I-7021, I-7022, I-7024, M-7022 and M-7024 Series User Manual

Warranty

All products manufactured by ICP DAS are under warranty regarding defective materials for a period of one year from the date of delivery to the original purchaser.

Warning

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Date: 2014/9/5

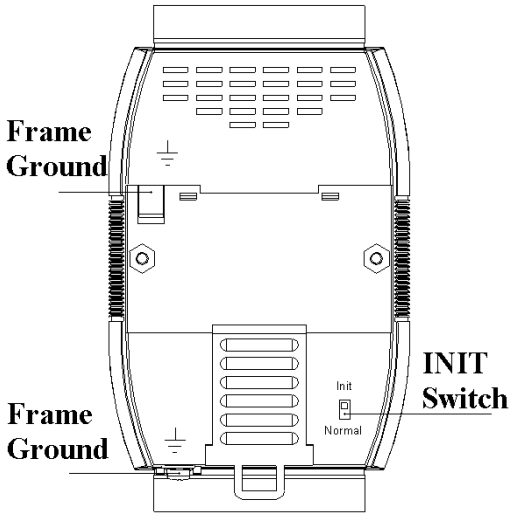
Table of Contents

1. Introduction

The I-7000 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. 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 115.2 Kbps can be selected.

The functionality of the M-7000 series is the same as the I-7000 series, with the exception that the M-7000 series offers extended support for the Modbus RTU protocol.

Some I-7000 modules feature a new design for the frame ground and INIT switch as shown in the figure (rear view). 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.3 for more details.



The common features of the I-7021/21P, I-7022, I-7024, I-7024R, M-7022, M-7024, M-7024R and M-7024U modules are as follows:

1. 3000V_{DC}, 2500V_{DC} for M-7024U, inter-module isolation
2. Programmable power-on value for analog output
3. Programmable slew rate
4. Software calibration

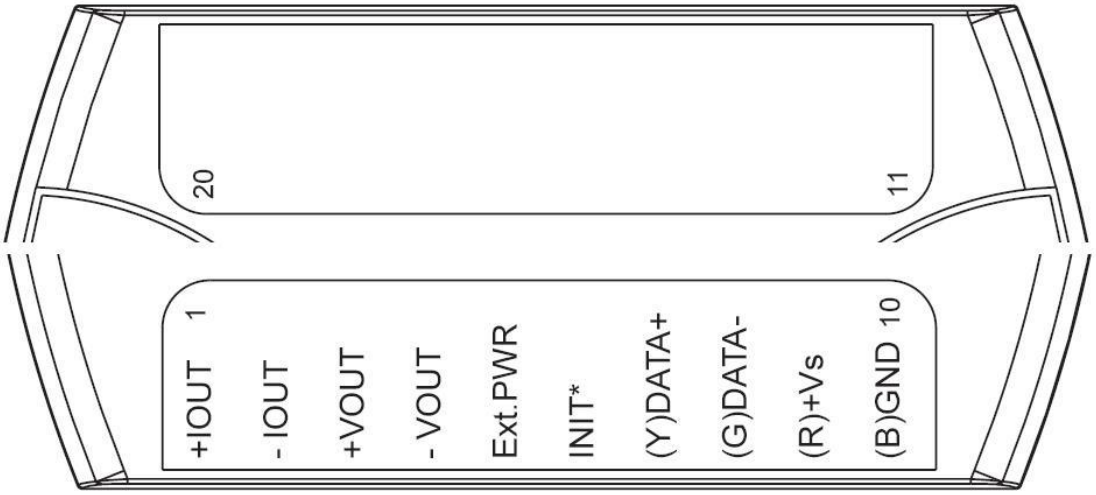
The I-7021 is a single channel analog output module with 12-bit resolution and output read-back function. The I-7021P is similar to the I-7021 but with 16-bit resolution. The I-7022/M-7022 is a 2-channel analog output module with 12-bit resolution and output read-back function. The I-7024/M-7024 is a 4-channel analog output module with 14-bit resolution and supports bipolar voltage output. The I-7024R/M-7024R is I-7024/M-7024 added 5-channel digital inputs. The M-7024U is a 4-channel analog output module with 16-bit resolution and supports bipolar voltage output. There is also 4-channel digital inputs and 4-channel digital outputs for the M-7024U.

1.1 More Information

For more information regarding the I-7000 series, please refer to chapter 1 of the "I-7000 Bus Converter User's Manual" as shown below or visit the ICP DAS website http://www.icpdas.com.

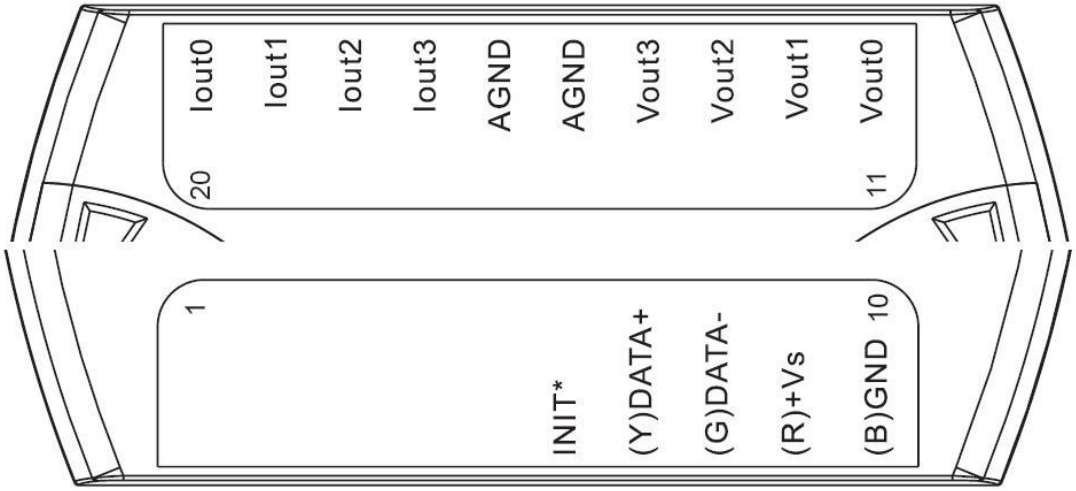
1.2 Terminal Assignment

7021/7021P

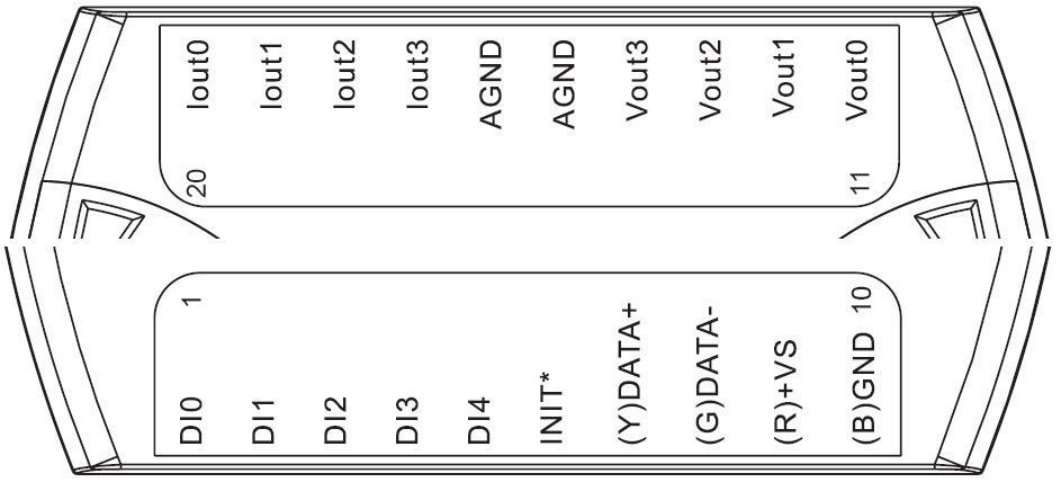


7022

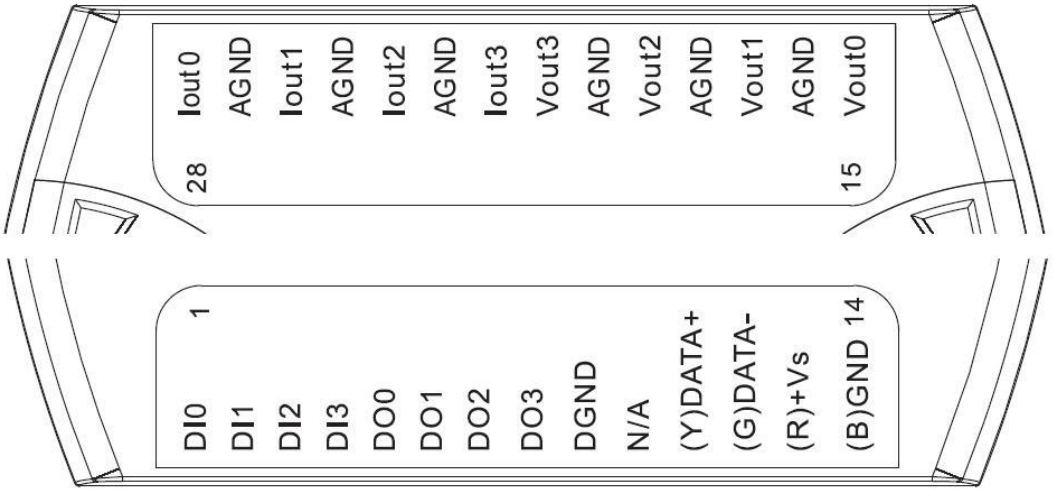
7024


Iout0
Iout1
Iout2
Iout3
AGND
AGND
Vout3
Vout2
Vout1
Vout0
20
11
1
INIT*
(Y)DATA+
(G)DATA-
(R)+Vs
(B)GND
10

7024R


Iout0
Iout1
Iout2
Iout3
AGND
AGND
Vout3
Vout2
Vout1
Vout0
20
11
DI0
1
DI1
DI2
DI3
DI4
INIT*
(Y)DATA+
(G)DATA-
(R)+VS
(B)GND
10

7024U


Iout0
AGND
Iout1
AGND
Iout2
AGND
Iout3
Vout3
AGND
Vout2
AGND
Vout1
AGND
Vout0
28
15
DI0
DI1
DI2
DI3
DO0
DO1
DO2
DO3
DGND
N/A
(Y)DATA+
(G)DATA-
(R)+Vs
(B)GND
1
14

1.3 Specifications

	I-7021/I-7021P	**I-7022/M-7022**	**I-7024/M-7024**
Analog Output			
Output Channels	1	2	4
Output Type	mA, V	mA, V	mA, V
Accuracy	±0.1% for I-7021 ±0.02% for I-7021P	±0.1% of FSR	±0.1% of FSR
Resolution	12-bit for I-7021 16-bit for I-7021P	12-bit	14-bit
Read-back Accuracy	±1% of FSR	±1% of FSR	NA
Programmable Output Slope	0.125 ~ 1024 mA/s 0.0625 ~ 512 V/s	0.125 ~ 1024 mA/s 0.0625 ~ 512 V/s	0.125 ~ 2048 mA/s 0.0625 ~ 1024 V/s
Current Load Resistance	Int. power: 500 ohm Ext. 24 V: 1050 ohm	Int. power: 500 ohm Ext. 24 V: 1050 ohm	Ext. 24 V: 1050 ohm
Isolation	3000 V_{DC}	3000 V_{DC}	3000 V_{DC}
Modbus RTU		M-7022	M-7024
Power			
Requirements	+10 to +30 V_{DC}	+10 to +30 V_{DC}	+10 to +30 V_{DC}
Consumption	1.8 W	3.0 W	2.4 W
Temperature Range			
Operating	-25℃ to +75℃	-25℃ to +75℃	-25℃ to +75℃
Storage	-40℃ to +85℃	-40℃ to +85℃	-40℃ to +85℃

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.

