tM-DA1P1R1
User Manual

Warranty

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Date: 2018/5/23

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1. Introduction

The tM series is a family of network data acquisition and control modules, providing analog-to-digital, digital-to-analog, digital input/output, timer/counter and other functions. The modules can be remotely controlled using a set of commands, which we call the DCON protocol, or the standard Modbus protocol. Communication between the module and the host is in ASCII format via an RS-485 bi-directional serial bus standard. Baud Rates are software programmable and transmission speeds of up to 115.2K baud can be selected.

The tM series feature a new design for the frame ground and INIT switch as shown in the figure. The frame ground provides enhanced static protection (ESD) abilities and ensures the module is more reliable. The INIT switch allows easier access to INIT mode. Please refer to Sections A.1 and A.8 for more details.



The features of the tM-DA1P1R1 are as follows:

1. 2500V_{DC} inter-module isolation
2. Programmable power-on values for analog output and digital output
3. Programmable slew rate for analog output

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4. Software calibration
5. one channel 12-bit analog output
6. one channel digital input
7. one channel relay output

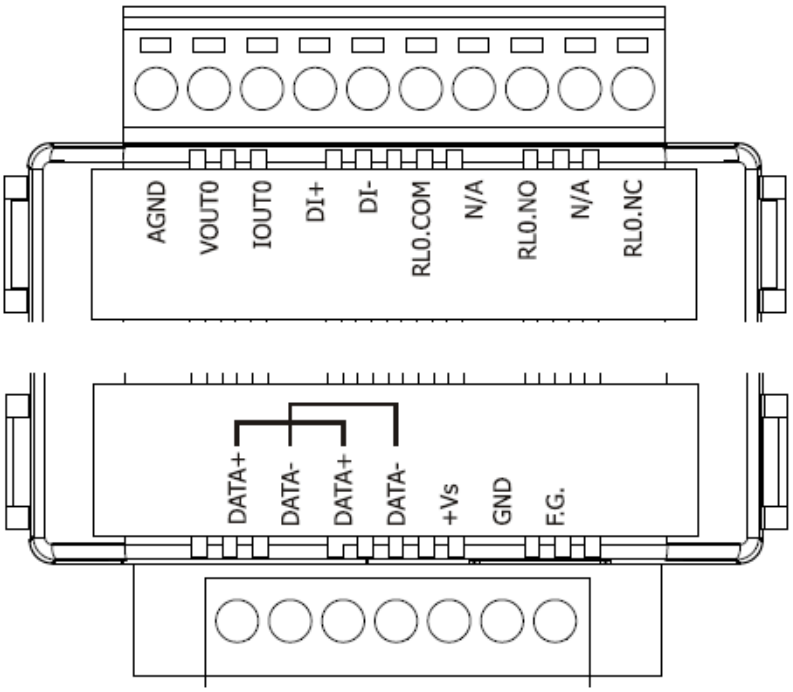
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1.1 More Information

- For details of **INIT mode** operation, please refer to Section A.1 INIT Mode.
- For details of **module watchdog** and **host watchdog**, please refer to Section A.2 Dual Watchdog Operation.
- For details of **ESD protection** and **grounding**, please refer to Section A.8 Frame Ground.

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1.2 Terminal Assignment



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1.3 Specifications

System Specifications:

Communication	
Interface	RS-485
Format	(N, 8, 1), (N, 8, 2), (O, 8, 1), (E, 8, 1)
Baud Rate	1200 ~ 115200 bps
Protocol	DCON, Modbus/RTU, Modbus/ASCII
Watchdog	Communication (Programmable)
LED Indicators/Diaplay	
System LED Indicator	Yes, 1 LED as Power/Communication Indicator
I/O LED Indicator	-
Isolation	
Intra-module Isolation, Filed-to-Logic	2500 VDC
EMS Protection	
ESD (IEC 61000-4-2)	±4 kV contact for Each Terminal
	±8 kV Air for Random Point
EFT (IEC 61000-4-4)	±4 kV for Power Line
Surge (IEC 61000-4-5)	-
Power	
Reverse Polarity Protection	Yes
Input Range	10 ~ 30 VDC
Consumption	1.8 W max.
Mechanical	
Dimensions (W x L x H)	52 mm x 98 mm x 27 mm
Installation	DIN-Rail Mounting
Environment	
Operating Temperature	-25 ~ +75 ℃
Storage Temperature	-30 ~ +80 ℃
Humidity	10 ~ 95% RH, Non-condensing

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I/O Specifications:

Analog Output		
Channel		1
Type		0~10V, 0~20mA, 4~20mA
Resolution		12-bit
Accuracy		±0.1% of FSR
DA Output Response Time		10 ms
Voltage Output Capability		20 mA
Current Load Resistance		500 Ω
Digital Input/Counter		
Channel		1
Type	**Dry Contact**	Sink
	Wet Contact	Sink/Source
Wet Contact	**On Voltage Level**	+3.5 VDC ~ +50VDC
	Off Voltage Level	+1 VDC Max.
Dry Contact	**On Voltage Level**	Close to GND
	Off Voltage Level	Open
Counters	**Max. Counts**	65536 (16-bit)
	Max. Input Frequency	100 Hz
	Min. Pulse Width	5 ms
Input Impedance		10 KΩ
Channel-to-Channel Isolation		-
Overvoltage Protection		±70 VDC
Relay Output		
Channel		1 (From C)
Relay Type		Power Relay
From C Relay	**Contact Rating**	NO : 10 A @250 $V_{AC,}$ 30 V_{DC} NC : 6 A @250 $V_{AC,}$ 30 V_{DC}
	Operate Time	15 ms max.
	Release Time	5 ms max.
	Mechanical Endurance	1 X 10^7 OPS
	Electrical Endurance	5 X 10^4 OPS
Power On and Safe Value		Yes, Programmable

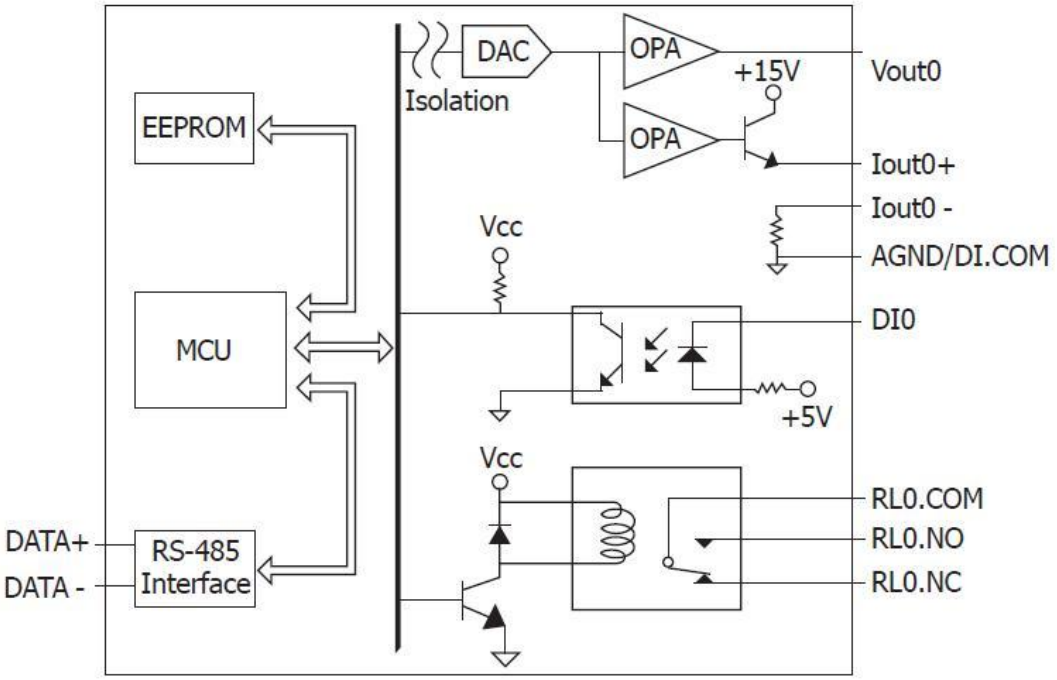
Notes:

1. A warm up period of 30 minutes is recommended in order to achieve the complete performance results described in the specifications.
2. The specifications are typical at 25℃ unless otherwise stated.

