Unit) that returns one immediate result.
- is directly called with its name (not through an instance).
- has no persistent state from one call to the other.
- can be used as an operand in other expressions.

Examples: boolean operators (`AND`), calculations, conversion (`BYTE_TO_INT`)

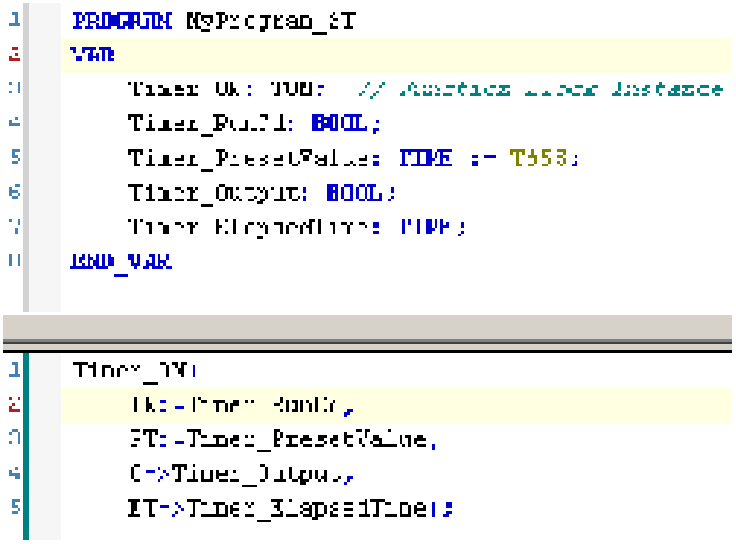
Function Block

A function block:

- is a POU (Program Organization Unit) that returns one or more outputs.
- needs to be called by an instance (function block copy with dedicated name and variables).
- each instance has a persistent state (outputs and internal variables) from one call to the other from a function block or a program.

Examples: timers, counters

In the example, `Timer_ON` is an instance of the function block `TON`:



How to Use a Function or a Function Block in IL Language

General Information

This part explains how to implement a function and a function block in IL language.

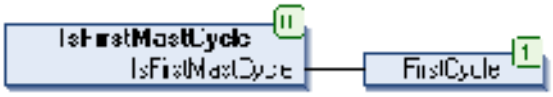
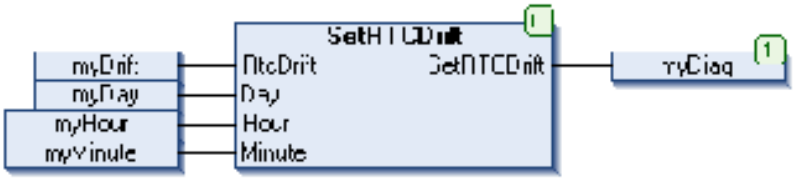
Functions `IsFirstMastCycle` and `SetRTCDrift` and Function Block `TON` are used as examples to show implementations.

Using a Function in IL Language

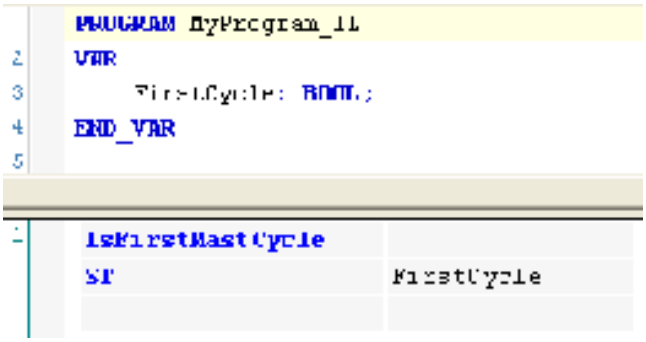
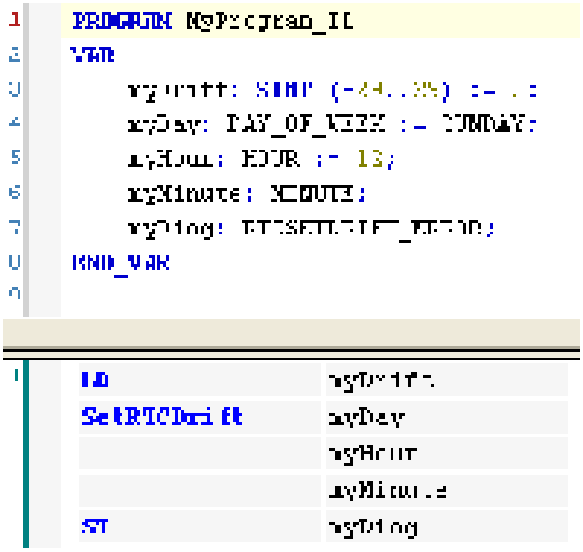
This procedure describes how to insert a function in IL language:

Step	Action
1	Open or create a new POU in Instruction List language. **NOTE:** The procedure to create a POU is not detailed here. For more information, refer to Adding and Calling POUs (see EcoStruxure Machine Expert, Programming Guide).
2	Create the variables that the function requires.
3	If the function has 1 or more inputs, start loading the first input using LD instruction.
4	Insert a new line below and: • type the name of the function in the operator column (left field), or • use the **Input Assistant** to select the function (select **Insert Box** in the contextual menu).
5	If the function has more than 1 input and when Input Assistant is used, the necessary number of lines is automatically created with `???` in the fields on the right. Replace the `???` with the appropriate value or variable that corresponds to the order of inputs.
6	Insert a new line to store the result of the function into the appropriate variable: type ST instruction in the operator column (left field) and the variable name in the field on the right.

To illustrate the procedure, consider the Functions `IsFirstMastCycle` (without input parameter) and `SetRTCDrift` (with input parameters) graphically presented below:

Function	Graphical Representation
without input parameter: `IsFirstMastCycle`	
with input parameters: `SetRTCDrift`	

In IL language, the function name is used directly in the operator column:

Function	Representation in POU IL Editor
IL example of a function without input parameter: `IsFirstMastCycle`	
IL example of a function with input parameters: `SetRTCDrift`	

Using a Function Block in IL Language

This procedure describes how to insert a function block in IL language:

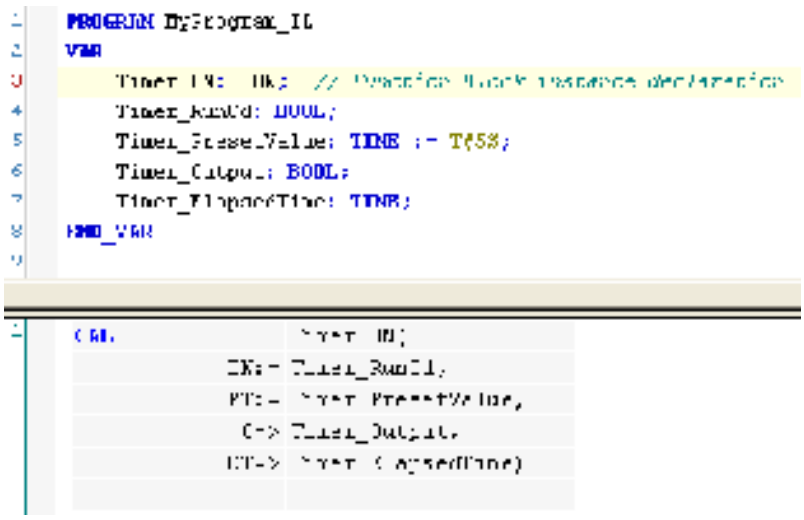
Step	Action
1	Open or create a new POU in Instruction List language. **NOTE:** The procedure to create a POU is not detailed here. For more information, refer to Adding and Calling POUs (see EcoStruxure Machine Expert, Programming Guide).
2	Create the variables that the function block requires, including the instance name.
3	Function Blocks are called using a `CAL` instruction: • Use the **Input Assistant** to select the function block (right-click and select **Insert Box** in the contextual menu).

Step	Action
	• Automatically, the CAL instruction and the necessary I/O are created. Each parameter (I/O) is an instruction: • Values to inputs are set by ":=". • Values to outputs are set by "=>".
4	In the CAL right-side field, replace ??? with the instance name.
5	Replace other ??? with an appropriate variable or immediate value.

To illustrate the procedure, consider this example with the TON Function Block graphically presented below:

Function Block	Graphical Representation
TON	

In IL language, the function block name is used directly in the operator column:

Function Block	Representation in POU IL Editor
TON	

How to Use a Function or a Function Block in ST Language

General Information

This part explains how to implement a Function and a Function Block in ST language.

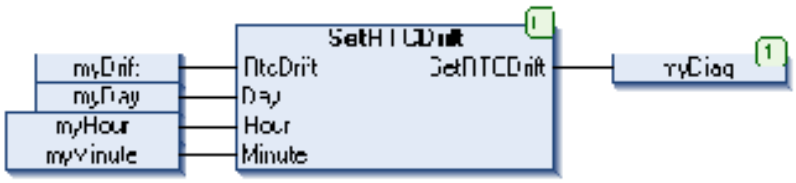
Function SetRTCDrift and Function Block TON are used as examples to show implementations.