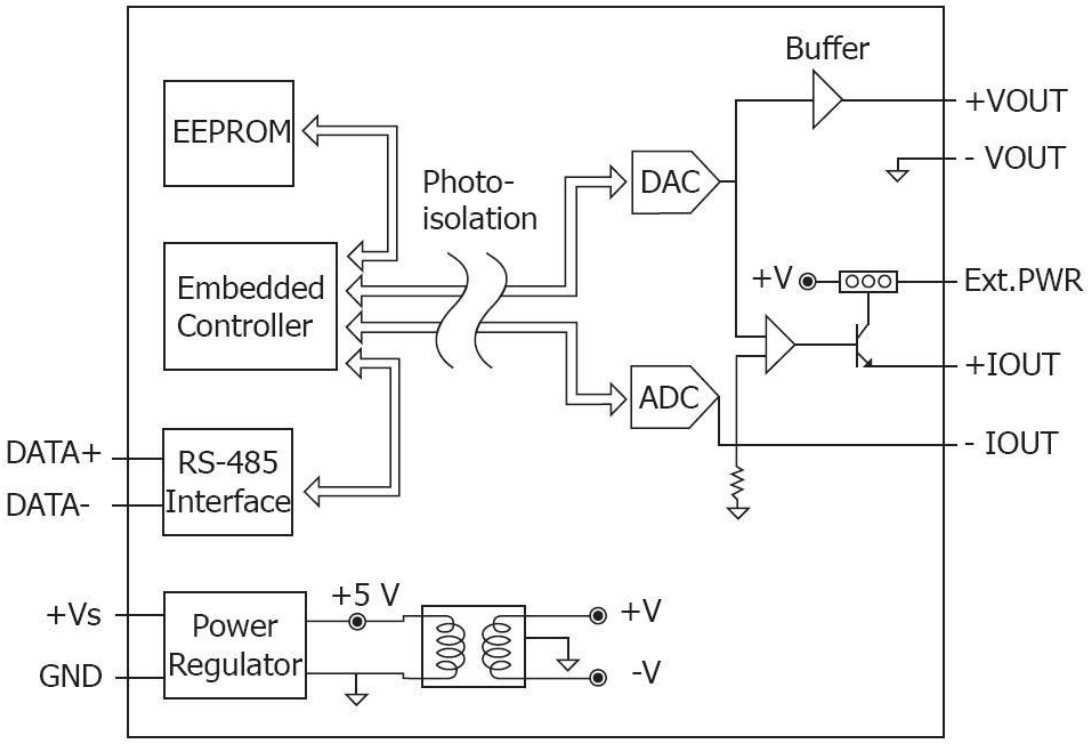
	I-7024R	M-7024R	M-7024U
Analog Output			
Output Channels	4	4	4
Output Type	mA, V	mA, V	mA, V
Accuracy	±0.1% of FSR	±0.1% of FSR	±0.02% of FSR
Resolution	14-bit	14-bit	16-bit
Read-back Accuracy	NA	NA	NA
Programmable Output Slope	0.125 ~ 2048 mA/s 0.0625 ~ 1024 V/s	0.125 ~ 2048 mA/s 0.0625 ~ 1024 V/s	0.125 ~ 1024 mA/s 0.0625 ~ 512 V/s
Current Load Resistance	Ext. 24 V: 1050 ohm	Ext. 24 V: 1050 ohm	Int. power: 1000 ohm
Digital Input			
Channels	5	5	4
Input Type	Dry Contact (Source)	Dry Contact (Source)	Dry Contact (Source)
Contact Level	On: Close to GND Off: Open	On: Close to GND Off: Open	On: Close to GND Off: Open
Counters	16-bit	16-bit	16-bit
	Min. Pulse Width: 10ms	Min. Pulse Width: 10ms	Min. Pulse Width: 5ms
Digital Output			
Channels			4
Output Type			Open Collector
Sink/Source			Sink
Load Voltage			+3.5 V_{DC} ~ +50 V_{DC}
Max. Load Current			700 mA/Channel
Isolation	3000 V_{DC}	3000 V_{DC}	2500 V_{DC}
Modbus RTU	No	Yes	Yes
Power			
Requirements	+10 to +30 V_{DC}	+10 to +30 V_{DC}	+10 to +30 V_{DC}
Consumption	3.2 W	3.2 W	4.5 W
Temperature Range			
Operating	-25℃ to +75℃	-25℃ to +75℃	-25℃ to +75℃
Storage	-40℃ to +85℃	-40℃ to +85℃	-40℃ to +85℃

Notes:

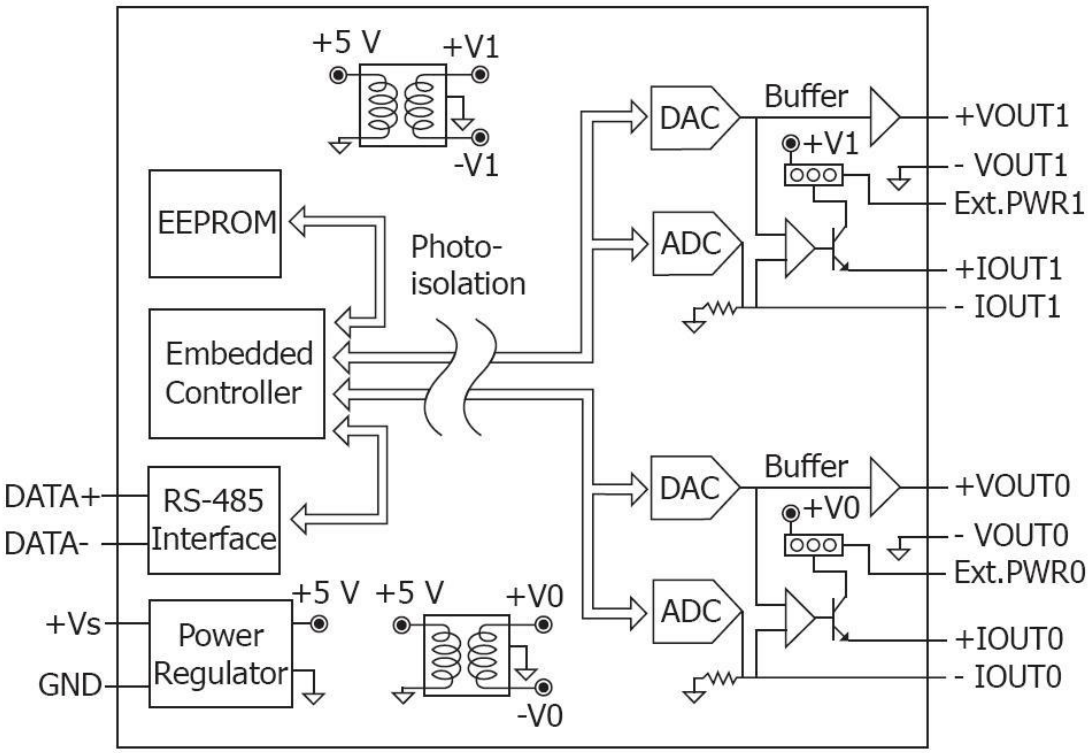
1. A warm up period of 30 minutes is recommended in order to achieve the complete performance results described in the specifications.
2. The specifications are typical at 25℃ unless otherwise stated.

1.4 Block Diagrams

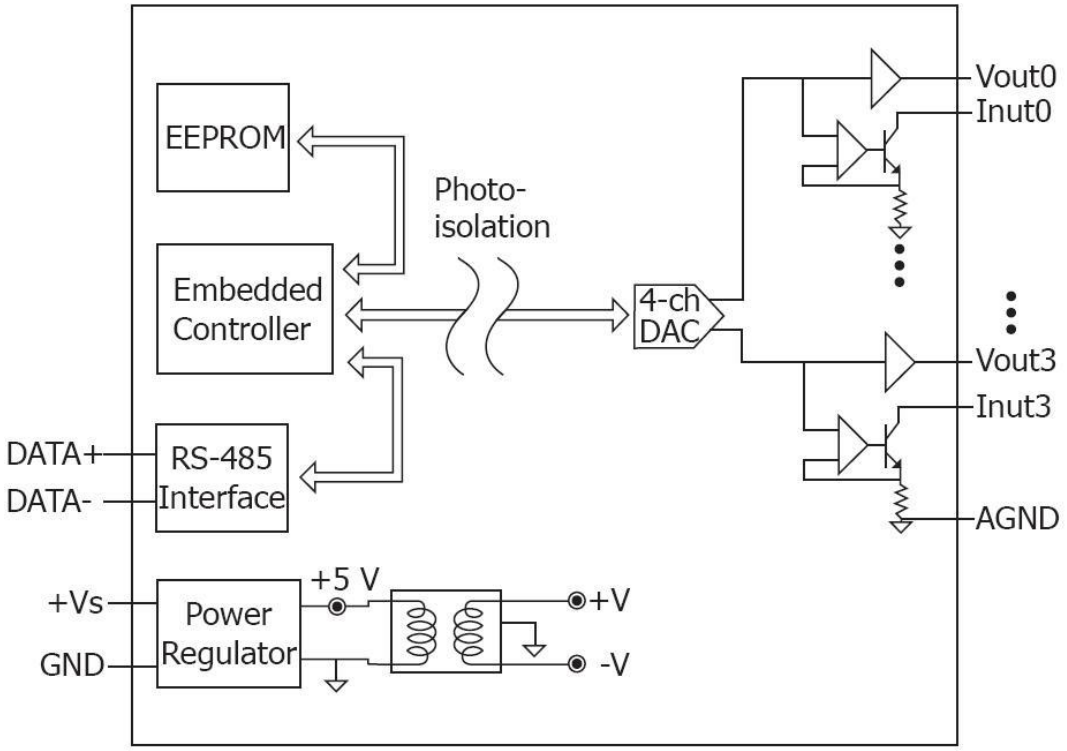
1.4.1 Block Diagram for the I-7021 and I-7021P