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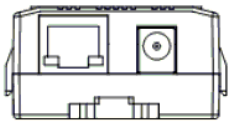
1.4 Block Diagrams

1.4.1 Block Diagram for the tM-DA1P1R1

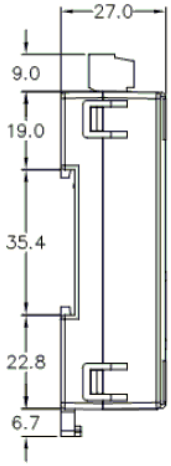


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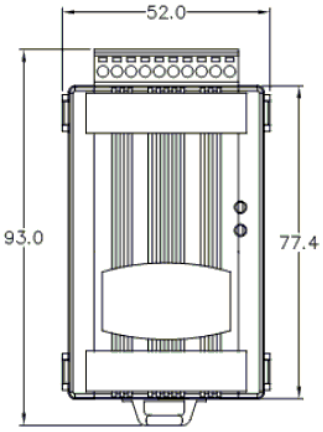
1.5 Dimensions



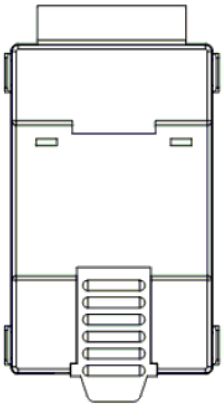
Top View



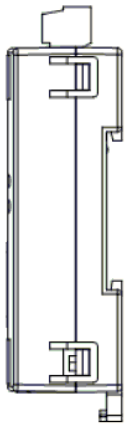
Left Side View



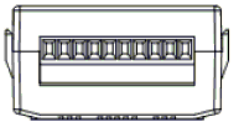
Front View



Back View



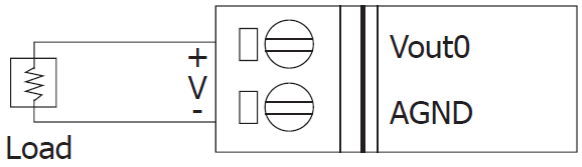
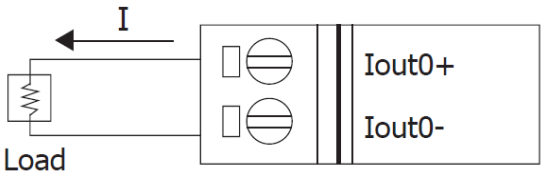
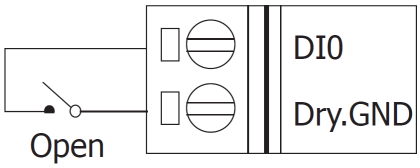
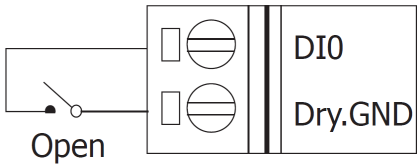
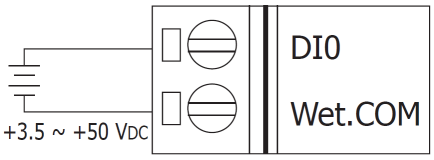
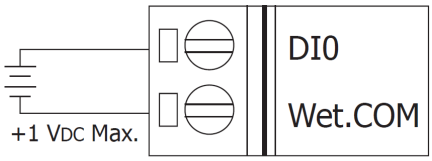
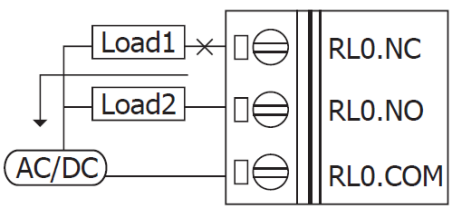
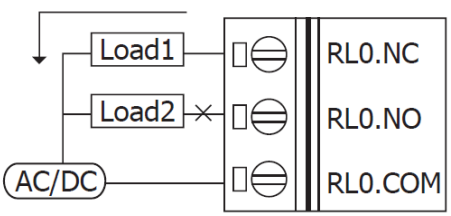
Right Side View



Bottom View

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1.6 Wiring

<table>
<tr><th colspan="3">Voltage Output</th></tr>
<tr><td colspan="3">
</td></tr>
<tr><th colspan="3">Current Output</th></tr>
<tr><td colspan="3">
</td></tr>
<tr><th colspan="3">Digital Input/Counter</th></tr>
<tr><td>Wiring</td><td>ON State
Readback as 1</td><td>OFF State
Readback as 0</td></tr>
<tr><td rowspan="2">Dry Contact</td><td>Close to Dry.GND</td><td>Open</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td rowspan="2">Wet Contact</td><td>+3.5 VDC ~ +50 VDC</td><td>+1 VDC Max.</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><th colspan="3">Relay Output</th></tr>
<tr><td colspan="2">ON State</td><td>OFF State</td></tr>
<tr><td colspan="2">
</td><td>
</td></tr>
</table>

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1.6.1 Wiring Recommendations

- Use 26-12 AWG wire for signal connections.
- Strip the wire to a length of 7±0.5 mm.
- Use a crimp terminal for wiring.
- Avoid high-voltage cables and power equipment as much as possible.
- For RS-485 communication, use insulated and twisted pair 24 AWG wire, e.g. Belden 9841.

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1.7 Quick Start

Please refer to the Quick Start for tM-DA1P1R1.

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1.8 Default Settings

Default settings for the tM-DA1P1R1 are as follows:

- Protocol: Modbus RTU
- Module address: 01
- Analog output type: 0 ~ +10 V
- Baud rate: 9600 bps
- Engineering unit format

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1.9 Calibration

Warning: *It is not recommended that calibration be performed until the process is fully understood.*

1. Warm up the module for at least 30 minutes.
2. If you want to calibrate for current type, then connect a current meter to the current output channel 0 terminal of the module. If you want to calibrate for voltage type, then connect a voltage meter to the voltage output channel 0 terminal of the module.
3. Set the type code to the type you want to calibrate. Refer to Section 2.13 for details.
4. Send command to output zero calibration current/voltage. Refer to Section. 2.2 for details.
5. Repeat to send the trim command and check the meter until the meter's reading is nearest to zero calibration current/voltage. Refer to Section 2.6 for details of sending the trim command.
6. Send the zero calibration command. Refer to Section 2. 3 for details.
7. Send command to output span calibration current/voltage. Refer to Section. 2.2 for details.
8. Repeat to send the trim command and check the meter until the meter's reading is nearest to span calibration current/voltage. Refer to Section 2.6 for details of sending the trim command.
9. Send the span calibration command. Refer to Section 2.4 for details.

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Notes:

1. The zero/span calibration voltages and currents are shown as below.
2. The tM-DA1P1R1 must be switched to the DCON protocol mode before calibrating. Refer to Section 3.9 for details of the switching protocol.

Calibration voltages/current used by the tM-DA1P1R1:

Type Code	0	1	2	4
Zero voltage/current	0mA	4mA	0V	0V
Span voltage/current	+20mA	+20mA	+10V	+5V

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1.10 Configuration Tables

Baud Rate Setting (CC)

7	6	5	4	3	2	1	0
Data		Baud					

Key	Description
Baud	Baud Rate 03: 1200 04: 2400 05: 4800 06: 9600 07: 19200 08: 38400 09: 57600 0A: 115200
Data	Data Format 0: N81 1: N82 2: E81 3: O81

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Data Format Setting (FF)

7	6	5	4	3	2	1	0
RS	CS	RS				DF	

Key	Description
DF	Data format 00: Engineering unit 01*: % of FSR (full scale range) 10*: 2's complement hexadecimal
CS	Checksum setting 0: Disabled 1: Enabled
RS	Reserved

Note: The reserved bits should be zero.

Analog Output Type and Data Format Table for tM-DA1P1R1

Type Code	Output Range	Data Format	Max.	Min.
0	0 ~ 20 mA	Engineering unit	+20.000	+00.000
		% of FSR	+100.00	+000.00
		2's comp HEX	FFFF	0000
1	4 ~ 20 mA	Engineering unit	+20.000	+04.000
		% of FSR	+100.00	+000.00
		2's comp HEX	FFFF	0000
2	0 ~ 10 V	Engineering unit	+10.000	+00.000
		% of FSR	+100.00	+000.00
		2's comp HEX	FFFF	0000
4	0 ~ 5 V	Engineering unit	+05.000	+00.000
		% of FSR	+100.00	+000.00
		2's comp HEX	FFFF	0000

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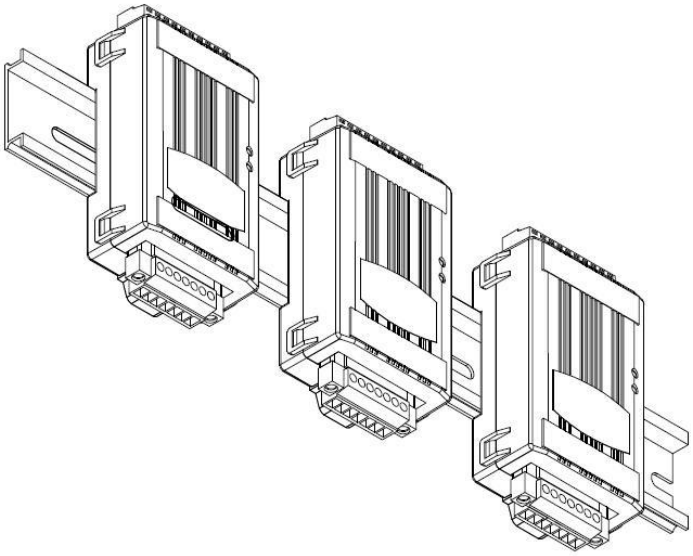
Slew Rate Setting (S)

S	V/s	mA/s
0	Immediate	Immediate
1	0.0625	0.125
2	0.125	0.25
3	0.25	0.5
4	0.5	1.0
5	1.0	2.0
6	2.0	4.0
7	4.0	8.0
8	8.0	16.0
9	16.0	32.0
A	32.0	64.0
B	64.0	128.0
C	128.0	256.0
D	256.0	512.0
E	512.0	1024.0

