Relay Driver MODBUS Specification
Morningstar Corporation

V02
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Contents

Parameters

The Relay Driver supports communication via its serial RS-232 interface and uses the industry standard MODBUS application protocol. This document assumes the user is familiar with the MODBUS protocol and its terminology. Please refer to the documents listed in the References section for more information.

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The Relay Driver supports RTU mode only.
16bit MODBUS addresses (per the modbus.org spec)
The serial communication parameters are
  · BPS: 9600 baud
  · Parity: None
  · Data bits: 8
  · Stop bits: 1 or 2
  · Flow control: None
All addresses listed are for the request PDU.
The Relay Driver defaults to server address of 0x09.

Supported Modbus Functions

Read Holding Registers (0x03) and Read Input Registers (0x04)

RAM

PDU Addr	Logical Addr	Variable name	Variable description	Units	Scaling or Range
0x0000	1	adc_vb	battery voltage, filtered ($\tau \approx 0.5s$)	V	$n \cdot 78.421 \cdot 2^{-15}$
0x0001	2	adc_vch[1]	Channel 1 voltage, filtered ($\tau \approx 0.5s$)	V	$n \cdot 78.421 \cdot 2^{-15}$
0x0002	3	adc_vch[2]	Channel 2 voltage, filtered ($\tau \approx 0.5s$)	V	$n \cdot 78.421 \cdot 2^{-15}$
0x0003	4	adc_vch[3]	Channel 3 voltage, filtered ($\tau \approx 0.5s$)	V	$n \cdot 78.421 \cdot 2^{-15}$
0x0004	5	adc_vch[4]	Channel 4 voltage, filtered ($\tau \approx 0.5s$)	V	$n \cdot 78.421 \cdot 2^{-15}$
0x0005	6	T_mod	Relay Driver Temperature, filtered ($\tau \approx 15s$) (0x80 on error)	ºC	±127
0x0006	7	global faults	Relay Driver fault bitfield	-	
0x0007	8	global alarms	Relay Driver alarm bitfield	-	
0x0008	9	hourmeter_HI	hourmeter, HI word	h	0 to $(2^{24}-1)$
0x0009	10	hourmeter_LO	hourmeter, LO word	-	
0x000A	11	ch_faults[1]	Channel 1 fault bitfield	-	
0x000B	12	ch_faults[2]	Channel 2 fault bitfield	-	
0x000C	13	ch_faults[3]	Channel 3 fault bitfield	-	
0x000D	14	ch_faults[4]	Channel 4 fault bitfield	-	
0x000E	15	ch_alarms[1]	Channel 1 alarm bitfield	-	
0x000F	16	ch_alarms[2]	Channel 2 alarm bitfield	-	
0x0010	17	ch_alarms[3]	Channel 3 alarm bitfield	-	
0x0011	18	ch_alarms[4]	Channel 4 alarm bitfield	-	

EEPROM

PDU Addr	Logical Addr	Variable name	Variable description	Write allowed	Units	Scaling or Range
0xE000	57345	Emodbus_id	MODBUS ID (default = 9)	✓	-	
0xE001	57346	Econtrol_addr	Meter Bus ID (default = 9)	✓	-	1-15
0xE002	57347 - 57456	reserved			-	
0xE070	57457	Ehourmeter_HI	hourmeter, HI word		h	0 to $(2^{24}-1)$
0xE071	57458	Ehourmeter_LO	hourmeter, LO word		-	
0xE072-0xE077	57459-57464	-	-			
0xE078-0xE07F	57465-57472	reserved	read or write not allowed			

Calibration Values

PDU Addr	Logical Addr	Variable name	Variable description	Scaling or Range
0xF000	61441	serial[1],[0]	serial number (8 byte ASCII string)	
0xF001	61442	serial[3],[2]		
0xF002	61443	serial[5],[4]		
0xF003	61444	serial[7],[6]		
0xF004 – 0xF009	61445 - 61450	reserved		
0xF00A	61451	K_hw ver[major, minor]	MSB: hardware version major LSB: hardware version minor	

Read Coils (0x01), Read Discrete Inputs (0x02), Write Single Coil (0x05)

PDU Addr	Logical Addr	Variable description
0x0000	1	Channel 0 (0 = inactive (high impedance), 1=active (low impedance), write is only possible when the channel is in modbus slave mode)
0x0001	2	Channel 1
0x0002	3	Channel 2
0x0003	4	Channel 3
...	5-20	
0x0014	21	Clear faults (set only, will always read 0)
0x0015	22	Clear alarms (set only, will always read 0)
0x0016	23	Force EEPROM update (set only, will always read 0)
0x0017	24	
...	25-254	reserved
0x00FF	256	Reset control (respond and then reset?)

Note: When a channel is NOT in modbus slave mode, the coil state will read the actual coil state. When it IS in modbus slave mode, the coil will always read the commanded state.

Write Single Register (0x06)

Any write to EEPROM will set an "EEPROM changed" fault. The Relay Driver must be reset to clear this fault.
Note: No verify is performed on the write.

See EEPROM table in Read Input Registers(0x04).

Read Device Identification (0x2B, subcode 0x0E)

Only supports "basic device identification (stream access)" (ID code 0x01)

Object Id	Object Name/Description	Typical Value
0x00	VendorName	"Morningstar Corp."
0x01	Product Code	"TS-45" or "TS-60"
0x02	MajorMinorRevision (hardware major.minor. software revision)	"v01.01.01"

Variables and Definitions

Variable_name
[Logical Address][PDU Address] (Units). *Short description.*
Definition.