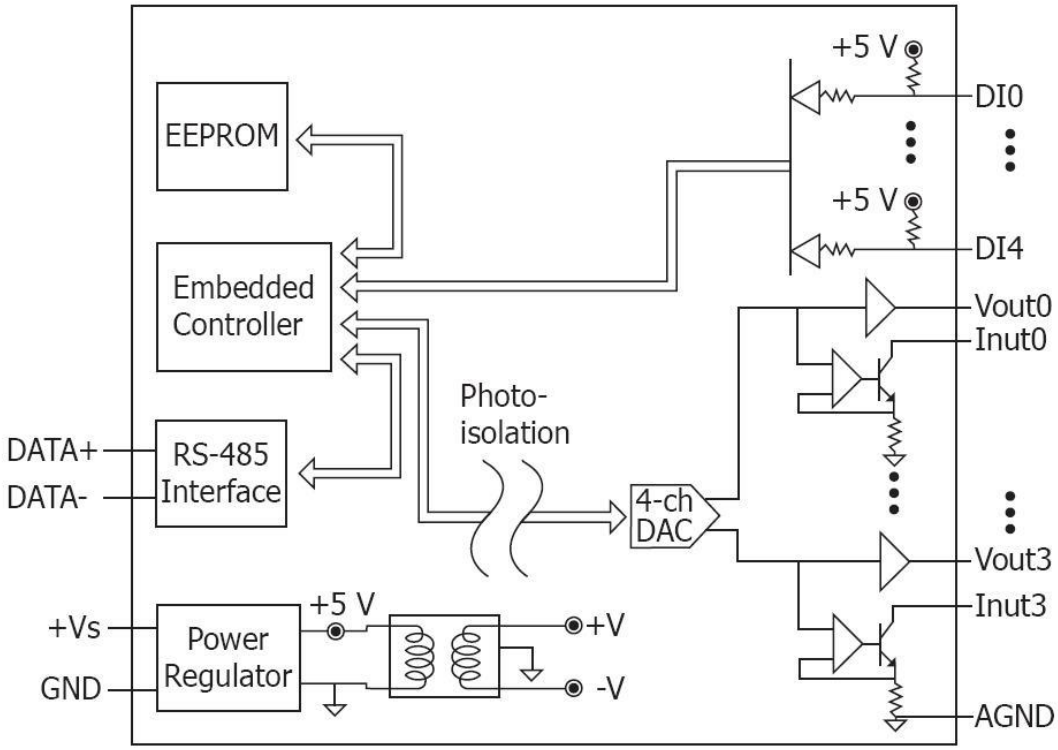
1.4.2 Block Diagram for the I-7022 and M-7022



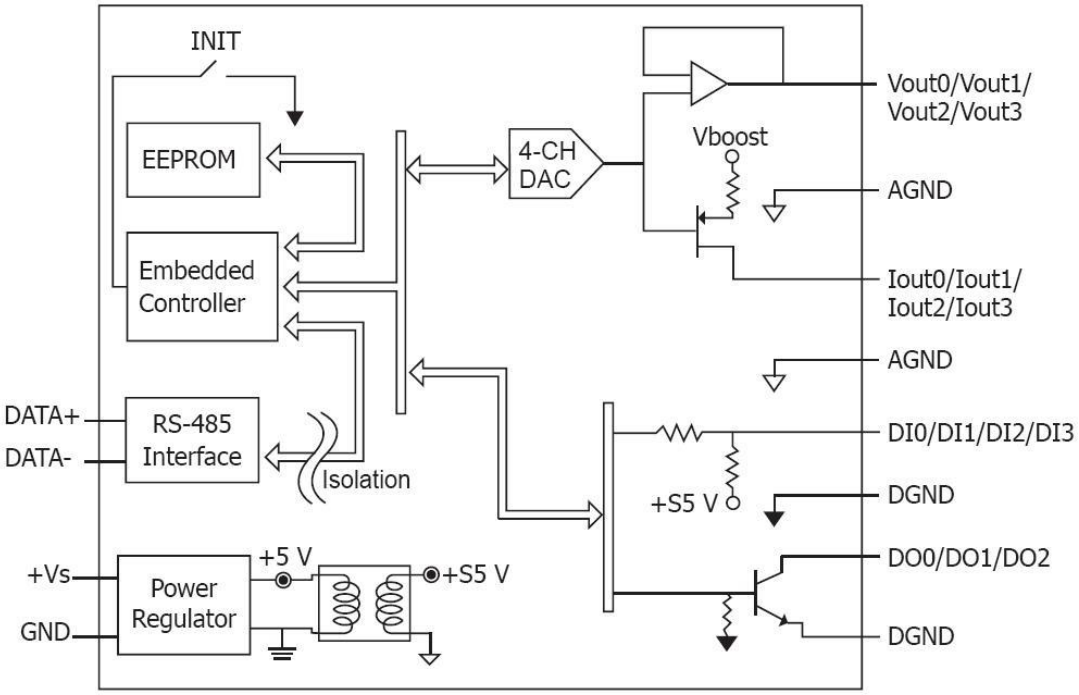
1.4.3 Block Diagram for the I-7024 and M-7024



1.4.4 Block Diagram for the I-7024R and M-7024R



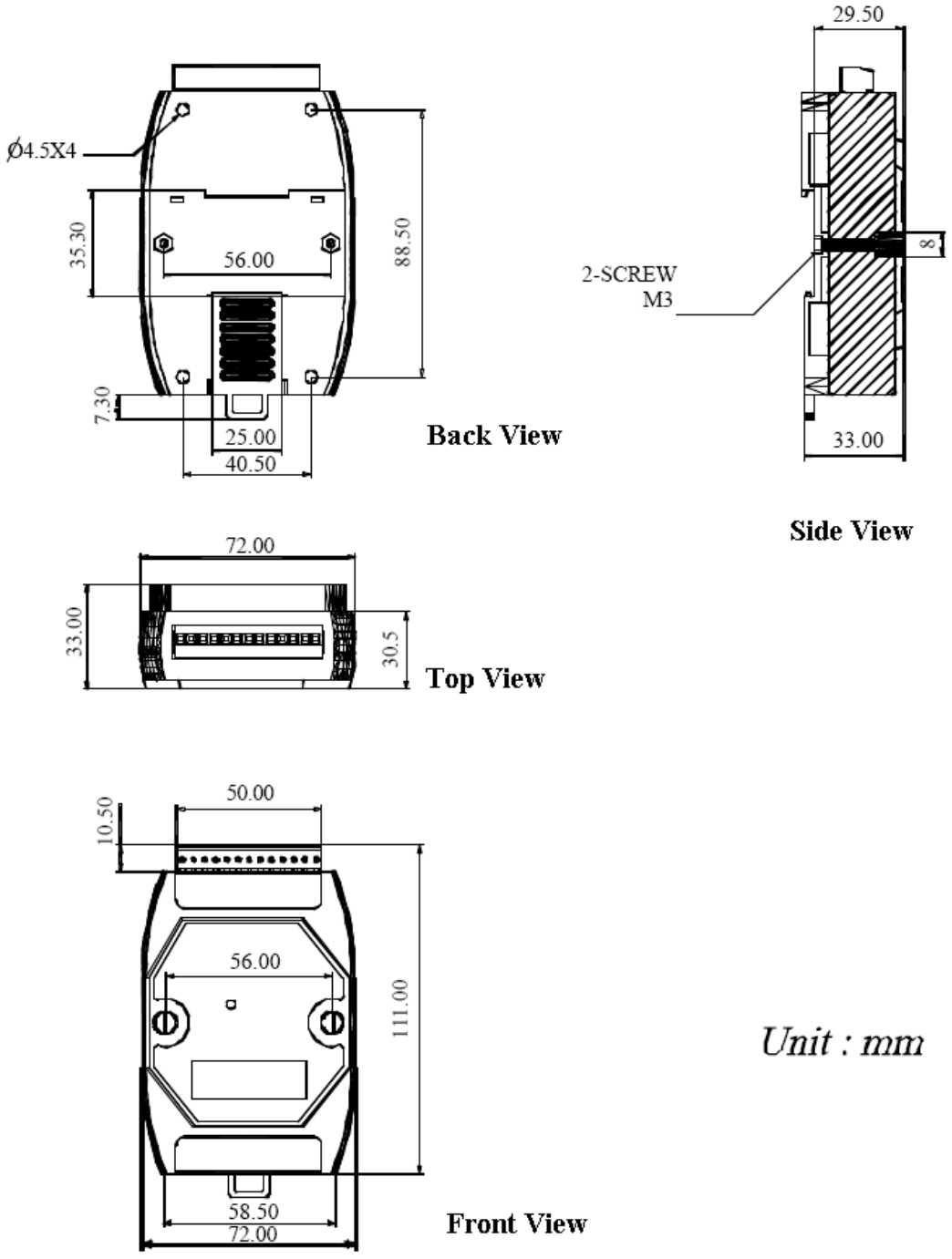
1.4.5 Block Diagram for the M-7024U



1.5 Dimensions

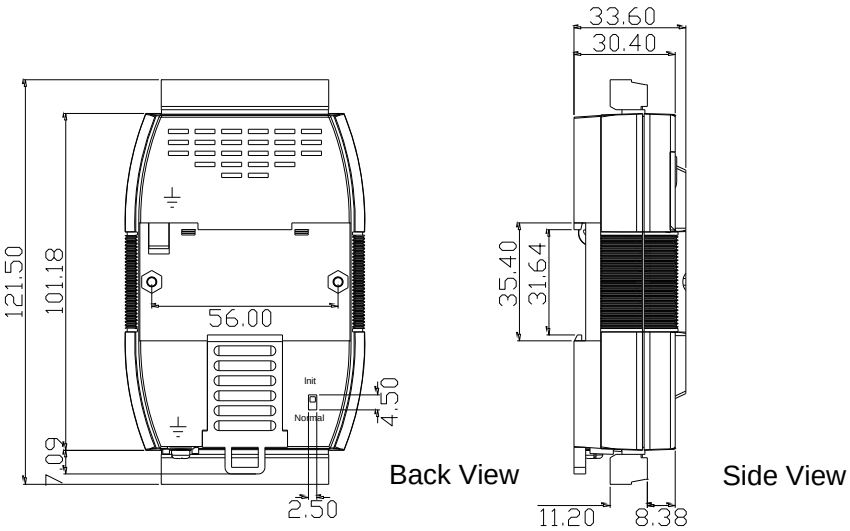
1.5.1 Modules without Frame Ground

The dimensions of the I-7021, I-7021P, I-7022, and M-7022 are as shown below.



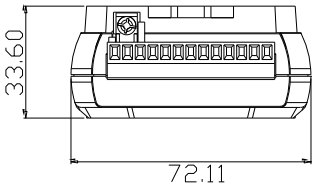
1.5.2 Modules with Frame Ground

The dimensions of the I-7024, M-7024, I-7024R, M-7024R, and M-7024U are as shown below.