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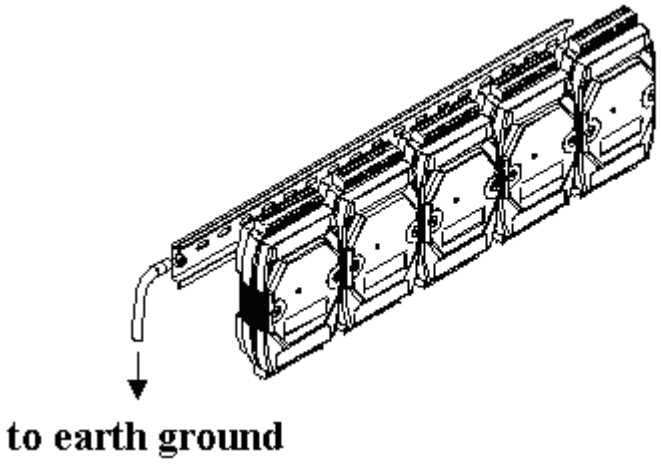
1.11 Mounting

1.11.1 Din-Rail Mounting



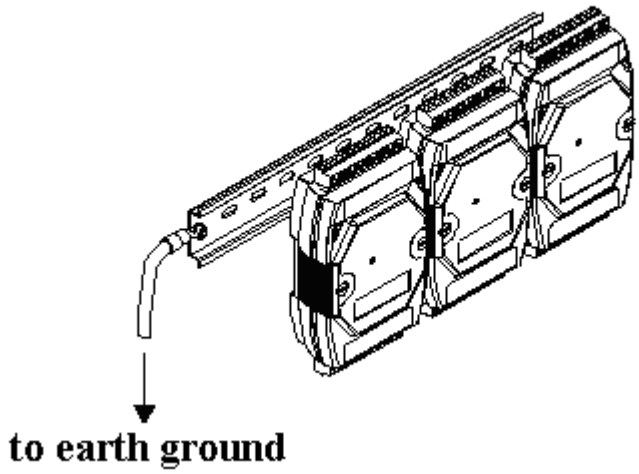
There are three new DIN rail models available. Each is made of stainless steel, which is stronger than those made of aluminum. There is a screw at one end and a ring terminal is included so that it can be easily connected to the earth ground. The three new DIN rail models are as follows.

Part number	Max. number of modules	Dimensions
DRS-360	5	360mm x 35mm

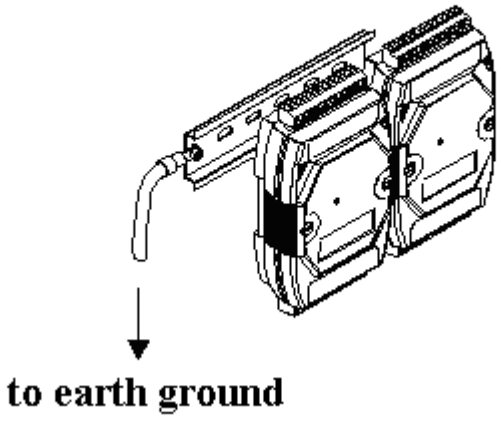


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Part number	Max. number of modules	Dimensions
DRS-240	3	240mm x 35mm



Part number	Max. number of modules	Dimensions
DRS-125	2	125mm x 35mm



Note: It is recommended that a 16 – 14 AWG wire is used to connect the DIN rail to the earth ground.

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1.12 Technical Support

Should you encounter any problems while using the tM series module, and are unable to find the help you need in this manual or on our website, please contact ICP DAS Product Support.

Email: service@icpdas.com
Website: http://www.icpdas.com.tw/contact_us/contact_us.html

When requesting technical support, be prepared to provide the following information about your system:

1. Module name and serial number: The serial number can be found printed on the barcode label attached to the cover of the module.
2. Firmware version: See Section 2.14 for information regarding the command used to identify the firmware version. Or, read the Modbus registers 40481 and 40482 for Modbus protocol.
3. Host configuration (type and operating system)
4. If the problem is reproducible, please give full details describing the procedure used to reproduce the problem.
5. Any specific error messages displayed. If a dialog box with an error message is displayed, please include the full text of the dialog box, including the text in the title bar.
6. If the problem involves other programs or hardware devices, please describe the details of the problem in full.
7. Any comments and suggestions related to the problem are welcome.

ICP DAS will reply to your request by email within three business days.

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2. DCON Protocol

All communication with tM modules consists of commands generated by the host and responses transmitted by the tM modules. Each module has a unique ID number that is used for addressing purposes and is stored in non-volatile memory. The ID is 01 by default and can be changed using a user command. All commands to the modules contain the ID address, meaning that only the addressed module will respond. The only exception to this is command ~** (Section 2.20), which is sent to all modules, but in these cases, the modules do not reply to the command.

Command Format:

Leading Character	Module Address	Command	[CHKSUM]	CR

Response Format:

Leading Character	Module Address	Data	[CHKSUM]	CR

CHKSUM A 2-character checksum which is present when the checksum setting is enabled. See Sections 1.10 (Data Format Setting) and 2.1 for details.

CR End of command character, carriage return (0x0D)

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Checksum Calculation:

1. Calculate the ASCII code sum of all the characters in the command/response string except for the carriage return character (CR).
2. The checksum is equal to the sum masked by 0FFh.

Example:

Command string: $012(CR)

1. Sum of the string = “$”+”0”+”1”+”2” = 24h+30h+31h+32h = B7h
2. Therefore the checksum is B7h, and so CHKSUM = “B7”
3. The command string with the checksum = $012B7(CR)

Response string: !01200600(CR)

1. Sum of the string = “!”+”0”+”1”+”2”+”0”+”0”+”6”+”0”+”0” = 21h+30h+31h+32h+30h+30h+36h+30h+30h = 1AAh
2. Therefore the checksum is AAh, and so CHKSUM = “AA”
3. The response string with the checksum = !01200600AA(CR)

Note:

All characters should be in upper case.

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General Command Sets			
Command	**Response**	**Description**	**Section**
%AANNTTCCFF	!AA	Sets the module configuration	2.1
$AA2	!AATTCCFF	Reads the module configuration	2.5
$AA5	!AAS	Reads the module reset status	2.8
$AAF	!AA(Data)	Reads the firmware version	2.14
$AAI	!AAS	Reads the INIT terminal status	2.15
$AAM	!AA(Data)	Reads the module name	2.16
$AAP	!AASC	Reads the communication protocol	2.17
$AAPN	!AA	Sets the communication protocol	2.18
~AAO(Name)	!AA	Sets the module name	2.19
~AARD	!AAVV	Reads the response delay time	2.29
~AARDVV	!AA	Sets the response delay time	2.30

Analog Output Command Sets			
Command	**Response**	**Description**	**Section**
#AAN(Data)	>	Sets the analog output of a channel	2.2
$AA0N	!AA	Performs zero calibration of a channel	2.3
$AA1N	!AA	Performs span calibration of a channel	2.4
$AA3NVV	!AA	Adjusts the analog output of a channel for calibration	2.6
$AA4N	!AA	Sets the current output value of a channel as power-on value	2.7
$AA6N	!AA(Data)	Reads the last written analog output value of a channel	2.9
$AA7N	!AA	Reads the power-on value of a channel	2.10
$AA8N	!AA(Data)	Reads the current analog output of a channel	2.11
$AA9N	!AATS	Reads the analog output configuration of a channel	2.12
$AA9NTS	!AA	Sets the analog output configuration of a channel	2.13

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Digital Input and Output Command Sets			
Command	**Response**	**Description**	**Section**
@AACECN	!AA	Resets the counter data of a digital channel	2.31
@AADI	!AA0OOII	Reads the digital output and input status	2.32
@AADODD	!AA	Sets the digital output value	2.33
@AARECN	!AA(Data)	Reads the counter data of a digital channel	2.34
~AA4	!AAPPSS	Reads the power on and safe digital output value	2.25
~AA5PPSS	!AA	Sets the power on and safe digital output value	2.28

Host Watchdog Command Sets			
Command	**Response**	**Description**	**Section**
~**	No Response	Host is OK	2.20
~AA0	!AASS	Reads the host watchdog status	2.21
~AA1	!AA	Resets the host watchdog status	2.22
~AA2	!AAETT	Reads the host watchdog timeout settings	2.23
~AA3ETT	!AA	Sets the host watchdog timeout settings	2.24
~AA4N	!AA(Data)	Reads the safe value of an analog output channel	2.26
~AA5N	!AA	Sets the current analog output value as safe value for a channel	2.27

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2.1 %AANNTTCCFF

Description:

Sets the configuration of an analog output module.

Syntax:

%AANNTTCCFF[CHKSUM](CR)

% Delimiter character

AA Address of the module to be configured in hexadecimal format (00 to FF)

NN New address of the module in hexadecimal format (00 to FF)

TT New type code, see Section 1.10 for details. Not used by the tM-DA1P1R1. For the tM-DA1P1R1, use the $AA9NTS command to set the type of each channel, see Section 2.13 for details.

CC New Baud Rate code, see Section 1.10 for details. To change the Baud Rate, the right slide switch must be set to the INIT position. See Section A.1 for details.

FF Used to set the data format and checksum. To change the checksum setting, the right slide switch must be set to the INIT position. See Section A.1 for details.