Using a Function in ST Language

This procedure describes how to insert a function in ST language:

Step	Action
1	Open or create a new POU in Structured Text language. **NOTE:** The procedure to create a POU is not detailed here. For more information, refer to Adding and Calling POUs (see EcoStruxure Machine Expert, Programming Guide).
2	Create the variables that the function requires.
3	Use the general syntax in the **POU ST Editor** for the ST language of a function. The general syntax is: `FunctionResult:= FunctionName(VarInput1, VarInput2,.. VarInputx);`

To illustrate the procedure, consider the function `SetRTCDrift` graphically presented below:

Function	Graphical Representation
`SetRTCDrift`	

The ST language of this function is the following:

Function	Representation in POU ST Editor

`SetRTCDrift`	`PROGRAM MyProgram_ST`
	`VAR myDrift: SINT(-29..29) := 5;`
	`myDay: DAY_OF_WEEK := SUNDAY;`
	`myHour: HOUR := 12;`
	`myMinute: MINUTE;`
	`myRTCAdjust: RTCDRIFT_ERROR;`
	`END_VAR`
	`myRTCAdjust:= SetRTCDrift(myDrift, myDay, myHour, myMinute);`

Using a Function Block in ST Language

This procedure describes how to insert a function block in ST language:

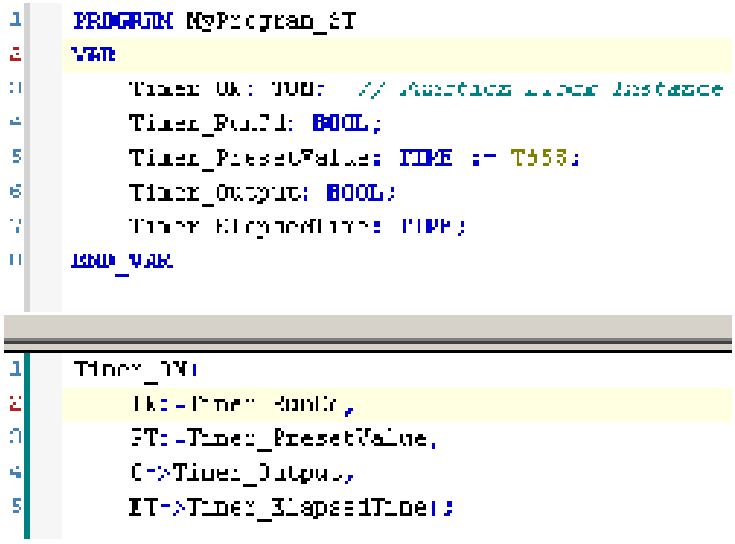
Step	Action
1	Open or create a new POU in Structured Text language. **NOTE:** The procedure to create a POU is not detailed here. For more information on adding, declaring and calling POUs, refer to the related documentation (see EcoStruxure Machine Expert, Programming Guide).
2	Create the input and output variables and the instance required for the function block: • Input variables are the input parameters required by the function block • Output variables receive the value returned by the function block

3	Use the general syntax in the **POU ST Editor** for the ST language of a Function Block. The general syntax is:
	`FunctionBlock_InstanceName(Input1:=VarInput1, Input2:=VarInput2,...`
	`Ouput1=>VarOutput1, Ouput2=>VarOutput2,...);`

To illustrate the procedure, consider this example with the `TON` function block graphically presented below:

Function Block	Graphical Representation
`TON`	

This table shows examples of a function block call in ST language:

Function Block	Representation in POU ST Editor
TON	

Glossary

A

%:

According to the IEC standard, % is a prefix that identifies internal memory addresses in the logic controller to store the value of program variables, constants, I/O, and so on.

application:

A program including configuration data, symbols, and documentation.

ARRAY:

The systematic arrangement of data objects of a single type in the form of a table defined in logic controller memory. The syntax is as follows: `ARRAY [<dimension>] OF <Type>`

Example 1: `ARRAY [1..2] OF BOOL` is a 1-dimensional table with 2 elements of type `BOOL`.

Example 2: `ARRAY [1..10, 1..20] OF INT` is a 2-dimensional table with 10 x 20 elements of type `INT`.

B

BOOL:

(*boolean*) A basic data type in computing. A `BOOL` variable can have one of these values: 0 (`FALSE`), 1 (`TRUE`). A bit that is extracted from a word is of type `BOOL`; for example, `%MW10.4` is a fifth bit of memory word number 10.