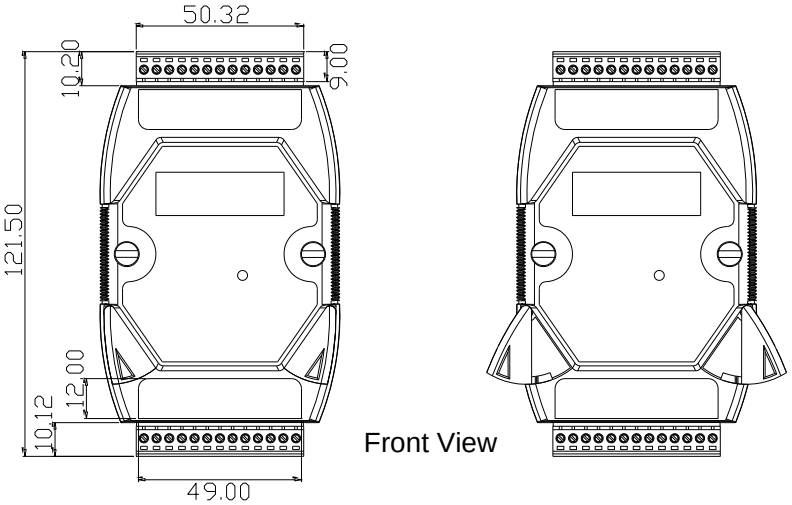
Back View

Side View



Top View

Unit : mm



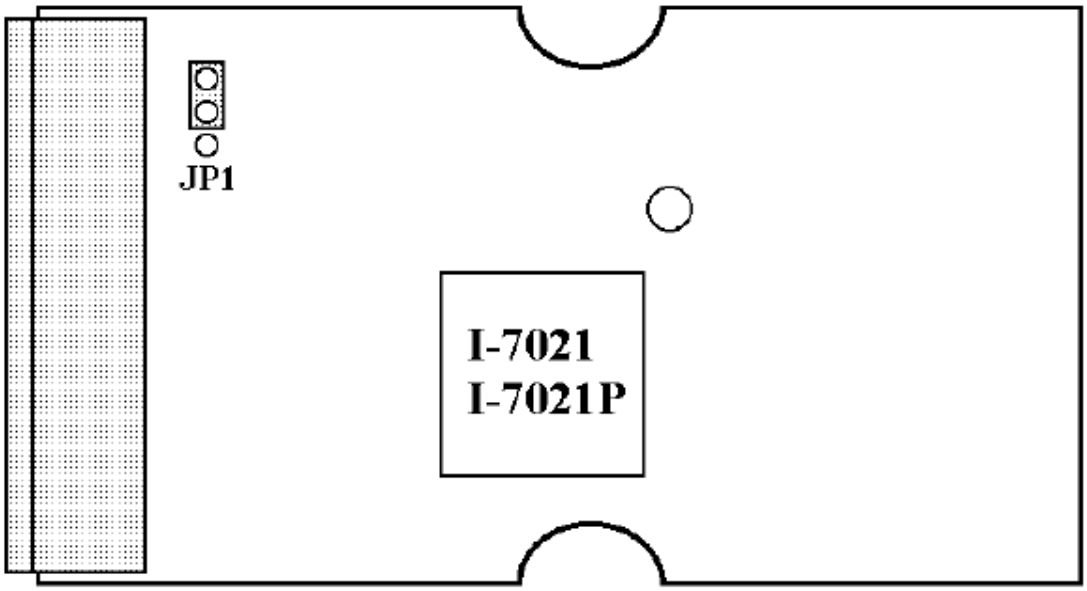
Front View

1.6 Jumper Settings

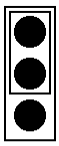
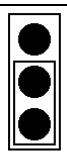
Note: To access the jumpers, the cover must be opened.

1.6.1 I-7021and I-7021P Jumper Settings

For the I-7021 and I-7021P modules, the power supply for current output can be either internal or external. The power supply is selected using the JP1 jumper. The position of the JP1 jumper is shown in the figure below.

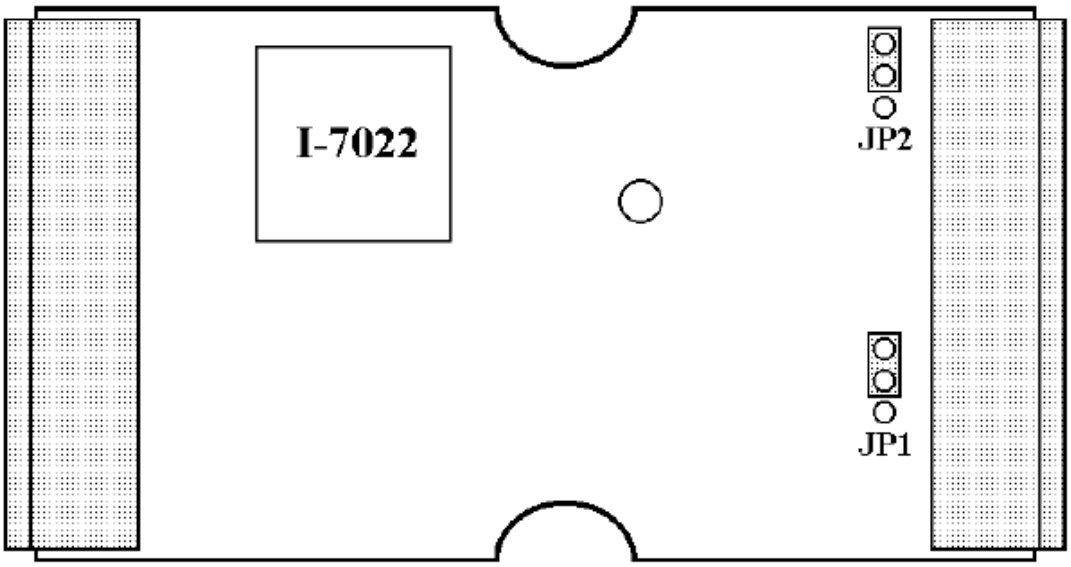


The settings for the JP1 jumper are as follows.

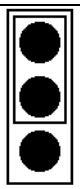
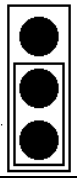
 JP1	Select internal power. It can drive load up to 500 ohm. (factory default)
 JP1	Select external power. It can drive load up to 1050 ohm for 24 V external power supply.

1.6.2 I-7022 and M-7022 Jumper Settings

For the I-7022 and M-7022 modules, the power supply for current output can be either internal or external. The power supply is selected using the JP1 jumper for channel 0 and JP2 for channel 1. The positions of the JP1 and JP2 jumpers are shown in the figure below.

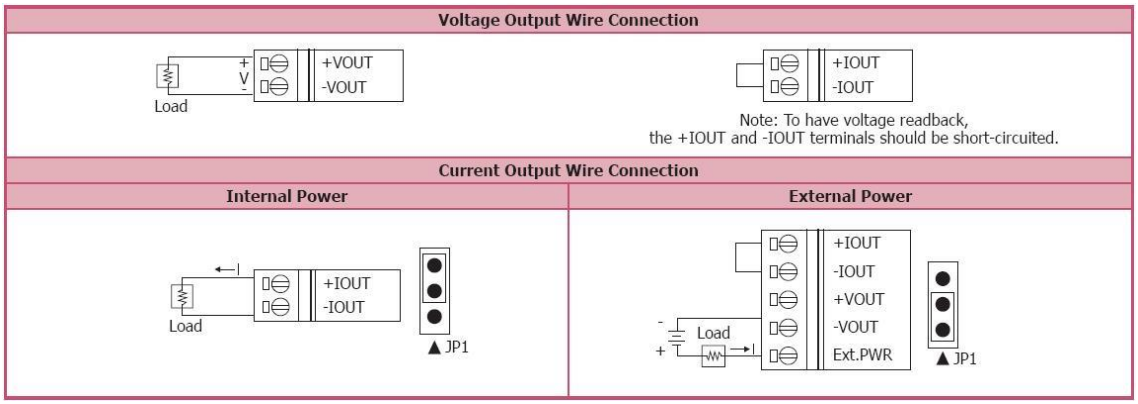


The settings for the JP1 and JP2 jumpers are as follows.

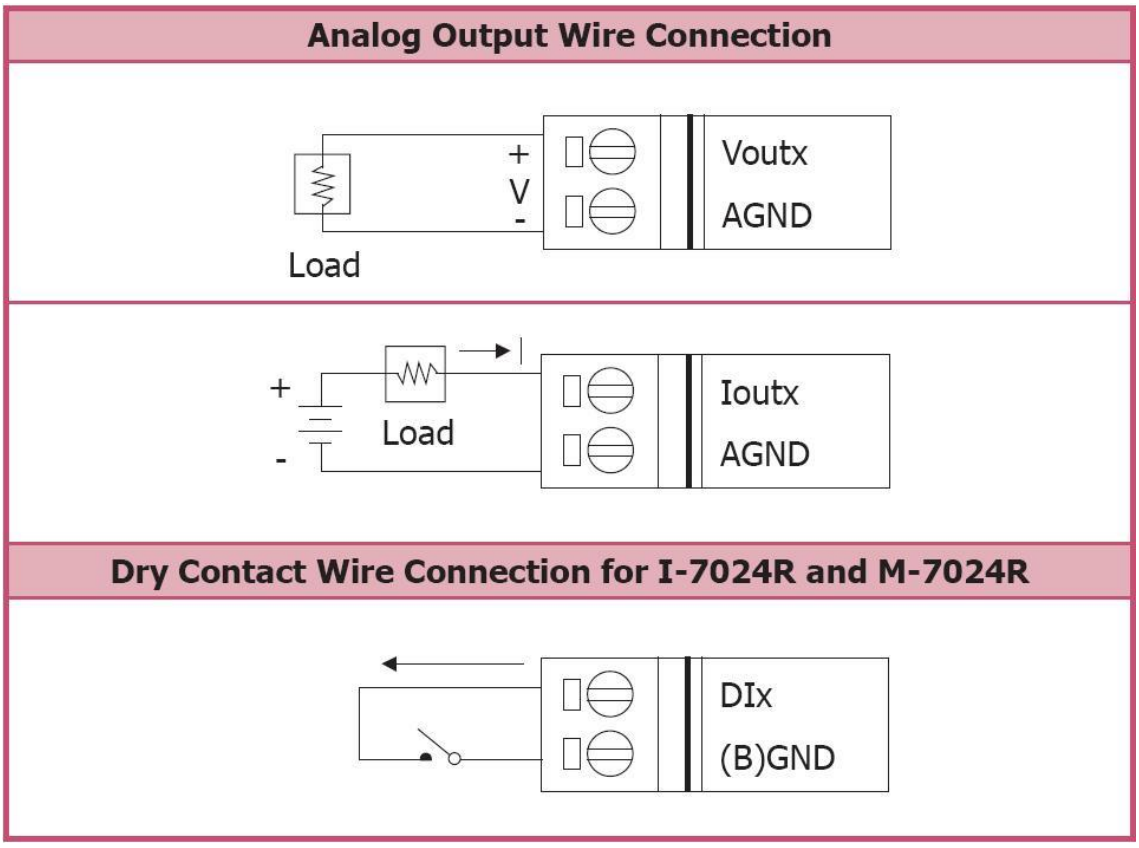
	Select internal power. It can drive load up to 500 ohm. (factory default)
	Select external power. It can drive load up to 1050 ohm for 24 V external power supply.

1.7 Wiring

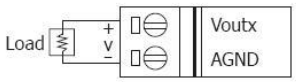
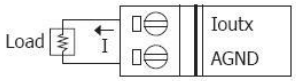
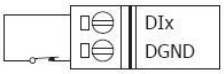
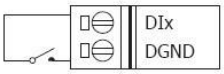
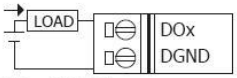
1.7.1 Wiring diagram for the I-7021, I-7021P, I-7022 and M-7022

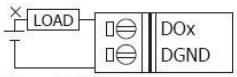


1.7.2 Wiring diagram for the I-7024, I-7024R, M-7024 and M-7024R



1.7.3 Wiring diagram for the M-7024U

<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>Digital Input/Counter</th><th>ON State
Readback as 1</th><th>OFF State
Readback as 0</th></tr>
<tr><td>Dry Contact (Source)</td><td> 
</td><td> 
</td></tr>
<tr><th>Digital Output</th><th>ON State
Readback as 1</th><th>OFF State
Readback as 0</th></tr>
<tr><td>Open Collector (Sink)</td><td> 

3.5 ~ 50 VDC</td><td> 

3.5 ~ 50 VDC</td></tr>
</table>

1.7.4 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.