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Response:

Valid Command: **!AA[CHKSUM](CR)**
Invalid Command: **?AA[CHKSUM](CR)**

! Delimiter for a valid command

? Delimiter for an invalid command. If changing the **Baud Rate** or **checksum** settings without switching the right slide switch to the INIT position, the module will return an invalid command.

AA Address of the module in hexadecimal format (00 to FF)

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

Examples:

Command: %0102000600 Response: !02

Changes the address of module 01 to 02. The module returns a valid response.

Command: %0101000A00 Response: ?01

Changes the Baud Rate of module 01 to 115200bps. The module returns an invalid command, because it is not in INIT* mode.

Command: %0101000A00 Response: !01

Changes the Baud Rate of module 01 to 115200bps and the module is in INIT* mode. The module returns a valid response.

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Related Commands:

Section 2.5 $AA2

Related Topics:

Section 1.10 Configuration Tables, Section A.1 INIT Mode

Note:

Changes to the address and data format settings take effect immediately after a valid command is received. Changes to the Baud Rate and checksum settings take effect on the next power-on reset.

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2.2 #AAN(Data)

Description:

Writes the data to a specified analog output channel.

Syntax:

#AAN(Data)[CHKSUM](CR)

#	Delimiter character
AA	Address of the module to be written (00 to FF)
N	The analog output channel to be written, 0 for tM-DA1P1R1.
(Data)	Data to be written to the analog output channel, see Section 1.10 for the data format.

Response:

Valid Command:	**>[CHKSUM](CR)**
Out of Range:	**?[CHKSUM](CR)**
Ignored:	**![CHKSUM](CR)**

>	Delimiter character for a valid command
?	Delimiter character indicates that the data is out of range. If it is over range, then the output will be set to the maximum value of the range. If it is under range, then the output will be set to the minimum value of the range.
!	Delimiter character indicates that the command is ignored, because the host watchdog timeout occurs. The output is set to the safe value.

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Command: $012 Response: !01000600

Reads the configuration of module 01. It returns: engineering data format.

Command: $0190 Response: !0110

Reads the configuration of analog output channel 0 of module 01. It returns: output type 4 mA to 20 mA and output changing immediately.

Command: #010+05.000 Response: >

Sets channel 0 of module 01 to output 5 mA. The module returns a valid response.

Command: #010+25.000 Response: ?

Sets channel 0 of module 01 to output 25 mA. The module returns an out of range response and the output is set to 20 mA.

Related Commands:

Section 2.1 %AANNTTCCFF, Section 2.5 $AA2

Related Topics:

Section 1.10 Configuration Tables, Section A.5 Analog Output

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2.3 $AA0N

Description:

Performs a zero calibration.

Syntax:

$AA0N[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be calibrated (00 to FF)
0	Command for the zero calibration
N	Specifies the channel to be calibrated, 0 for tM-DA1P1R1

Response:

Valid Command: **!AA[CHKSUM](CR)**

Invalid Command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

Examples:

Command: $0100 Response: !01

Performs a zero calibration on channel 0 of module 01 and returns a valid response.

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Related Commands:

Section 2.4 $AA1N, Section 2.6 $AA3NVV

Related Topics:

Section 1.9 Calibration

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2.4 $AA1N

Description:

Performs a span calibration.

Syntax:

$AA1N[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be calibrated (00 to FF)
1	Command for the span calibration
N	Specifies the channel to be calibrated, 0 for tM-DA1P1R1

Response:

Valid Command: **!AA[CHKSUM](CR)**

Invalid Command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

Examples:

Command: $0110 Response: !01

Performs a span calibration on channel 0 of module 01 and returns a valid response.

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Related Commands:
Section 2.3 $AA0N, Section 2.6 $AA3NVV

Related Topics:
Section 1.9 Calibration

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2.5 $AA2

Description:

Reads the module configuration.

Syntax:

$AA2[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be read (00 to FF)
2	Command to read the module configuration

Response:

Valid Command: **!AATTCCFF[CHKSUM](CR)**

Invalid Command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)
TT	Type code of the module. For the tM-DA1P1R1, this field is set to 00.
CC	Baud Rate code of the module, see Section 1.10 for details.
FF	Data format and checksum settings of the module, see Section 1.10 for details.

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: $012 Response: !01000600

Reads the configuration of module 01.

Command: $022 Response: !02000602

Reads the configuration of module 02.

Related Commands:

Section 2.1 %AANNTTCCFF

Related Topics:

Section 1.10 Configuration Tables

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2.6 $AA3NVV

Description:

Adjusts the analog output of a specified channel for calibration.

Syntax:

$AA3NVV[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be adjusted (00 to FF)
3	Command to adjust the analog output
N	The channel to be adjusted, 0 for tM-DA1P1R1
VV	A two-digit 2's complement hexadecimal value to adjust the analog output. The value of 00 to 5F is to increase 0 to 95 counts and FF to A1 is to decrease 1 to 95 counts, where each count is about 4.88uA or 2.44mV.

Response:

Valid Command: **!AA[CHKSUM](CR)**

Invalid Command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: $01301F Response: !01

Sets the analog output channel 0 of module 01 to be increased by 31 and returns a valid response.

Related Commands:

Section 2.3 $AA0N, Section 2.4 $AA1N

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2.7 $AA4N

Description:

Sets the current output of a specified channel as the power-on value.

Syntax:

$AA4N[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be set (00 to FF)
4	Command to set the power on value
N	The channel to be set, 0 for tM-DA1P1R1

Response:

Valid Command: **!AA[CHKSUM](CR)**

Invalid Command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

Examples:

Command: #01000.000 Response: >

Sets the output of channel 0 of module 01 to 0.0mA and returns a valid response.

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Command: $0140 Response: !01

Sets the current output of channel 0 of module 01 as the power-on value and returns a valid response.

Related Commands:

Section 2.2 #AAN(data), Section 2.10 $AA7N

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2.8 $AA5

Description:

Reads the reset status of a module.

Syntax:

$AA5[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be read (00 to FF)
5	Command to read the module reset status

Response:

Valid Command: **!AAS[CHKSUM](CR)**

Invalid Command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)
S	Reset status of the module 1: This is the first time the command has been sent since the module was powered on. 0: This is not the first time the command has been sent since the module was powered on, which denotes that there has been no module reset since the last $AA5 command was sent.

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: $015 Response: !011

Reads the reset status of module 01. The response shows that it is the first time the $AA5 command has been sent since the module was powered-on.

Command: $015 Response: !010

Reads the reset status of module 01. The response shows that there has been no module reset since the last $AA5 command was sent.

Related Topics:

Section A.4 Reset Status

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2.9 $AA6N

Description:

Reads the last written analog output value of a specified channel.

Syntax:

$AA6N[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be read (00 to FF)
6	Command to read the last written analog output value
N	The channel to be read, 0 for tM-DA1P1R1

Response:

Valid command: **!AA(Data)[CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command or invalid type code
AA	Address of the responding module (00 to FF)
(Data)	The last written analog output value, see Section 1.10 for details of the data format.

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: #010+10.000 Response: >

Sets the output of channel 0 of the module 01 to +10.000 and the module returns a valid response.

Command: $0160 Response: !01+10.000

Reads the last written analog output value of channel 1 of the module 01 and the module returns +10.000.

Related Commands:

Section 2.2 #AAN(Data), Section 2.11 $AA8N

Related Topics:

Section 1.10 Configuration Tables, Section A.7 Analog Output Read-back

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2.10 $AA7N

Description:

Reads the power-on analog output value of a specified channel.

Syntax:

$AA7N[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be read (00 to FF)
7	Command to read the power-on analog output value
N	The channel to be read, 0 for tM-DA1P1R1

Response:

Valid command: **!AA(Data)[CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command or invalid type code
AA	Address of the responding module (00 to FF)
(Data)	The power-on analog output value, see Section 1.10 for details of the data format.

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: $0170 Response: !01+10.000

Reads the power-on analog output value of channel 0 of the module 01 and the module returns +10.000.

Related Commands:

Section 2.7 $AA4N

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2.11 $AA8N

Description:

Reads the current analog output value of a specified channel.

Syntax:

$AA8N[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be read (00 to FF)
8	Command to read the current analog output value
N	The channel to be read, 0 for tM-DA1P1R1

Response:

Valid command: **!AA(Data)[CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command or invalid type code
AA	Address of the responding module (00 to FF)
(Data)	The current analog output value, see Section 1.10 for details of the data format.

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: $012 Response: !01000614

Reads the configuration of module 01 and the module returns a response of 9600 bps and engineering data format.

Command: #010+10.000 Response: >

Sets the output of channel 0 of the module 01 to +10.000 and the module returns a valid response.

Command: $0160 Response: !01+10.000

Reads the last written analog output value of channel 2 of the module 01 and the module returns +10.000.

Command: $0180 Response: !01+01.000

Reads the current analog output value of channel 2 of the module 01 and the module returns +01.000.

Related Commands:

Section 2.2 #AAN(Data), Section 2.9 $AA6N

Related Topics:

Section 1.10 Configuration Tables, Section A.6 Slew Rate Control, Section A.7 Analog Output Read-back

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2.12 $AA9N

Description:

Reads the analog output configuration of a specified channel.