Boot application:

(*boot application*) The binary file that contains the application. Usually, it is stored in the controller and allows the controller to boot on the application that the user has generated.

BOOTP:

(*bootstrap protocol*) A UDP network protocol that can be used by a network client to automatically obtain an IP address (and possibly other data) from a server. The client identifies itself to the server using the client MAC address. The server, which maintains a pre-configured table of client device MAC addresses and associated IP addresses, sends the client its pre-configured IP address. BOOTP was originally used as a method that enabled diskless hosts to be remotely booted over a network. The BOOTP process assigns an infinite lease of an IP address. The BOOTP service utilizes UDP ports 67 and 68.

byte:

A type that is encoded in an 8-bit format, ranging from 00 hex to FF hex.

C

CAN:

(*controller area network*) A protocol (ISO 11898) for serial bus networks, designed for the interconnection of smart devices (from multiple manufacturers) in smart systems and for real-time industrial applications. Originally developed for use in automobiles, CAN is now used in a variety of industrial automation control environments.

CFC:

(*continuous function chart*) A graphical programming language (an extension of the IEC 61131-3 standard) based on the function block diagram language that works like a flowchart. However, no networks are used and free positioning of

graphic elements is possible, which allows feedback loops. For each block, the inputs are on the left and the outputs on the right. You can link the block outputs to the inputs of other blocks to create complex expressions.

configuration:

The arrangement and interconnection of hardware components within a system and the hardware and software parameters that determine the operating characteristics of the system.

control network:

A network containing logic controllers, SCADA systems, PCs, HMI, switches, ...

Two kinds of topologies are supported:

- flat: all modules and devices in this network belong to same subnet.
- 2 levels: the network is split into an operation network and an inter-controller network.

These two networks can be physically independent, but are generally linked by a routing device.

CRC:

(*cyclical redundancy check*) A method used to determine the validity of a communication transmission. The transmission contains a bit field that constitutes a checksum. The message is used to calculate the checksum by the transmitter according to the content of the message. Receiving nodes, then recalculate the field in the same manner. Any discrepancy in the value of the 2 CRC calculations indicates that the transmitted message and the received message are different.

D

DHCP:

(*dynamic host configuration protocol*) An advanced extension of BOOTP. DHCP is more advanced, but both DHCP and BOOTP are common. (DHCP can handle BOOTP client requests.)

DWORD:

(*double word*) Encoded in 32-bit format.

E

element:

The short name of the ARRAY element.

EtherNet/IP:

(*Ethernet industrial protocol*) An open communications protocol for manufacturing automation solutions in industrial systems. EtherNet/IP is in a family of networks that implement the common industrial protocol at its upper layers. The supporting organization (ODVA) specifies EtherNet/IP to accomplish global adaptability and media independence.

Ethernet:

A physical and data link layer technology for LANs, also known as IEEE 802.3.

F

FB:

(*function block*) A convenient programming mechanism that consolidates a group of programming instructions to perform a specific and normalized action, such as speed control, interval control, or counting. A function block may comprise configuration data, a set of internal or external operating parameters and usually 1 or more data inputs and outputs.

firmware:

Represents the BIOS, data parameters, and programming instructions that constitute the operating system on a controller. The firmware is stored in non-volatile memory within the controller.

function block diagram:

One of the 5 languages for logic or control supported by the standard IEC 61131-3 for control systems. Function block diagram is a graphically oriented programming language. It works with a list of networks where each network contains a graphical structure of boxes and connection lines representing either a logical or arithmetic expression, the call of a function block, a jump, or a return instruction.

function block:

A programming unit that has 1 or more inputs and returns 1 or more outputs. FBs are called through an instance (function block copy with dedicated name and variables) and each instance has a persistent state (outputs and internal variables) from 1 call to the other.

Examples: timers, counters

function:

A programming unit that has 1 input and returns 1 immediate result. However, unlike FBs, it is directly called with its name (as opposed to through an instance), has no persistent state from one call to the next and can be used as an operand in other programming expressions.

Examples: boolean (AND) operators, calculations, conversions (BYTE_TO_INT)

G

GVL:

(*global variable list*) Manages global variables within an EcoStruxure Machine Expert project.