1.8 Quick Start

To install the module, follow the steps below:

1. For current output, adjust the jumper setting for the I-7021/21P, I-7022 and M-7022. See Section 1.6 for the jumper settings.
2. Connect the output load. See Section 1.2 for the terminal assignment and Section 1.7 for the wiring diagram.
3. Connect the module to the RS-485 network using the DATA+ and DATA- terminals. See Section 1.2 for the terminal assignment. If the host is only equipped with an RS-232 interface, then an RS-232 to RS-485 converter will be required. Refer to the "**I-7000 Bus Converter User's Manual**" for more information.
4. Connect the module to the power supply using the +Vs and GND terminals. See Section 1.2 for the terminal assignment. Note that the voltage supplied to the module should be in the range of +10 to +30 VDC.
5. For I-7000 modules, configure the module by sending the %AANNTTCCFF command. See Section 2.1 for details. To configure the I-7022, the $AA9NTS command must also be sent. See Section 2.24 for details. For M-7000 modules using the Modbus RTU protocol, configure the module using the following Modbus registers: 40485, 40486, and 40487. The Modbus registers started at 40257 are required for configuring M-7022 and M-7024U. The default settings for the module can be found in Section 1.9.
6. For I-7000 modules, in order to write data to the analog output channels, send the #AA(data) or #AAN(data) commands to the module. See Sections 2.2 and 2.4 for details. For M-7000 modules using the Modbus RTU protocol, use Functions 06h or 10h to write the data to

the analog output channels. See Section 3.6 and 3.8 for details.

7. If the host is a PC with a Windows operating system installed, the DCON Utility can be used to allow easy configuration and reading of data. The DCON Utility can be downloaded from the ICP DAS website (http://www.icpdas.com). The documentation for the DCON Utility can be found in the ”**Getting Started For I-7000 Series Modules**” manual.

Please refer to the “**I-7000 Bus Converter User’s Manual**” and ”**Getting Started For I-7000 Series Modules**” manuals for more details. The “**Getting Started for I-7000 Series Modules**” manual can be downloaded from the ICP DAS website (http://www.icpdas.com).

1.9 Default Settings

Default settings for the I-7021/21P, I-7022, I-7024 and I-7024R modules are as follows:

- Module address: 01
- Analog output type: 0 ~ +10 V
- Baud rate: 9600 bps
- Checksum disabled
- Engineering unit format
- I-7021/21P and I-7022 jumper setting: internal power

Default settings for the M-7022, M-7024, M-7024R and M-7024U modules are as follows:

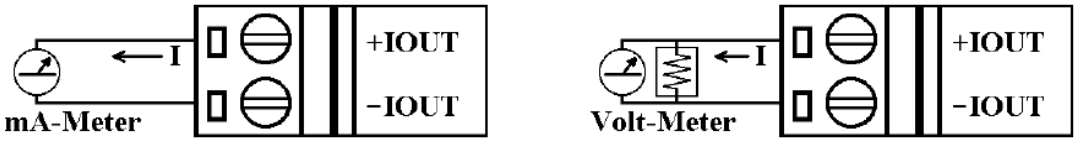
- Protocol: Modbus RTU
- Module address: 01
- Analog output type: 0 ~ +10 V
- Baud Rate: 9600 bps
- Engineering unit format
- M-7022 jumper setting: internal power

1.10 Calibration

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

I-7021/21P Current Output Calibration

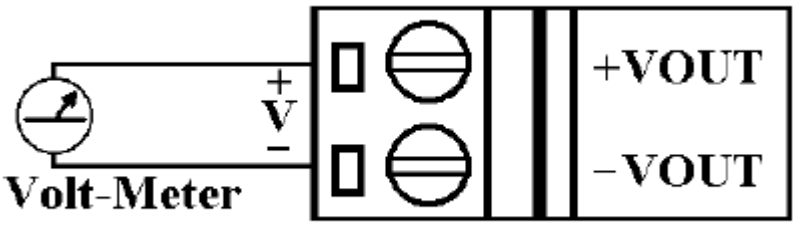
1. Set the jumper JP1 to select internal power and connect a current meter to the current output terminal of the module. If there is no current meter then you can use a voltage meter with a shunt resistor of 250 ohm and 0.1%. The current (I) can be calculated using the equation, I = V (voltage) / 250.



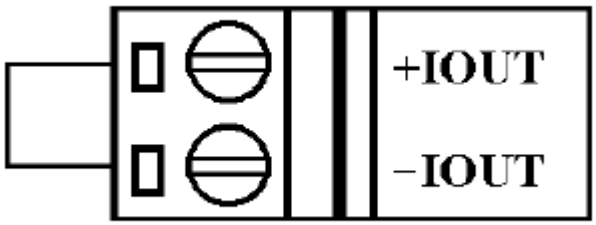
2. Warm up the module for at least 30 minutes.
3. Set the type code to 30, 0 ~ 20 mA. Refer to Section 2.1 for details.
4. Send command to output 4 mA. Refer to Section. 2.2 for details.
5. Repeat to send the trim command and check the meter until the meter's reading is nearest to 4 mA. Refer to Section 2.10 for details of sending the trim command.
6. Send the 4 mA calibration command. Refer to Section 2.5 for details.
7. Send command to output 20 mA. 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 20 mA. Refer to Section 2.10 for details of sending the trim command.
9. Send the 20 mA calibration command. Refer to Sections 2.7 for details.

I-7021/21P Voltage Output Calibration

1. Connect a voltage meter to the voltage output terminal of the module.



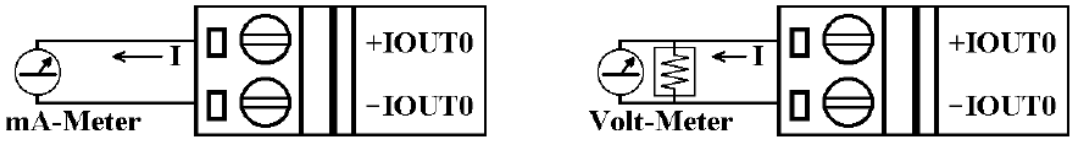
Short the current output terminal for the read-back requirement



2. Warm up the module for at least 30 minutes.
3. Set the type code to 32, 0 ~ 10 V. Refer to Section 2.1 for details.
4. Send command to output 10 V. 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 10 V. Refer to Section 2.10 for details of sending the trim command.
6. Send the 10 V calibration command. Refer to Section 2.18 for details.

I-7022/M-7022 Current Output Calibration

1. Set the jumper JP1 to select internal power and connect a current meter to the current output channel 0 terminal of the module. If there is no current meter then you can use a voltage meter with a shunt resistor of 250 ohm and 0.1%. The current (I) can be calculated using the equation, I = V (voltage) / 250.



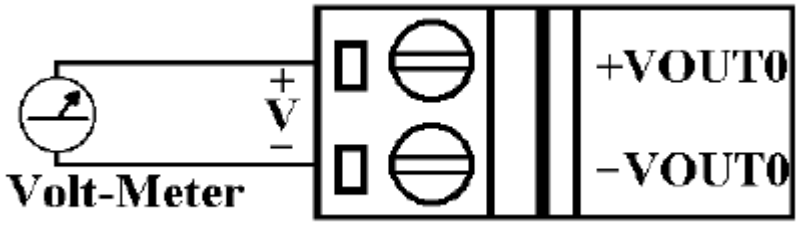
2. Warm up the module for at least 30 minutes.
3. Set the type code to 0, 0 ~ 20 mA. Refer to Section 2.24 for details.
4. Send command to output 4 mA. Refer to Section. 2.4 for details.
5. Repeat to send the trim command and check the meter until the meter's reading is nearest to 4 mA. Refer to Section 2.11 for details of sending the trim command.
6. Send the 4 mA calibration command. Refer to Section 2.6 for details.
7. Send command to output 20 mA. Refer to Section. 2.4 for details.
8. Repeat to send the trim command and check the meter until the meter's reading is nearest to 20 mA. Refer to Section 2.11 for details of sending the trim command.
9. Send the 20 mA calibration command. Refer to Sections 2.8 for details.
10. Repeat steps 1 to 9 for channel 1.

Note:

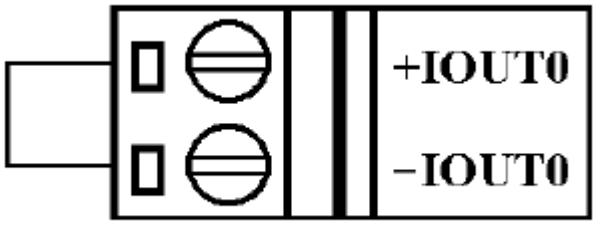
The M-7022 must be switched to the DCON protocol mode before calibrating. Refer to Sections 1.12.1 and 3.3.4 for details of the switching protocol.

I-7022/M-7022 Voltage Output Calibration

1. Connect a voltage meter to the voltage output channel 0 terminal of the module.



Short the current output terminal for the read-back requirement

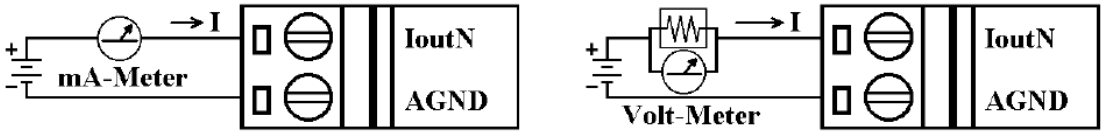


2. Warm up the module for at least 30 minutes.
3. Set the type code to 2, 0 ~ 10 V. Refer to Section 2.24 for details.
4. Send command to output 10 V. Refer to Section. 2.15 for details.
5. Repeat to send the trim command and check the meter until the meter's reading is nearest to 10 V. Refer to Section 2.18 for details of sending the trim command.
6. Send the 10 V calibration command. Refer to Section 2.21 for details.
7. Repeat steps 1 to 9 for channel 1.

Note:
The M-7022 must be switched to the DCON protocol mode before calibrating. Refer to Section 1.12.1 for details of the switching protocol.

I-7024/24R/M-7024/24R Current Output Calibration

1. Connect a current meter and an external power source to the current output channel 0 terminal of the module. If there is no current meter then you can use a voltage meter with a shunt resistor of 250 ohm and 0.1%. The current (I) can be calculated using the equation, I = V (voltage) / 250.



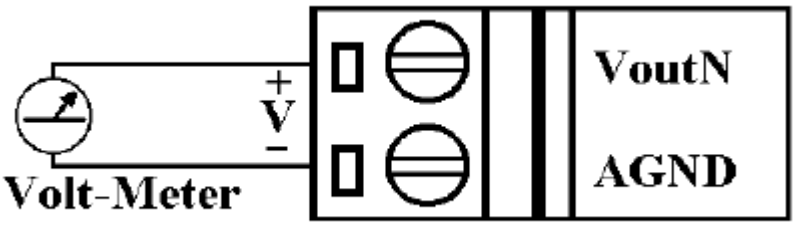
2. Warm up the module for at least 30 minutes.
3. Set the type code to 30, 0 ~ 20 mA. Refer to Section 2.1 for details.
4. Send command to output 0 mA. Refer to Section. 2.4 for details.
5. Repeat to send the trim command and check the meter until the meter's reading is nearest to 0 mA. Refer to Section 2.11 for details of sending the trim command.
6. Send the 0 mA calibration command. Refer to Section 2.6 for details.
7. Send command to output 20 mA. Refer to Section. 2.4 for details.
8. Repeat to send the trim command and check the meter until the meter's reading is nearest to 20 mA. Refer to Section 2.11 for details of sending the trim command.
9. Send the 20 mA calibration command. Refer to Sections 2.8 for details.
10. Repeat steps 1 to 9 for channel 1, 2 and 3.

Note:

The M-7024/24R must be switched to the DCON protocol mode before calibrating. Refer to Sections 1.12.1 for details of the switching protocol.