Syntax:

$AA9N[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be read (00 to FF)
9	Command to read the analog output configuration
N	The channel to be read, 0 for tM-DA1P1R1

Response:

Valid command: **!AATS[CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)
T	Analog output type, see Section 1.10 for details.
S	Analog output slew rate, see Section 1.10 for details.

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: $0190 Response: !0110

Reads the configuration of channel 0 for module 01 and returns a configuration of 4 to 20mA range and output changing immediately.

Related Commands:

Section 2.13 $AA9NTS

Related Topics:

Section 1.10 Configuration Tables

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2.13 $AA9NTS

Description:

Sets the analog output configuration of a specified channel.

Syntax:

$AA9NTS[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be set (00 to FF)
9	Command to set the analog output configuration
N	The channel to be set, 0 for tM-DA1P1R1
T	Analog output type, see Section 1.10 for details.
S	Analog output slew rate, see Section 1.10 for details.

Response:

Valid command: **!AA[CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: $019021 Response: !01

Sets the configuration of channel 0 for module 01 to 0 to 10V range and 0.625V/second slew rate and returns a valid response.

Related Commands:

Section 2.12 $AA9N

Related Topics:

Section 1.10 Configuration Tables

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2.14 $AAF

Description:

Reads the firmware version of a module.

Syntax:

$AAF[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be read (00 to FF)
F	Command to read the firmware version

Response:

Valid command: **!AA(Data)[CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)
(Data)	Firmware version string of the module

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

Examples:

Command: $01F Response: !01A2.0

Reads the firmware version of module 01, and shows that it is version A2.0.

Command: $02F Response: !02B1.1

Reads the firmware version of module 02, and shows that it is version B1.1.

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2.15 $AAI

Description:

Reads the INIT terminal status of a module.

Syntax:

$AAI[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be read (00 to FF)
I	Command to read the module INIT status

Response:

Valid command: **!AAS[CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)
S	INIT terminal status of the module 0: The INIT terminal is connected to the GND terminal 1: The INIT terminal is not connected to the GND terminal

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: $01I Response: !010

Reads the INIT status of module 01. The response shows that the right slide is in the INIT position.

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2.16 $AAM

Description:

Reads the name of a module.

Syntax:

$AAM[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be read (00 to FF)
M	Command to read the module name

Response:

Valid command: **!AA(Data)[CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)
(Name)	Name string of the module

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

Examples:

Command: $01M Response: !017021

Reads the module name of module 01 and returns the name “7021”.

Related Commands:

Section 2.19 ~AAO(Name)

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2.17 $AAP

Description:

Reads the communication protocol information.

Syntax:

$AAP[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be read (00 to FF)
P	Command to read the communication protocol

Response:

Valid Response: !AASC[CHKSUM](CR)

Invalid Response: ?AA[CHKSUM](CR)

!	Delimiter character for a valid response
?	Delimiter character for an invalid response
AA	Address of the responding module (00 to FF)
S	The protocols supported by the module 0: only DCON protocol is supported 1: both the DCON and Modbus RTU protocols are supported 3: all of the DCON and Modbus RTU/ASCII protocols are supported
C	Current protocol saved in EEPROM that will be used at the next power on reset 0: the protocol set in EEPROM is DCON 1: the protocol set in EEPROM is Modbus RTU 3: the protocol set in the EEPROM is Modbus ASCII

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There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

Examples:

Command: $01P Response: !0110

Reads the communication protocol of module 01 and returns a response of 10 meaning that it supports both the DCON and Modbus RTU protocols and the protocol that will be used at the next power on reset is DCON.

Related Commands:

Section 2.18 $AAPN

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2.18 $AAPN

Description:

Sets the communication protocol.

Syntax:

$AAPN[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be set (00 to FF)
P	Command to set the communication protocol
N	0: DCON protocol 1: Modbus RTU protocol 3: Modbus ASCII protocol Before using this command, the right slide switch must be in the INIT position, see Section A.1 for details. The new protocol is saved in the EEPROM and will be effective after the next power on reset.

Response:

Valid Response: !AA[CHKSUM](CR)
Invalid Response: ?AA[CHKSUM](CR)

!	Delimiter character for a valid response
?	Delimiter character for an invalid response
AA	Address of the responding module (00 to FF)

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: $01P1 Response: ?01

Sets the communication protocol of module 01 to Modbus RTU and returns an invalid response because the module is not in INIT mode.

Command: $01P1 Response: !01

Sets the communication protocol of module 01 to Modbus RTU and returns a valid response.

Related Commands:

Section 2.17 $AAP

Related Topics:

Section A.1 INIT Mode

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2.19 ~AAO(Name)

Description:

Sets the name of a module.

Syntax:

~AAO(Name)[CHKSUM](CR)

~	Delimiter character
AA	Address of the module to be set (00 to FF)
O	Command to set the module name
(Name)	New name of the module (max. 6 characters).

Response:

Valid command: **!AA[CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: ~01O7021N Response: !01

Sets the name of module 01 to be “7021N” and returns a valid response.

Command: $01M Response: !017021N

Reads the name of module 01 and returns the name “7021N”.

Related Commands:

Section 2.16 $AAM

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2.20 ~**

Description:

Informs all modules that the host is OK.

Syntax:

~[CHKSUM](CR)**

~ Delimiter character

** Host OK command

Response:

No response.

Examples:

Command: ~** No response

Sends a “Host OK” command to all modules.

Related Commands:

Section 2.21 ~AA0, Section 2.22 ~AA1, Section 2.23 ~AA2, Section 2.24 ~AA3EVV

Related Topics:

Section A.2 Dual Watchdog Operation

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2.21 ~AA0

Description:

Reads the host watchdog status of a module.

Syntax:

~AA0[CHKSUM](CR)

~	Delimiter character
AA	Address of the module to be read (00 to FF)
0	Command to read the module status

Response:

Valid command: **!AASS[CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)
SS	Two hexadecimal digits that represent the host watchdog status, where: Bit 7: 0 indicates that the host watchdog is disabled, and 1 indicates that the host watchdog is enabled, Bit 2: 1 indicates that a host watchdog timeout has occurred, and 0 indicates that no host watchdog timeout has occurred. The host watchdog status is stored in EEPROM and can only be reset by using the ~AA1 command.

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There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

Examples:

Command: ~010 Response: !0100

Reads the host watchdog status of module 01 and returns 00, meaning that the host watchdog is disabled and no host watchdog timeout has occurred.

Command: ~020 Response: !0204

Reads the host watchdog status of module 02 and returns 04, meaning that a host watchdog timeout has occurred.

Related Commands:

Section 2.20 ~**, Section 2.22 ~AA1, Section 2.23 ~AA2, Sec 2.24 ~AA3EVV

Related Topics:

Section A.2 Dual Watchdog Operation

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2.22 ~AA1

Description:

Resets the host watchdog timeout status of a module.

Syntax:

~AA1[CHKSUM](CR)

~	Delimiter character
AA	Address of the module to be reset (00 to FF)
1	Command to reset the host watchdog timeout status

Response:

Valid command: **!AA[CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: ~010 Response: !0104

Reads the host watchdog status of module 01 and shows that a host watchdog timeout has occurred.

Command: ~011 Response: !01

Resets the host watchdog timeout status of module 01 and returns a valid response.

Command: ~010 Response: !0100

Reads the host watchdog status of module 01 and shows that no host watchdog timeout has occurred.

Related Commands:

Section 2.20 ~**, Section 2.21 ~AA0, Section 2.23~AA2, Section 2.24~AA3EVV

Related Topics:

Section A.2 Dual Watchdog Operation

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2.23 ~AA2

Description:

Reads the host watchdog timeout value of a module.

Syntax:

~AA2[CHKSUM](CR)

~	Delimiter character
AA	Address of the module to be read (00 to FF)
2	Command to read the host watchdog timeout value

Response:

Valid command : **!AAEVV[CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)
E	1: the host watchdog is enabled 0: the host watchdog is disabled
VV	Two hexadecimal digits to represent the timeout value in tenths of a second, for example, 01 denotes 0.1 seconds and FF denotes 25.5 seconds.

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: ~012 Response: !011FF

Reads the host watchdog timeout value of module 01 and returns FF, which denotes that the host watchdog is enabled and the host watchdog timeout value is 25.5 seconds.

Related Commands:

Section 2.20 ~**, Section 2.21 ~AA0, Section 2.22 ~AA1, Section 2.24 ~AA3EVV

Related Topics:

Section A.2 Dual Watchdog Operation

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2.24 ~AA3EVV

Description:

Enables/disables the host watchdog and sets the host watchdog timeout value of a module.

Syntax:

~AA3EVV[CHKSUM](CR)

~	Delimiter character
AA	Address of the module to be set (00 to FF)
3	Command to set the host watchdog
E	1: enable the host watchdog 0: disable the host watchdog
VV	Two hexadecimal digits to represent the timeout value in tenths of a second, for example, 01 denotes 0.1 seconds and FF denotes 25.5 seconds.

Response:

Valid command: **!AA[CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: ~013164 Response: !01

Enables the host watchdog of module 01 and sets the host watchdog timeout value to 10.0 seconds. The module returns a valid response.

Command: ~012 Response: !01164

Reads the host watchdog timeout value of module 01. The module returns 164, which denotes that the host watchdog is enabled and the host watchdog timeout value is 10.0 seconds.