H

hex:

(*hexadecimal*)

I

I/O:

(*input/output*)

ID:

(*identifier/identification*)

IEC 61131-3:

Part 3 of a 3-part IEC standard for industrial automation equipment. IEC 61131-3 is concerned with controller programming languages and defines 2 graphical and 2 textual programming language standards. The graphical programming languages are ladder diagram and function block diagram. The textual programming languages include structured text and instruction list.

IEC:

(*international electrotechnical commission*) A non-profit and non-governmental international standards organization that prepares and publishes international standards for electrical, electronic, and related technologies.

IEEE 802.3:

A collection of IEEE standards defining the physical layer, and the media access control sublayer of the data link layer, of wired Ethernet.

IL:

(*instruction list*) A program written in the language that is composed of a series of text-based instructions executed sequentially by the controller. Each instruction includes a line number, an instruction code, and an operand (refer to IEC 61131-3).

INT:

(*integer*) A whole number encoded in 16 bits.

IP:

(*Internet protocol* Part of the TCP/IP protocol family that tracks the Internet addresses of devices, routes outgoing messages, and recognizes incoming messages.

L

LD:

(*ladder diagram*) A graphical representation of the instructions of a controller program with symbols for contacts, coils, and blocks in a series of rungs executed sequentially by a controller (refer to IEC 61131-3).

LED:

(*light emitting diode*) An indicator that illuminates under a low-level electrical charge.

LWORD:

(*long word*) A data type encoded in a 64-bit format.

M

MAC address:

(*media access control address*) A unique 48-bit number associated with a specific piece of hardware. The MAC address is programmed into each network card or device when it is manufactured.

MAST:

A processor task that is run through its programming software. The MAST task has 2 sections:

- **IN:** Inputs are copied to the IN section before execution of the MAST task.
- **OUT:** Outputs are copied to the OUT section after execution of the MAST task.

Modbus:

The protocol that allows communications between many devices connected to the same network.

%MW:

According to the IEC standard, %MW represents a memory word register (for example, a language object of type memory word).

N

network:

A system of interconnected devices that share a common data path and protocol for communications.

NVM:

(Non-volatile memory) A non-volatile memory that can be overwritten. It is stored on a special EEPROM that can be erased and reprogrammed.

P

PCI:

(*peripheral component interconnect*) An industry-standard bus for attaching peripherals.

PLC:

(*programmable logic controller*) An industrial computer used to automate manufacturing, industrial, and other electromechanical processes. PLCs are different from common computers in that they are designed to have multiple input and output arrays and adhere to more robust specifications for shock, vibration, temperature, and electrical interference among other things.

POU:

(*program organization unit*) A variable declaration in source code and a corresponding instruction set. POUs facilitate the modular re-use of software programs, functions, and function blocks. Once declared, POUs are available to one another.

program:

The component of an application that consists of compiled source code capable of being installed in the memory of a logic controller.

protocol:

A convention or standard definition that controls or enables the connection, communication, and data transfer between 2 computing system and devices.

R

RTC:

(*real-time clock*) A battery-backed time-of-day and calender clock that operates continuously, even when the controller is not powered for the life of the battery.

run:

A command that causes the controller to scan the application program, read the physical inputs, and write to the physical outputs according to solution of the logic of the program.

S

SINT:

(*signed integer*) A 15-bit value plus sign.

STOP:

A command that causes the controller to stop running an application program.

string:

A variable that is a series of ASCII characters.

ST:

(*structured text*) A language that includes complex statements and nested instructions (such as iteration loops, conditional executions, or functions). ST is compliant with IEC 61131-3.

system variable:

A variable that provides controller data and diagnostic information and allows sending commands to the controller.

T

task:

A group of sections and subroutines, executed cyclically or periodically for the MAST task or periodically for the FAST task.

A task possesses a level of priority and is linked to inputs and outputs of the controller. These I/O are refreshed in relation to the task.

A controller can have several tasks.

TCP:

(*transmission control protocol*) A connection-based transport layer protocol that provides a simultaneous bi-directional transmission of data. TCP is part of the TCP/IP protocol suite.

U

UDINT:

(*unsigned double integer*) Encoded in 32 bits.

UINT:

(*unsigned integer*) Encoded in 16 bits.

unlocated variable:

A variable that does not have an address (refer to *located variable*).

V

variable:

A memory unit that is addressed and modified by a program.

W

watchdog:

A watchdog is a special timer used to ensure that programs do not overrun their allocated scan time. The watchdog timer is usually set to a higher value than the scan time and reset to 0 at the end of each scan cycle. If the watchdog timer reaches the preset value, for example, because the program is caught in an endless loop, an error is declared and the program stopped.

WORD:

A type encoded in a 16-bit format.

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