I-7024/24R/M-7024/24R Voltage Output Calibration

1. Connect a voltage meter to the voltage output channel 0 terminal of the module.



2. Warm up the module for at least 30 minutes.
3. Set the type code to 33, -10 V ~ +10 V. Refer to Section 2.1 for details.
4. Send command to output -10 V. Refer to Section. 2.4 for details.
5. Repeat to send the trim command and check the meter until the meter's reading is nearest to –10 V. Refer to Section 2.11 for details of sending the trim command.
6. Send the –10 V calibration command. Refer to Section 2. 6 for details.
7. Send command to output +10 V. Refer to Section. 2.4 for details.
8. Repeat to send the trim command and check the meter until the meter's reading is nearest to +10 V. Refer to Section 2.11 for details of sending the trim command.
9. Send the 10 V calibration command. Refer to Sections 2.8 for details.
10. Repeat steps 1 to 9 for channel 1, 2 and 3.

Note:
The M-7024/24R must be switched to the DCON protocol mode before calibrating. Refer to Sections 1.12.1 for details of the switching protocol.

M-7024U Analog Output Calibration

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 2.24 for details.
4. Send command to output zero calibration current/voltage. Refer to Section. 2.4 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 2.11 for details of sending the trim command.
6. Send the zero calibration command. Refer to Section 2. 6 for details.
7. Send command to output span calibration current/voltage. Refer to Section. 2.4 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 2.11 for details of sending the trim command.
9. Send the span calibration command. Refer to Section 2.8 for details.
10. Repeat steps 1 to 9 for channel 1, 2 and 3.

Notes:

1. The zero/span calibration voltages and currents are shown on the next page.
2. The M-7024U must be switched to the DCON protocol mode before calibrating. Refer to Sections 1.12.1 for details of the switching protocol.

Calibration voltages/current used by the M-7024U:

Type Code	0	1	2	3	4	5
Zero voltage/current	0mA	4mA	0V	-10V	0V	-5V
Span voltage/current	+20mA	+20mA	+10V	+10V	+5V	+5V

1.11 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

The firmware version that supports the data format other than N81 is as follows.

Module	Firmware Version
7021	B2.0 and later
7022	B1.2 and later
7024 series	A1.8 and later

Analog Output Type Setting (TT)

Type Code	Output Range
30	0 mA ~ +20 mA
31	+4 mA ~ +20 mA
32	0 V ~ +10 V
33	-10 V ~ +10 V
34	0 ~ +5 V
35	-5 V ~ +5 V
3F	For I-7022/M-7022 only
00	For M-7024U only

Note:

1. Type 30, 31, and 32 are only applicable to the I-7021, I-7021P, I-7024, I-7024R, M-7024 and M-7024R.
2. Types 33, 34 and 35 are only applicable to the I-7024, I-7024R, M-7024 and M-7024R.
3. For I-7022 and M-7022, this field must be set to 3F. For M-7024U, this field must be set to 00.

Data Format Setting (FF)

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

<table>
<tr><td>Key</td><td>Description</td></tr>
<tr><td>DF</td><td>Data format
00: Engineering unit
01*: % of FSR (full scale range)
10*: 2’s complement hexadecimal
Note: the data format 01 and 10 are only available to the I-7021/21P, I-7022, M-7022 and M-7024U</td></tr>
<tr><td>SR</td><td>Slew rate for I-7021, I-7021P, I-7024, I-7024R, M-7024 and M-7024R
<table>
<tr><td></td><td>V/s</td><td>mA/s</td><td></td><td>V/s</td><td>mA/s</td></tr>
<tr><td>0000</td><td colspan="2">immediate</td><td>1000</td><td>8.0</td><td>16.0</td></tr>
<tr><td>0001</td><td>0.0625</td><td>0.125</td><td>1001</td><td>16.0</td><td>32.0</td></tr>
<tr><td>0010</td><td>0.125</td><td>0.25</td><td>1010</td><td>32.0</td><td>64.0</td></tr>
<tr><td>0011</td><td>0.25</td><td>0.5</td><td>1011</td><td>64.0</td><td>128.0</td></tr>
<tr><td>0100</td><td>0.5</td><td>1.0</td><td>1100</td><td>128.0</td><td>256.0</td></tr>
<tr><td>0101</td><td>1.0</td><td>2.0</td><td>1101</td><td>256.0</td><td>512.0</td></tr>
<tr><td>0110</td><td>2.0</td><td>4.0</td><td>1110</td><td>512.0</td><td>1024.0</td></tr>
<tr><td>0111</td><td>4.0</td><td>8.0</td><td>1111</td><td>1024.0</td><td>2048.0</td></tr>
<tr><td colspan="6">Note: the setting 1111 is for I-7024, I-7024R, M-7024 and M-7024R only</td></tr>
</table>
0 for I-7022, M-7022 and M-7024U</td></tr>
<tr><td>CS</td><td>Checksum setting
0: Disabled
1: Enabled</td></tr>
</table>

Analog Output Type and Data Format Table for I-7021 and I-7021P

Type Code	Output Range	Data Format	Max.	Min.
30	0 ~ +20 mA	Engineering unit	20.000	00.000
		% of FSR	+100.00	+000.00
		2's comp HEX	FFF	000
31	+4 ~ +20 mA	Engineering unit	20.000	04.000
		% of FSR	+100.00	+000.00
		2's comp HEX	FFF	000
32	0 ~ 10 V	Engineering unit	10.000	00.000
		% of FSR	+100.00	+000.00
		2's comp HEX	FFF	000

Analog Output Type and Data Format Table for I-7022 and M-7022

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	FFF	000
1	4 ~ 20 mA	Engineering unit	20.000	04.000
		% of FSR	+100.00	+000.00
		2's comp HEX	FFF	000
2	0 ~ 10 V	Engineering unit	10.000	00.000
		% of FSR	+100.00	+000.00
		2's comp HEX	FFF	000
4*	0 ~ 5 V	Engineering unit	05.000	00.000
		% of FSR	+100.00	+000.00
		2's comp HEX	FFF	000
Note: The type code 4 is only available to firmware version B1.2 and later.				

Analog Output Type and Data Format Table for I-7024, I-7024R, M-7024 and M-7024R

Type Code	Output Range	Data Format	Max.	Min.
30	0 ~ +20 mA	Engineering unit	+20.000	+00.000
31	+4 ~ +20 mA	Engineering unit	+20.000	+04.000
32	0 ~ +10 V	Engineering unit	+10.000	+00.000
33	-10 ~ +10 V	Engineering unit	+10.000	-10.000
34	0 ~ +5 V	Engineering unit	+05.000	+00.000
35	-5 V ~ +5 V	Engineering unit	+05.000	-05.000

Analog Output Type and Data Format Table for M-7024U

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
3	-10 ~ +10V	Engineering unit	+10.000	-10.000
		% of FSR	+100.00	-100.00
		2’s comp HEX	7FFF	8000
4	0 ~ +5 V	Engineering unit	+05.000	+00.000
		% of FSR	+100.00	+000.00
		2’s comp HEX	FFFF	0000
5	-5 ~ +5 V	Engineering unit	+05.000	-05.000
		% of FSR	+100.00	-100.00
		2’s comp HEX	7FFF	8000

Analog Output Configuration for I-7022, M-7022 and M-7024U

Analog Output Type Setting (T)

Type Code	Output Range
0	0 mA ~ +20 mA
1	+4 mA ~ +20 mA
2	0 V ~ +10 V
3*	-10 V ~ +10 V
4*	0 V ~ +5 V
5*	-5 V ~ +5 V

Notes:

1. The type code 4 is only available to M-7024U and I-7022/ M-7022 firmware version B1.2 and later.
2. The type code 3 and 5 are only available to M-7024U.

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

1.12 M-7000 Notes

The main difference between the I-7000 and M-7000 series is that the M-7000 series has additional support for the Modbus RTU communication protocol, which is the default protocol of the M-7000 series. The communication Baud Rates for the Modbus RTU protocol can be in the range of 1200 bps to 115200 bps.

Modbus functions supported by the module are described in Chapter 3.

1.12.1 Protocol Switching

To switch to the DCON protocol:

1. Set Modbus register 00257 to 1.
2. After a power-on reset, the communication protocol will be changed to DCON.

To switch to the Modbus RTU protocol:

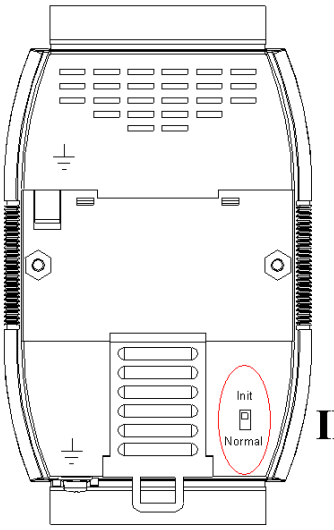
1. Sends the $AAPN command and set N to a value of 1. Note that the INIT* terminal should be connected to the GND terminal, or the slide switch on the rear side of the module should be set to the INIT position. See Section 2.31 for details.
2. After a power-on reset, the communication protocol will be changed to the Modbus RTU protocol.

1.12.2 INIT Mode

When the module is powered on with the INIT* pin connected to the GND pin or the rear slide switch set to the INIT position as shown in the figure below, the module is in INIT mode, (see Section A.1 for details), and the communication settings are as follows:

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

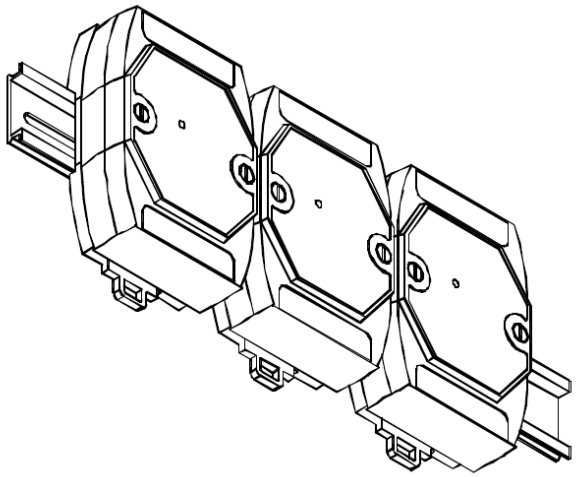
If communication with the module is not possible, set the module to the INIT mode and use the above settings to communicate with the module. To read the current settings, send the commands $AA2, (see Section 2.9), and $AAP, (see Section 2.30). To set new settings, send the commands %AANNTTCCFF, (see Section 2.1) and $AAPN, (see Section 2.31). The new communication settings will be effective after the next power-on reset.