Related Commands:

Section 2.20 ~**, Section 2.21 ~AA0, Section 2.22 ~AA1, Section 2.23 ~AA2

Related Topics:

Section A.2 Dual Watchdog Operation

Notes:

When a host watchdog timeout occurs, the host watchdog is disabled. The ~AA3EVV command should be sent again to re-enable the host watchdog.

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2.25 ~AA4

Description:

Reads the power on and safe digital output values of a module.

Syntax:

~AA4[CHKSUM](CR)

~	Delimiter character
AA	Address of the module to be read (00 to FF)
4	Command to read the power on and safe digital output values

Response:

Valid command : **!AAPPSS[CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)
PP	Two hexadecimal digits to represent the power-on DO value.
SS	Two hexadecimal digits to represent the safe DO value.

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: ~014 Response: !010000

Reads the power-on DO value and the safe DO value of module 01 and returns 0000.

Related Commands:

Section 2.20 ~**, Section 2.21 ~AA0, Section 2.22 ~AA1, Section 2.24 ~AA3EVV, Section 2.28 ~AA5PPSS

Related Topics:

Section A.2 Dual Watchdog Operation, Section A.3 Module Output Status

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2.26 ~AA4N

Description:

Reads the safe analog output value of a specified channel of a module.

Syntax:

~AA4N[CHKSUM](CR)

~	Delimiter character
AA	Address of the module to be read (00 to FF)
4	Command to read the safe analog output value
N	The channel to be read, 0 for tM-DA1P1R1

Response:

Valid command : **!AA(Data)[CHKSUM](CR)**
Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)
(Data)	The safe analog output value, see Section 1.10 for details of the data format.

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

Examples:

Command: ~0140 Response: !0105.000

Reads the safe analog output value of channel 0 of module 01 and returns 05.000.

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Related Commands:

Section 2.20 ~**, Section 2.21 ~AA0, Section 2.22 ~AA1, Section 2.24 ~AA3EVV, Section 2.27 ~AA5N

Related Topics:

Section A.2 Dual Watchdog Operation, Section A.3 Module Output Status

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2.27 ~AA5N

Description:

Sets the current analog output value as the safe analog output value for a specified channel of a module.

Syntax:

~AA5N[CHKSUM](CR)

~	Delimiter character
AA	Address of the module to be set (00 to FF)
5	Command to set the safe analog output value
N	The channel to be set, 0 for tM-DA1P1R1

Response:

Valid command : **!AA[CHKSUM](CR)**
Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

Examples:

Command: ~0150 Response: !01

Sets the safe analog output value of channel 0 of module 01 and returns a valid response.

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Related Commands:

Section 2.20 ~**, Section 2.21 ~AA0, Section 2.22 ~AA1, Section 2.24 ~AA3EVV, Section 2.26 ~AA4N

Related Topics:

Section A.2 Dual Watchdog Operation, Section A.3 Module Output Status

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2.28 ~AA5PPSS

Description:

Sets the power on and safe digital output values of a module.

Syntax:

~AA5PPSS[CHKSUM](CR)

~	Delimiter character
AA	Address of the module to be set (00 to FF)
5	Command to set the power on and safe digital output values
PP	Two hexadecimal digits to represent the power-on DO value.
SS	Two hexadecimal digits to represent the safe DO value.

Response:

Valid command : **!AA[CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: ~0150000 Response: !01

Sets the power-on DO value to 0 and the safe DO value to 0. The module returns a valid response.

Command: ~014 Response: !010000

Reads the power-on DO value and the safe DO value of module 01 and returns 0000.

Related Commands:

Section 2.20 ~**, Section 2.21 ~AA0, Section 2.22 ~AA1, Section 2.24 ~AA3EVV, Section 2.25 ~AA4

Related Topics:

Section A.2 Dual Watchdog Operation, Section A.3 Module Output Status

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2.29 ~AARD

Description:

Reads the response delay time value of a module.

Syntax:

~AARD[CHKSUM](CR)

~	Delimiter character
AA	Address of the module to be read (00 to FF)
RD	Command to read the response delay time value

Response:

Valid Response: !AAVV[CHKSUM](CR)

Invalid Response: ?AA[CHKSUM](CR)

!	Delimiter character for a valid response
?	Delimiter character for an invalid response
AA	Address of the responding module (00 to FF)
VV	Two hexadecimal digits to represent the response delay time value in milli-second, for example, 01 denotes 1ms and 1E denotes 30ms. The max allowable value is 30 (1Eh).

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: ~01RD Response: !0102

Reads the response delay time value of module 01 and returns 02, which denotes that the response delay time value is 2ms.

Related Commands:

Section 2.30 ~AARDVV

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2.30 ~AARDVV

Description:

Sets the response delay time value of a module.

Syntax:

~AARDVV[CHKSUM](CR)

~	Delimiter character
AA	Address of the module to be read (00 to FF)
RD	Command to set the communication protocol
VV	Two hexadecimal digits to represent the response delay time value in milli-second, for example, 01 denotes 1ms and 1E denotes 30s. The max allowable value is 30 (1Eh).

Response:

Valid Response: !AA[CHKSUM](CR)
Invalid Response: ?AA[CHKSUM](CR)

!	Delimiter character for a valid response
?	Delimiter character for an invalid response
AA	Address of the responding module (00 to FF)

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: ~01RD06 Response: !01

Sets the response delay time value to 6ms. The module returns a valid response.

Command: ~01RD Response: !0106

Reads the response delay time value of module 01. The module returns 06, which denotes that the response delay time value is 6ms.

Related Commands:

Section 2.29 ~AARD

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2.31 @AACECN

Description:

Clears the digital input counter of a specified channel.

Syntax:

@AACECN[CHKSUM](CR)

@	Delimiter character
AA	Address of the module to be cleared (00 to FF)
CE	Command to clear the digital input counter
CN	N is to specify the channel to be cleared, 0 for tM-DA1P1R1.

Response:

Valid command : **!AA[CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: @03REC0 Response: !0300103

Reads data from channel 0 of module 03 and the returned counter value is 103.

Command: @03CEC0 Response: !03

Clears the counter value of channel 0 of module 03 and returns a valid response.

Command: @03REC0 Response: !0300000

Reads counter data from channel 0 of module 03 and the returned counter value is 0.

Related Commands:

Section 2.34 @AARECN

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2.32 @AADI

Description:

Reads the digital input and digital output status of a module.

Syntax:

@AADI[CHKSUM](CR)

@	Delimiter character
AA	Address of the module to be read (00 to FF)
DI	Command to read the digital input and digital output status

Response:

Valid command : **!AA0OOII [CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)
OO	A two-digit hexadecimal value, where bit 0 corresponds to DO0, bit 1 corresponds to DO1, etc. When the bit is 1, it denotes that the digital output port is on, and 0 denotes that the digital output port is off.
II	A two-digit hexadecimal value, where bit 0 corresponds to DI0, bit 1 corresponds to DI1, etc. When the bit is 1, it denotes that the digital input port is on, and 0 denotes that the digital input port is off

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There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

Examples:

Command: @01DI Response: !0100102

Reads the digital input and output port status of module 01 and returns 00102h, which denotes that DO0 and DI` are on and DO1 and DI0 are off.

Related Commands:

Section 2.33 @AADODD

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2.33 @AADODD

Description:

Sets the digital output ports of a module.

Syntax:

@AADODD[CHKSUM](CR)

@	Delimiter character
AA	Address of the module to be set (00 to FF)
DO	Command to set the digital output ports
DD	A two-digit hexadecimal value, where bit 0 corresponds to DO0, bit 1 corresponds to DO1, etc. When the bit is 1, it denotes that the digital output port is on, and 0 denotes that the digital output port is off.

Response:

Valid command : **!AA[CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: @01DO02 Response: !01

Sets DO0, 2 and 3 to off and DO1 to on, and the module returns a valid response.

Related Commands:

Section 2.32 @AADI

Note:

When a host watchdog timeout occurs, the module will respond with an invalid command for this command and the DO value that was sent is ignored.

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2.34 @AARECN

Description:

Reads the digital input counter of a specified channel.

Syntax:

@AARECN[CHKSUM](CR)

@	Delimiter character
AA	Address of the module to be read (00 to FF)
RE	Command to read the digital input counter
CN	N is to specify the channel to be read, 0 for tM-DA1P1R1.

Response:

Valid command : **!AA(Data)[CHKSUM](CR)**

Invalid command: **?AA[CHKSUM](CR)**

!	Delimiter character for a valid command
?	Delimiter character for an invalid command
AA	Address of the responding module (00 to FF)
(Data)	Five digits data of the counter value of the specified channel.

There will be no response if the command syntax is incorrect, there is a communication error, or there is no module with the specified address.

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Examples:

Command: @03REC0 Response: !0300103

Reads data from channel 0 of module 03 and the returned counter value is 103.

Command: @02REC9 Response: ?02

Reads data from channel 9 of module 02. An error is returned because channel 9 is invalid.

Related Commands:

Section 2.31 @AACECN

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3. Modbus RTU Protocol

The Modbus protocol is developed by Modicon Inc., originally developed for Modicon controllers. Detailed information can be found at http://www.modicon.com/techpubs/toc7.html. You can also visit http://www.modbus.org to find more valuable information.