Read Holding and Read Input Registers
Located in processor RAM, updated continuously.

adc_vs

[01][0x0000] (V). *source voltage, filtered ($\tau \approx 0.5s$).*
Voltage measured at the source power connection on the Relay Driver.

adc_vch[x]

[2 - 5][0x0001 – 0x0004] *channel x voltage, filtered ($\tau \approx 0.5s$).*
Voltage reading at each of the four channels respectively. The voltage can be polled regardless of the function assigned to the channel (the channel does not have to be configured as an input)

T_mod

[06][0x0005] (C). *Relay Driver temperature, filtered ($\tau \approx 0.5s$).*
An on-board thermistor reports the measured ambient temperature of the Relay Driver. Some self-heating may skew temperature measurement slightly warmer than actual ambient temperature.

global faults

[07][0x0006] (bit field). *self diagnostic faults.*
Reports Relay Driver faults identified by self-diagnostics. Each bit corresponds to a specific fault. See appendix for bit definitions.

global alarms

[08][0x0007] (bit field). *self diagnostic alarms.*
Reports Relay Driver alarms identified by self-diagnostics. Each bit corresponds to a specific alarm. See appendix for bit definitions.

hourmeter_HI / hourmeter_LO

[09,10][0x0008, 0x0009] (hrs).*hour meter counter.*
Reports total hours of operation since installed.

ch_faults[x]

[11-14][0x000A - 0x000D] (bit field).*channel x faults.*
Reports channel faults identified by self-diagnostics. Each bit corresponds to a specific fault. Faults indicated in these bit fields are specific to their respective channels. See appendix for bit definitions.

ch_alarms[x]

[15-18][0x000E - 0x0011] (bit field).*channel x alarms.*
Reports channel alarms identified by self-diagnostics. Each bit corresponds to a specific alarm. Alarms indicated in these bit fields are specific to their respective channels. See appendix for bit definitions.

EEPROM Values

EEPROM values that require updating are done so once every 24 hours.

Emodbus_id

[57345][0xE000](-). *MODBUS Server ID.*
Modbus address which uniquely identifies the Relay Driver on the MODBUS network. Default factory address is 9. Valid address range is 1-247.

Econtrol_addr

[57346][0xE001](-). *Meter Bus ID.*
Address which uniquely identifies the Relay Driver on the Meter Bus network. Default factory address is 9. Valid address range is 1-15.

Calibration Values

serial[1],[0] / serial[3],[2] / serial[5],[4] / serial[7],[6]

[61441 - 61444] [0xF000 - 0xF003]
serial number (8 byte ASCII string)

K_hw ver (major, minor)

[61451] [0xF00A]
MSB: hardware version major
LSB: hardware version minor

Coils

0x0000	1	Channel 0 (0 = inactive (high impedance), 1=active (low impedance), write is only possible when the channel is in modbus slave mode)

0x0001	2	Channel 1
0x0002	3	Channel 2
0x0003	4	Channel 3
...	5-20	reserved
0x0014	21	Clear faults (set only, will always read 0)
0x0015	22	Clear alarms (set only, will always read 0)
0x0016	23	Force EEPROM update (set only, will always read 0)
0x0017	24	reserved
...	25-254	reserved
0x00FF	256	Reset control (respond and then reset?)

Channel x

[01-04] [0x0000-0x0003]
Toggle channel x on/off.
0 = inactive, off (high impedance)
1=active, on (low impedance)

note: Channel x must be configured for Modbus Slave to control the output state.

Clear faults

[21] [0x0014]
Clears the faults bit field.
(set only, will always read 0)

Clear alarms

[22] [0x0015]
Clears the alarms bit field.
(set only, will always read 0)

Force EEPROM update

[23] [0x0016]
Force the controller to update EEPROM with RAM values.
(set only, will always read 0)

Reset control

[256] [0x00FF]
Reset control will force a reboot of the processor software. Useful for clearing faults/alarms after settings changes, or firmware updates.

Appendix

Global Faults Table	
Bit	Fault
0	software error
1	EEPROM settings edit
2	execution timing error
3 - 7	reserved

Global Alarms Table	
Bit	Alarm
0	Internal temperature sensor open
1	Internal temperature sensor shorted
2	Relay driver uncalibrated
3 - 7	reserved

Channel Faults Table	
Bit	Fault
0	channel overcurrent
1	illegal function type
2	function specific fault
3 - 7	reserved

* Threshold Function: Illegal variable ID
Genstart Function: Illegal variable ID, genstart retries expired

Channel Alarms Table	
Bit	Alarm
0	Communication timeout
1 - 7	reserved

Examples

Scaling

Scaling Source voltage, filtered ($\tau \approx 0.5s$)
Read Holding Register Value: 0x1507
Scaling for this variable: $n \cdot 78.421 \cdot 2^{-15}$

```
1007 hex → 5383 decimal
(5383 x 78.421) / 32768  = 12.9V
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References

- Modbus Protocol Reference Guide, Modicon, June 1996, PI-MODBUS-300 Rev.J
- Modbus Application Protocol Specification, modbus.org, May 2002

Document History

V01   1st public release
V02   added fault and alarm bitfield definitions