INIT Switch

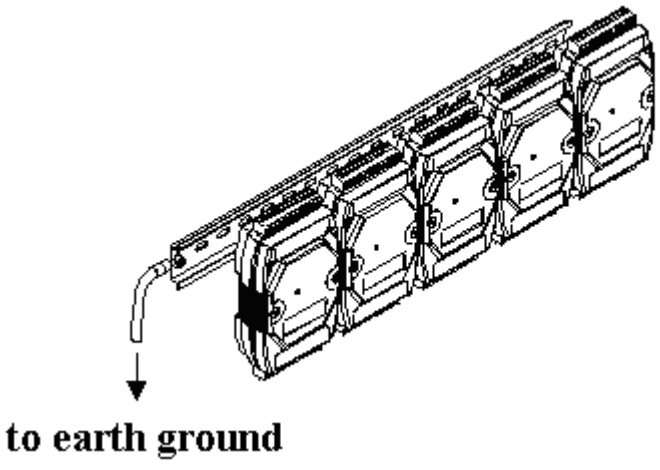
1.13 Mounting

1.13.1 Din-Rail Mounting

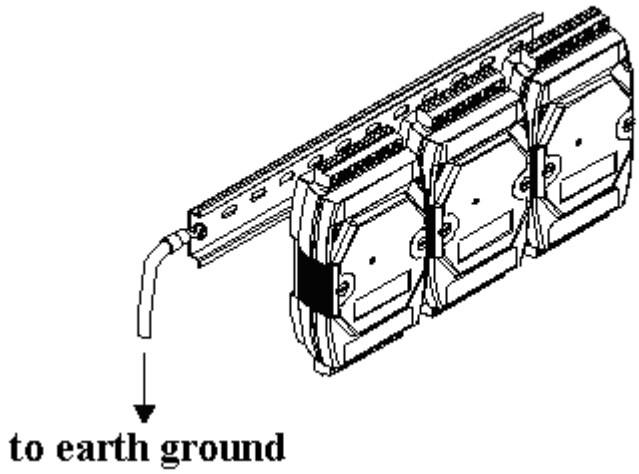


There are three new DIN rail models available. Each is made of stainless steel, which is stronger than those made of aluminum. There is a screw at one end and a ring terminal is included so that it can be easily connected to the earth ground. The three new DIN rail models are as follows.

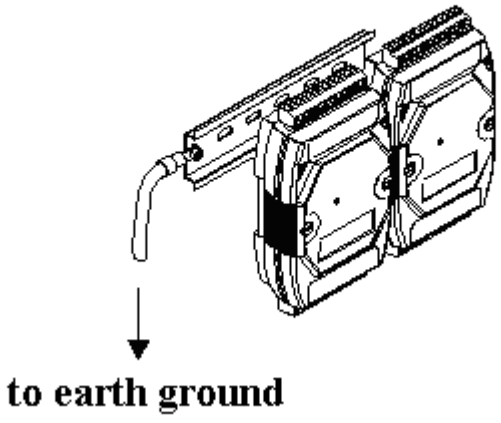
Part number	Max. number of modules	Dimensions
DRS-360	5	360mm x 35mm



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



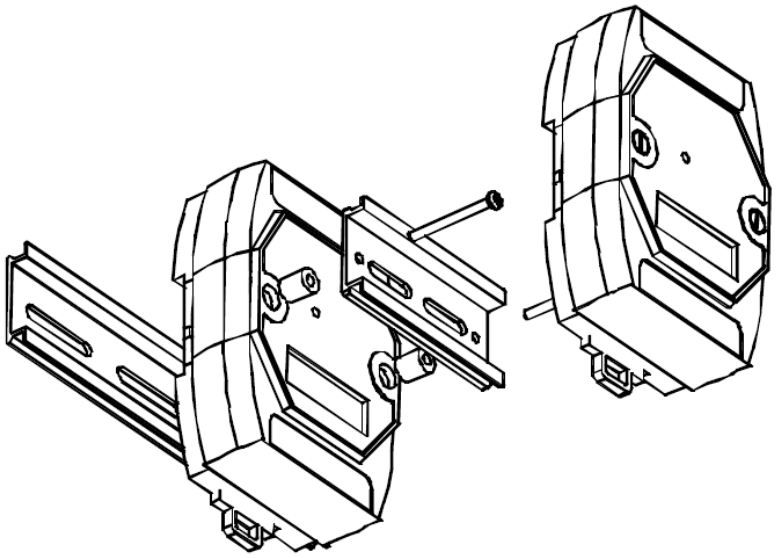
Part number	Max. number of modules	Dimensions
DRS-125	2	125mm x 35mm



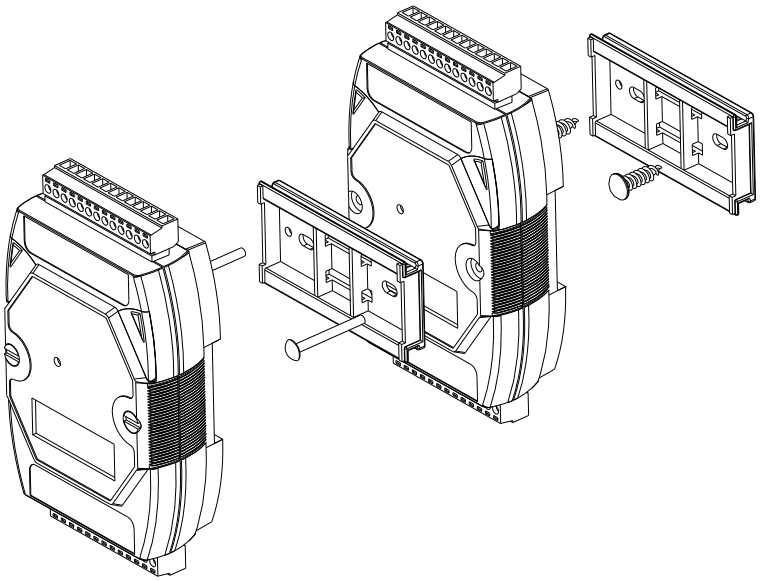
Note: It is recommended that a 16 – 14 AWG wire is used to connect the DIN rail to the earth ground.

1.13.2 Piggyback Mounting

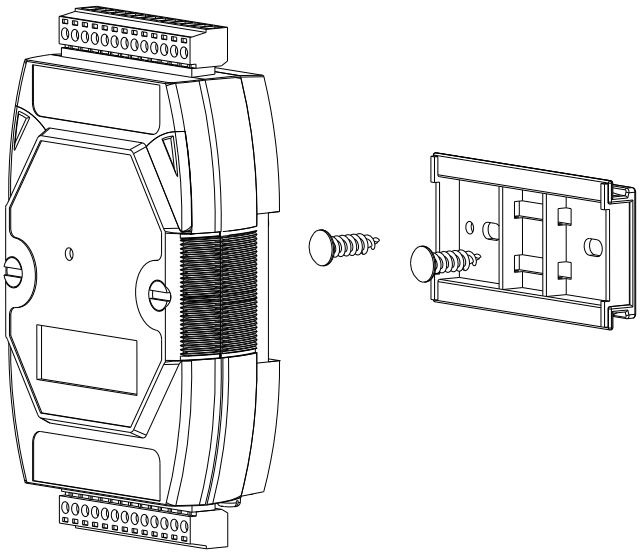
For I-7021, I-7021P, I-7022, and M-7022 modules



For other modules



1.13.3 Wall Mounting



1.14 Technical Support

Should you encounter any problems while using the I-7000 and M-7000 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 2.27 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.

2. DCON Protocol

All communication with I-7000 modules consists of commands generated by the host and responses transmitted by the I-7000 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 2.34), which are sent to all modules, but 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 1.11 (Data Format Setting) and 2.1 for details.

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

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.

General Command Sets			
Command	**Response**	**Description**	**Section**
%AANNTTCCFF	!AA	Sets the module configuration	2.1
$AA2	!AATTCCFF	Reads the module configuration	2.9
$AA5	!AAS	Reads the module reset status	2.14
$AAF	!AA(Data)	Reads the firmware version	2.27
$AAI	!AAS	Reads the INIT terminal status	2.28
$AAM	!AA(Data)	Reads the module name	2.29
$AAP	!AASC	Reads the communication protocol	2.30
$AAPN	!AA	Sets the communication protocol	2.31
~AAO(Name)	!AA	Sets the module name	2.33

I-7021/21P Analog Output Command Sets			
Command	**Response**	**Description**	**Section**
#AA(Data)	>	Sets the analog output channel	2.2
$AA0	!AA	Performs a 4mA calibration	2.5
$AA1	!AA	Performs a 20mA calibration	2.7
$AA3VV	!AA	Adjusts the analog output for calibration	2.10
$AA4	!AA	Sets the current output value as power-on value	2.12
$AA6	!AA(Data)	Reads the last written analog output value	2.15
$AA7	!AA	Performs a 10V calibration	2.18
$AA8	!AA(Data)	Reads the analog output channel via an analog-to-digital converter	2.21

I-7022/M-7022 Analog Output Command Sets			
Command	**Response**	**Description**	**Section**
#AAN(Data)	>	Sets the analog output of a channel	2.4
$AA0N	!AA	Performs a 4mA calibration of a channel	2.6
$AA1N	!AA	Performs a 20mA calibration of a channel	2.8
$AA3NVV	!AA	Adjusts the analog output of a channel for calibration	2.11
$AA4N	!AA	Sets the current output value of a channel as power-on value	2.13
$AA6N	!AA(Data)	Reads the last written analog output value of a channel	2.17
$AA7N	!AA	Performs a 10V calibration of a channel	2.19

$AA8N	!AA(Data)	Reads the analog output channel via an analog-to-digital converter	2.22
$AA9N	!AATS	Reads the analog output configuration of a channel	2.23
$AA9NTS	!AA	Sets the analog output configuration of a channel	2.24

I-7024/I-7024R/M-7024/M-7024R Analog Output Command Sets			
Command	**Response**	**Description**	**Section**
#AAN(Data)	>	Sets the analog output of a channel	2.4
$AA0N	!AA	Performs a 4mA or –10V calibration of a channel	2.6
$AA1N	!AA	Performs a 20mA or +10V calibration of a channel	2.8
$AA3NVV	!AA	Adjusts the analog output of a channel for calibration	2.11
$AA4N	!AA	Sets the current output value of a channel as power-on value	2.13
$AA6N	!AA(Data)	Reads the last written analog output value of a channel	2.17
$AA7N	!AA	Reads the power-on value of a channel	2.20
$AA8N	!AA(Data)	Reads the current analog output of a channel	2.22

M-7024U Analog Output Command Sets			
Command	**Response**	**Description**	**Section**
#AAN(Data)	>	Sets the analog output of a channel	2.4
$AA0N	!AA	Performs zero calibration of a channel	2.6
$AA1N	!AA	Performs span calibration of a channel	2.8
$AA3NVV	!AA	Adjusts the analog output of a channel for calibration	2.11
$AA4N	!AA	Sets the current output value of a channel as power-on value	2.13
$AA6N	!AA(Data)	Reads the last written analog output value of a channel	2.17
$AA7N	!AA	Reads the power-on value of a channel	2.20
$AA8N	!AA(Data)	Reads the current analog output of a channel	2.22
$AA9N	!AATS	Reads the analog output configuration of a channel	2.23
$AA9NTS	!AA	Sets the analog output configuration of a channel	2.24
@AABB	!AAHH	Reads the retained analog output status	2.45
@AABBHH	!AA	Sets the retained analog output status	2.46

I-7024R/M-7024R Digital Input Command Sets			
Command	**Response**	**Description**	**Section**
#AAN	!AA(Data)	Reads the counter data of a digital channel	2.3
$AA6	!(Data)	Reads the digital input status	2.16
$AACN	!AA	Resets the counter data of a digital channel	2.26
@AACECN*	!AA	Resets the counter data of a digital channel	2.47
@AADI*	!AA000II	Reads the digital input status	2.48
@AARECN*	!AA(Data)	Reads the counter data of a digital channel	2.50
*Note: It is recommended to use these commands for firmware version A2.3 and later.			