The tM series modules support both the Modbus RTU and Modbus ASCII protocols. The communication Baud Rates range from 1200bps to 115200bps. The following Modbus functions are supported.

Function Code	Description	Section
01 (0x01)	Read coils	3.1
02 (0x02)	Read digital inputs	3.2
03 (0x03)	Read output channels	3.3
04 (0x04)	Read input channels	3.4
05 (0x05)	Write single coil	3.5
06 (0x06)	Write single register	3.6
15 (0x0F)	Write multiple coils	3.7
16 (0x10)	Write multiple registers	3.8

If the function specified in the message is not supported, then the module responds as follows.

Error Response

00	Address	1 Byte	1 to 247
01	Function code	1 Byte	Function code | 0x80
02	Exception code	1 Byte	01

If a CRC mismatch occurs, the module will not respond.

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3.1 01 (0x01) Read Coils

This function code is used to read the current digital output read back value of a module.

Request

00	Address	1 Byte	1 ~ 247
01	Function code	1 Byte	0x01
02 ~ 03	Starting channel	2 Bytes	0x0000 for tM-DA1P1R1 DO read back value
04 ~ 05	Number of output channel	2 Bytes	0x0001 for tM-DA1P1R1

Response

00	Address	1 Byte	1 ~ 247
01	Function code	1 Byte	0x01
02	Byte count	1 Byte	1
03	Data of output channels	1 Byte	A bit corresponds to a channel. When the bit is 1, it denotes that the channel is on. If the bit is 0, it denotes that the channel is off.

Error Response

00	Address	1 Byte	1 ~ 247
01	Function code	1 Byte	0x81
02	Exception code	1 Byte	02: starting channel out of range 03: (starting channel + number of output channels) out of range, incorrect number of bytes received

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3.2 02 (0x02) Read Discrete Inputs

This function code is used to read the digital input status of a module.

Request

00	Address	1 Byte	1 to 247
01	Function code	1 Byte	0x02
02 ~ 03	Starting channel	2 Bytes	0x20 for tM-DA1P1R1 where 0x20 corresponds to channel 0
04 ~ 05	Number of input channels	2 Bytes	1 for tM-DA1P1R1

Response

00	Address	1 Byte	1 to 247
01	Function code	1 Byte	0x02
02	Byte count	1 Byte	1
03	Data of input channels	1 Byte	A bit corresponds to a channel. When the bit is 1 it denotes that the channel is on. If the bit is 0 it denotes that the channel is off.

Error Response

00	Address	1 Byte	1 to 247
01	Function code	1 Byte	0x82
02	Exception code	1 Byte	02: starting channel out of range 03: (starting channel + number of input channels) out of range, incorrect number of bytes received

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3.3 03 (0x03) Read Output Channels

This function code is used to read the analog output values of a module.

Request

00	Address	1 Byte	1 ~ 247
01	Function code	1 Byte	0x03
02 ~ 03	Starting channel	2 Bytes	0x0000 for tM-DA1P1R1
04 ~ 05	Number of output channels (N)	2 Bytes	0x0001 for tM-DA1P1R1

Response

00	Address	1 Byte	1 ~ 247
01	Function code	1 Byte	0x03
02	Byte count	1 Byte	N x 2
03 ~	Data of output channels	N x 2 Bytes	Data in the specified data format

Error Response

00	Address	1 Byte	1 ~ 247
01	Function code	1 Byte	0x83
02	Exception code	1 Byte	02: starting channel out of range 03: (starting channel + number of output channels) out of range, incorrect number of bytes received

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3.4 04 (0x04) Read Input Channels

This function code is used to read the current digital input counter value of a module.

Request

00	Address	1 Byte	1 to 247
01	Function code	1 Byte	0x04
02 ~ 03	Starting channel	2 Bytes	0x0080 for tM-DA1P1R1
04 ~ 05	Number of input channels (N)	2 Bytes	1 for tM-DA1P1R1.

Response

00	Address	1 Byte	1 to 247
01	Function code	1 Byte	0x04
02	Byte count	1 Byte	2 x N
03 ~	Data of input channels	2 x N Bytes	Data of counter value.

Error Response

00	Address	1 Byte	1 to 247
01	Function code	1 Byte	0x84
02	Exception code	1 Byte	02: starting channel out of range 03: (starting channel + number of input channels) out of range, incorrect number of bytes received

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3.5 05 (0x05) Write Single Coil

This function code is used to write a digital output value of a module.

Request

00	Address	1 Byte	1 ~ 247
01	Function code	1 Byte	0x05
02 ~ 03	Output channel numbers	2 Bytes	0x0000 for tM-DA1P1R1
04 ~ 05	Output value	2 Bytes	A value of 0xFF00 sets the output to ON. A value of 0x0000 sets it to OFF. All other values are illegal and will not affect the coil.

Response

00	Address	1 Byte	1 ~ 247
01	Function code	1 Byte	0x05
02 ~ 03	Output channel numbers	2 Bytes	The value is the same as byte 02 and 03 of the Request
04 ~ 05	Output value	2 Bytes	The value is the same as byte 04 and 05 of the Request

Error Response

00	Address	1 Byte	1 ~ 247
01	Function code	1 Byte	0x85
02	Exception code	1 Byte	Refer to the Modbus standard for more details.

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3.6 06 (0x06) Write Single Register

This function code is used to write a digital output value of a module.

Request

00	Address	1 Byte	1 ~ 247
01	Function code	1 Byte	0x06
02 ~ 03	Output channel numbers	2 Bytes	0x0000 for tM-DA1P1R1
04 ~ 05	Output value	2 Bytes	Data in the specified data format

Response

00	Address	1 Byte	1 ~ 247
01	Function code	1 Byte	0x06
02 ~ 03	Output channel numbers	2 Bytes	The value is the same as byte 02 and 03 of the Request
04 ~ 05	Output value	2 Bytes	The value is the same as byte 04 and 05 of the Request

Error Response

00	Address	1 Byte	1 ~ 247
01	Function code	1 Byte	0x86
02	Exception code	1 Byte	Refer to the Modbus standard for more details.

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3.7 15 (0x0F) Write Multiple Coils

This function code is used to write the digital output values of a module.

Request

00	Address	1 Byte	1 ~ 247
01	Function code	1 Byte	0x0F
02 ~ 03	Starting channel	2 Bytes	0x0000 for tM-DA1P1R1
04 ~ 05	Number of output channels	2 Bytes	0x0001 for tM-DA1P1R1
06	Byte count (N)	1 Byte	Number of bytes of the following output values, 0x01
07	Data of output channels	N Bytes	A bit corresponds to a channel. When the bit is 1 it denotes that the value of the channel that was set is ON. If the bit is 0 it denotes that the value of the channel that was set is OFF.

Response

00	Address	1 Byte	1 ~ 247
01	Function code	1 Byte	0x0F
02 ~ 03	Starting channel	2 Bytes	The value is the same as byte 02 and 03 of the Request
04 ~ 05	Number of output channels	2 Bytes	The value is the same as byte 04 and 05 of the Request

Error Response

00	Address	1 Byte	1 ~ 247
01	Function code	1 Byte	0x8F
02	Exception code	1 Byte	Refer to the Modbus standard for more details.

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3.8 16 (0x10) Write Multiple Registers

This function code is used to write the analog output values of a module.

Request

00	Address	1 Byte	1 ~ 247
01	Function code	1 Byte	0x10
02 ~ 03	Starting channel	2 Bytes	0x0000 for tM-DA1P1R1
04 ~ 05	Number of output channels (N)	2 Bytes	0x0001 for tM-DA1P1R1
06	Byte count	1 Byte	Number of bytes of the following output values, 2 x N
07	Data of output channels	2 x N Bytes	Data in the specified data format, 2 bytes for each channel

Response

00	Address	1 Byte	1 ~ 247
01	Function code	1 Byte	0x10
02 ~ 03	Starting channel	2 Bytes	The value is the same as byte 02 and 03 of the Request
04 ~ 05	Number of output channels	2 Bytes	The value is the same as byte 04 and 05 of the Request

Error Response

00	Address	1 Byte	1 ~ 247
01	Function code	1 Byte	0x90
02	Exception code	1 Byte	Refer to the Modbus standard for more details.

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3.9 tM-DA1P1R1 Address Mappings

<table>
<tr><th>Address</th><th>Description</th><th>Attribute</th></tr>
<tr><td>30065
40065</td><td>Analog output read back of channel 0</td><td>R</td></tr>
<tr><td>30129
40129</td><td>Counter value of digital input channel 0</td><td>R</td></tr>
<tr><td>40033</td><td>Analog output value of channel 0</td><td>R/W</td></tr>
<tr><td>40097</td><td>Safe analog output value of channel 0</td><td>R/W</td></tr>
<tr><td>40193</td><td>Power on analog output value of channel 0</td><td>R/W</td></tr>
<tr><td>40289</td><td>Analog output slew rate of channel 0</td><td>R/W</td></tr>
<tr><td>40417</td><td>Analog output type code of channel 0</td><td>R/W</td></tr>
<tr><td>40481</td><td>Firmware version (low word)</td><td>R</td></tr>
<tr><td>40482</td><td>Firmware version (high word)</td><td>R</td></tr>
<tr><td>40483</td><td>Module name (low word), 0x0070</td><td>R</td></tr>
<tr><td>40484</td><td>Module name (high word), 0x2425</td><td>R</td></tr>
<tr><td>40485</td><td>Module address, valid range: 1 ~ 247</td><td>R/W</td></tr>
<tr><td>40486</td><td>Bits 5:0
Baud rate, 0x03 ~ 0x0A
<table>
<tr><td>Code</td><td>0x03</td><td>0x04</td><td>0x05</td><td>0x06</td></tr>
<tr><td>Baud</td><td>1200</td><td>2400</td><td>4800</td><td>9600</td></tr>
<tr><td>Code</td><td>0x07</td><td>0x08</td><td>0x09</td><td>0x0A</td></tr>
<tr><td>Baud</td><td>19200</td><td>38400</td><td>57600</td><td>115200</td></tr>
</table>
Bits 7:6
00: no parity, 1 stop bit
01: no parity, 2 stop bits
10: even parity, 1 stop bit
11: odd parity, 1 stop bit</td><td>R/W</td></tr>
<tr><td>40488</td><td>Modbus response delay time in ms, valid range: 0 ~ 30</td><td>R/W</td></tr>
<tr><td>40489</td><td>Host watchdog timeout value, 0 ~ 255, in 0.1s</td><td>R/W</td></tr>
<tr><td>40492</td><td>Host watchdog timeout count, write 0 to clear</td><td>R/W</td></tr>
</table>

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Address	Description	Attribute
00033 10033	Digital input value of channel 0	R
00065 10065	High latched value of DI	R
00073 10073	High latched value of DO	R
00097 10097	Low latched value of DI	R
00105 10105	Low latched value of DO	R
00001	Digital output value of channel 0	R/W
00129	Safe value of digital output channel 0	R/W
00161	Power on value of digital output channel 0	R/W
00193	Counter update trigger edge of digital input channel 0	R/W
00257	Protocol, 0: DCON, 1: Modbus	R/W
00258	Protocol, 0: Modbus RTU, 1: Modbus ASCII	R/W
00260	Modbus host watchdog mode 0: same as I-7000 1: can use AO and DO command to clear host watchdog timeout status	R/W
00261	1: enable, 0: disable host watchdog	R/W
00264	Write 1 to clear latched DIO states	W
00265	DI active state	R/W
00266	DO active state	R/W
00269	Modbus data format, 0: hex, 1: engineering	R/W
00270	Host watch dog timeout status, write 1 to clear host watch dog timeout status	R/W
00273	Reset status, 1: first read after powered on, 0: not the first read after powered on	R
00513	Write 1 to clear counter value of digital input channel 0	W

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Analog Outputs

Type Code	Range	Data Format	Minimum	Maximum
0	0 mA ~ +20 mA	Engineering	0	+20000
		Hexadecimal	0000h	FFFFh
1	+4 mA ~+20 mA	Engineering	+4000	+20000
		Hexadecimal	0000h	FFFFh
2	0V ~ +10 V	Engineering	0	+10000
		Hexadecimal	0000h	FFFFh
4	0 V ~ +5 V	Engineering	0	+5000
		Hexadecimal	0000h	FFFFh

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4. Troubleshooting

If you are having difficulty using the tM module, here are some suggestions that may help. If you cannot find the answers you need in these guides, contact ICP DAS Product Support. Contact information is located in Section 1.12.

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4.1 Communicating with the module

If you attempt to communicate with the module and receive no response, first check the following:

- Ensure that the supplied power is within the range of +10 to +30 V DC. If the supplied power is OK, then the power LED should be on.
- When the module receives a command, the power LED is set to “off”. The power LED is shown as “on” after the module responds. This method can be used to check whether the module has received a command sent from the host.
- If possible, use another device to check whether the host can communicate with the device through the same RS-485 network.
- If the host is a PC installed with a Windows operating system, then execute the DCON Utility to determine whether the module can be found. The DCON Utility can be downloaded from the ICP DAS website http://www.icpdas.com. The DCON Utility documentation can be found in the ”**Getting Started For I-7000 Series Modules**” manual.
- Set the module to “INIT mode” and communicate with the module using the following settings: address 00, Baud Rate 9600bps, no checksum and DCON protocol. See Section A.1 for details.

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A. Appendix

A.1 INIT Mode

Each tM module has a built-in EEPROM to store configuration information such as module address, type code, Baud Rate, etc. Occasionally, the configuration of a module may be forgotten and there are no visual indications of the configuration of the module. It is difficult to communicate with the module when the configuration of the module is unknown. To help avoid this problem, the tM series has a special mode called **"INIT mode"**. When the module is powered on in **"INIT mode"** the configuration of the module is reset as follows, allowing it to be operated as normal.

1. Address: 00
2. Baud Rate: 9600 bps
3. No checksum
4. Protocol: DCON

The configuration information stored in the EEPROM is not changed and can be read by sending the $002(CR) command at 9600bps.

There are commands that require the module to be in INIT mode. They are:

1. %AANNTTCCFF when changing Baud Rate and checksum settings. See Section 2.1 for details.
2. $AAPN, see Section 2.18 for details.

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The tM modules have the INIT switch located on the right side of the module allow easier access to INIT mode. For these modules, INIT mode is accessed by sliding the INIT switch to the Init position as shown below.



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A.2 Dual Watchdog Operation

Dual Watchdog = Module Watchdog + Host Watchdog

The Module Watchdog is a hardware reset circuit that monitors the operating status of the module. While working in harsh or noisy environments, the module may be shut down by external signals. The circuit allows the module to work continuously without disruption.

The Host Watchdog is a software function that monitors the operating status of the host. Its purpose is to prevent problems due to network/communication errors or host malfunctions. When a host watchdog timeout occurs, the module will reset all outputs to a safe state in order to prevent any erroneous operations of the controlled target.

The tM series modules include an internal Dual Watchdog, making the control system more reliable and stable.

For more information regarding the Dual Watchdog, please refer to Chapter 5 of the "**Getting Started For I-7000 Series Modules**" manual that can be downloaded from the ICP DAS website http://www.icpdas.com.

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A.3 Module Output Status

The power-on reset and module watchdog reset will set all outputs to power-on values. Then, the module can accept command to change the output values.

The host watchdog timeout will set the host watchdog timeout flag and set all outputs to safe values. Then, the output command will be ignored. The module's LED will be blinking. The reset host watchdog status command, ~AA1, must be sent to go to normal mode to accept the output command.

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A.4 Reset Status

The reset status flag is set when the module is powered on or reset by the module watchdog. It is cleared after the responding of the first read reset status command, $AA5. This can be used to check whether the module had been reset. When the $AA5 command responds that the reset status is cleared, that means the module has not been reset since the last $AA5 command was sent. When the $AA5 command responds that the reset status is set and it is not the first time $AA5 command is sent after powered-on, it means that the module has been reset by the module watchdog and the analog output value had been changed to the power-on value.

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A.5 Analog Output

Besides setting by the analog output commands, the analog outputs can be set by two other conditions.

When the host watchdog is enabled and a host watchdog timeout occurs, the "**safe value**" is loaded into the analog output ports. The analog output commands have no effect on the analog output ports until the host watchdog timeout status is cleared. The host watchdog timeout status is saved in the EEPROM. The status is not changed even after power-on reset. It can be cleared only by the reset host watchdog timeout status command ~AA1. See Section A.2 for host watchdog details.

When the module is powered on and the host watchdog timeout status is cleared, the "**power-on value**" is loaded into the analog output ports. If the host watchdog timeout status is not cleared on power-on, then the safe value is loaded into the analog output ports.

The safe value is set by ~AA5N command. The power-on value is set by the $AA4N command.

When the module receives the analog output command #AA(data) or #AAN(data), if the host watchdog timeout status is not cleared, then it responds '!' to indicate that the command is ignored. If the host watchdog timeout status is cleared, it responds '>' to indicate a successful command. If the output value specified by the command is larger than the upper limit, then it responds '?' to indicate out of range and set the analog output to the upper limit. If the output value specified by the command is less

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than the lower limit, then it responds ‘?’ to indicate out of range and set the analog output to the lower limit.

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A.6 Slew Rate Control

Usually, the output of an analog output module changes instantaneously. That is, when the module receives an output command, its output changes to the specified value immediately. However, it may require that the output change to the specified value gradually in some applications. The slew rate control is to adjust the output change rate.

The tM-DA1P1R1 modules support programmable slew rate control. When an analog output command is received, the analog output will change to the new value in the specified slew rate automatically. The tM-DA1P1R1 modules update the analog output every 10 ms. The analog output is updated smoothly until it reaches the specified output value.

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A.7 Analog Output Read-back

The tM-DA1P1R1 modules do not have the analog-to-digital converter to monitor the analog output signal. However, they can respond the value that is set to the digital-to-analog converter. This value cannot be used to check improper wire connection and load.

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A.8 Frame Ground

Electronic circuits are constantly vulnerable to ESD which become worse in a continental climate area. The tM modules feature a new design for the frame ground. The frame ground provides a path for bypassing ESD, which provides enhanced static protection (ESD) abilities and ensures the module is more reliable.

Connect the frame ground terminal to a wire/DIN rail and connect the wire/DIN rail to the earth ground will provide a better protection for the module.

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