M-7024U Digital Input and Output Command Sets			
Command	**Response**	**Description**	**Section**
@AACECN	!AA	Resets the counter data of a digital channel	2.47
@AADI	!AA0OOII	Reads the digital output and input status	2.48
@AADO	!AA	Sets the digital output value	2.49
@AARECN	!AA(Data)	Reads the counter data of a digital channel	2.50
~AA4	!AAPPSS	Reads the power on and safe digital output value	2.40
~AA5PPSS	!AA	Sets the power on and safe digital output value	2.44

Host Watchdog Command Sets			
Command	**Response**	**Description**	**Section**
~**	No Response	Host is OK	2.34
~AA0	!AASS	Reads the host watchdog status	2.35
~AA1	!AA	Resets the host watchdog status	2.36
~AA2	!AAETT	Reads the host watchdog timeout settings	2.37
~AA3ETT	!AA	Sets the host watchdog timeout settings	2.38
~AA4	!AA(Data)	Reads the analog output safe value	2.39
~AA4N	!AA(Data)	Reads the safe value of an analog output channel	2.41
~AA5	!AA	Sets the current analog output value as safe value	2.42
~AA5N	!AA	Sets the current analog output value as safe value for a channel	2.43

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 1.11 for details. For the I-7022, M-7022 and M-7024U, this field should be set to 3F, 00 for M-7024U, and use the $AA9NTS command to set the type of each channel, see Section 2.24 for details.
CC	New Baud Rate code, see Section 1.11 for details. The module must be switched to INIT* mode in order to change Baud Rates. See Section A.1 for details.
FF	Used to set the data format, checksum, and slew rate settings (Section 1.11). For the I-7022, M-7022 and M-7024U, use the $AA9NTS command to set the slew rate of each channel, see Section 2.24 for details. The module must be switched to INIT* mode in order to change the checksum setting. See Section A.1 for details.

Response:

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

! Delimiter for a valid command

? Delimiter for an invalid command. If the **Baud Rate** or **checksum** settings are changed without connecting the INIT* terminal to ground, 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: %0102300600 Response: !02

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

Command: %0101300A00 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: %0101300A00 Response: !01

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

Related Commands:

Section 2.9 $AA2

Related Topics:

Section 1.11 Configuration Tables, Section A.1 INIT Mode

Note:

Changes to the address, type code, data format and slew rate 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.

2.2 #AA(Data)

Description:

Writes the data to analog output channel.

Syntax:

#AA(Data)[CHKSUM](CR)

#	Delimiter character
AA	Address of the module to be written (00 to FF)
(Data)	Data to be written to the analog output channel, see Section 1.11 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.

Examples:

Command: $012 Response: !01300600

Reads the configuration of module 01. It returns: output type 0 mA ~ 20 mA, engineering data format and output changing immediately.

Command: #0105.000 Response: >

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

Command: #0125.000 Response: ?

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

Command: $032 Response: !03300602

Reads the configuration of module 01. It returns: output type 0 mA ~ 20 mA, hexadecimal data format and output changing immediately.

Command: #03800 Response: >

Sets module 03 to output 800h (10 mA). The module returns a valid response.

Related Commands:

Section 2.1 %AANNTTCCFF, Section 2.9 $AA2

Related Topics:

Section 1.11 Configuration Tables, Section A.5 Analog Output

Note:

This command is only applicable to the I-7021 and I-7021P.

2.3 #AAN

Description:

Reads the counter data of a specified digital input channel.

Syntax:

#AAN[CHKSUM](CR)

#	Delimiter character
AA	Address of the module to be read (00 to FF)
N	The channel to be read, zero based.

Response:

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

!	Delimiter character for a valid command
?	Delimiter character for an invalid command. An invalid command is returned if the specified channel is incorrect.
AA	Address of the module in hexadecimal format (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.

Examples:

Command: #032 Response: !0302513

Reads counter data from channel 2 of module 03 and returns the counter value 2513.

Related Commands:

Section 2.26 $AACN, Section 2.47 @AACECN, Section 2.50 @AARECN

Notes:

1. This command is only applicable to the I-7024R and M-7024R.
2. For I-7024R and M-7024R with firmware version A2.3 and later, it is recommended to use @AARECN command to read the counter value.

2.4 #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, zero based.
(Data)	Data to be written to the analog output channel, see Section 1.11 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.

Examples for I-7022 and M-7022:

Command: $012 Response: !013F0600

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: #01005.000 Response: >

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

Command: #01025.000 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.

Examples for I-7024, I-7024R, M-7024 and M-7024R:

Command: $012 Response: !01300600

Reads the configuration of module 01. It returns: output type 0 mA ~ 20 mA, engineering data format 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.

Examples for M-7024U:

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 2.9 $AA2

Related Topics:

Section 1.11 Configuration Tables, Section A.5 Analog Output

Note:

This command is only applicable to the I-7022, I-7024, I-7024R, M-7022, M-7024, M-7024R and M-7024U.

2.5 $AA0

Description:

I-7021, I-7021P: Performs a 4 mA calibration.
I-7021A: Performs a zero calibration.

Syntax:

$AA0[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be calibrated (00 to FF)
0	Command for the 4 mA/zero calibration

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: $010 Response: !01

Performs a 4 mA output calibration on module 01 and returns a valid response.

Related Commands:

Section 2.7 $AA1, Section 2.10 $AA3VV

Related Topics:

Section 1.10 Calibration

Note:

This command is only applicable to the I-7021, I-7021A, and I-7021P.

2.6 $AA0N

Description:

I-7022/M-7022: Performs 4 mA calibration.
I-7024/I-7024R/M-7024/M-7024R: Performs 0 mA or -10 V calibration.
M-7022A/M-7024U: 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 4 mA/0 mA/-10 V/zero calibration
N	Specifies the channel to be calibrated, zero based

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: $0101 Response: !01

Performs a zero calibration on channel 1 of module 01 and returns a valid response.

Related Commands:

Section 2.8 $AA1N, Section 2.11 $AA3NVV

Related Topics:

Section 1.10 Calibration

Notes:

This command is only applicable to the I-7022, I-7024, I-7024R, M-7022, M-7022A, M-7024, M-7024R and M-7024U.

2.7 $AA1

Description:

I-7021, I-7021P: Performs a 20 mA calibration.
I-7021A: Performs a span calibration.

Syntax:

$AA1[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be calibrated (00 to FF)
1	Command for the 20 mA/span calibration

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: $011 Response: !01

Performs a 20 mA output calibration on module 01 and returns a valid response.

Related Commands:

Section 2.5 $AA0, Section 2.10 $AA3VV

Related Topics:

Section 1.10 Calibration

Note:

This command is only applicable to the I-7021, I-7021A, and I-7021P.

2.8 $AA1N

Description:

I-7022/M-7022: Performs 20 mA calibration.
I-7024/I-7024R/M-7024/M-7024R: Performs 20 mA or +10 V calibration.
M-7022A/M-7024U: 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 20 mA/+10 V/span calibration
N	Specifies the channel to be calibrated, zero based

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: $0111 Response: !01
Performs a span calibration on channel 1 of module 01 and returns a valid response.

Related Commands:

Section 2.6 $AA0N, Section 2.11 $AA3NVV

Related Topics:

Section 1.10 Calibration

Notes:

This command is only applicable to the I-7022, I-7024, I-7024R, M-7022, M-7022A, M-7024, M-7024R and M-7024U.

2.9 $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 I-7022, M-7022 and M-7024U, this field is to 3F and 00 for M-7024U, see Section 1.110 for details.
CC	Baud Rate code of the module, see Section 1.11 for details.
FF	Data format, checksum settings and slew rate settings of the module, see Section 1.11 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.

Examples:

Command: $012 Response: !01300600

Reads the configuration of module 01.

Command: $022 Response: !02330602

Reads the configuration of module 02.

Related Commands:

Section 2.1 %AANNTTCCFF

Related Topics:

Section 1.11 Configuration Tables

2.10 $AA3VV

Description:

Adjusts the analog output for calibration.

Syntax:

$AA3VV[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be adjusted (00 to FF)
3	Command to adjust the analog output
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.

Examples:

Command: $0131F Response: !01

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

Related Commands:

Section 2.5 $AA0, Section 2.7 $AA1

Note:

This command is only applicable to the I-7021/21P.

2.11 $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, zero based
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 for I-7022 and M-7022, 2.44uA or 1.22mV for I-7024/24R and M-7024/24R, 0.61uA or 0.30mA for M-7024U.

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: $01321F Response: !01

Sets the analog output channel 2 of module 01 to be increased by 31 and returns a valid response.

Related Commands:

Section 2.6 $AA0N, Section 2.8 $AA1N

Note:

This command is only applicable to the I-7022, M-7022, I-7024, I-7024R, M-7024, M-7024R and M-7024U.

2.12 $AA4

Description:

Sets the current output as the power-on value.

Syntax:

$AA4[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be set (00 to FF)
4	Command to set the power on 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.

Examples:

Command: #0100.000 Response: >

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

Command: $014 Response: !01

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

Related Commands:

Section 2.2 #AA(data)

Note:

This command is only applicable to the I-7021/21P.

2.13 $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, zero based

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: #01100.000 Response: >

Sets the output of channel 1 of module 01 to 0.0mA and returns a valid response.

Command: $0141 Response: !01

Sets the current output of channel 1 of module 01 as the power-on value and returns a valid response.

Related Commands:

Section 2.4 #AAN(data), Section 2.20 $AA7N

Notes:

This command is only applicable to the I-7022, M-7022, I-7024, I-7024R, M-7024, M-7024R and M-7024U.

2.14 $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.

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

2.15 $AA6

Description:

Reads the last written analog output value.

Syntax:

$AA6[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

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 1.11 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: #0110.000 Response: >

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

Command: $016 Response: !0110.000

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

Related Commands:

Section 2.2 #AA(Data), Section 2.21 $AA8

Related Topics:

Section 1.11 Configuration Tables, Section A.7 Analog Output Read-back

Note:

This command is only applicable to the I-7021/21P.

2.16 $AA6

Description:

Reads the status of the digital input channels..

Syntax:

$AA6[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be read (00 to FF)
6	Command to read the digital input channels

Response:

Valid command: **!(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)	Status of the digital input channels, a two-digit hexadecimal value followed by 0000.

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: $016 Response: !0F0000

Reads the digital input channel status of module 01 and returns 0F0000h, which denotes that digital input channels 0 to 3 are on and digital input channel 4 is off.

Related Commands:

Section 2.48 @AADI

Notes:

1. This command is only applicable to the I-7024R and M-7024R.
2. For I-7024R and M-7024R with firmware version A2.3 and later, it is recommended to use @AADI command to read the digital input status.

2.17 $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, zero based

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 1.11 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: #01110.000 Response: >

Sets the output of channel 1 of the module 01 to 10.000 and the module returns a valid response.

Command: $0161 Response: !0110.000

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

Related Commands:

Section 2.4 #AAN(Data), Section 2.22 $AA8N

Related Topics:

Section 1.11 Configuration Tables, Section A.7 Analog Output Read-back

Notes:

This command is only applicable to the I-7022, I-7024, I-7024R, M-7022, M-7024, M-7024R and M-7024U.

2.18 $AA7

Description:

Performs a 10 V calibration.

Syntax:

$AA7[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be calibrated (00 to FF)
7	Command for the 10 V calibration

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: $017 Response: !01

Performs a 10 V output calibration on module 01 and returns a valid response.

Related Commands:

Section 2.7 $AA1, Section 2.10 $AA3VV

Related Topics:

Section 1.10 Calibration

Note:

This command is only applicable to the I-7021/21P.

2.19 $AA7N

Description:

Performs a 10 V calibration on a specified channel.

Syntax:

$AA7N[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be calibrated (00 to FF)
7	Command for the 10 V calibration
N	Specifies the channel to be calibrated, zero based

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: $0170 Response: !01

Performs a 10 V output calibration on channel 0 of module 01 and returns a valid response.

Related Commands:

Section 2.8 $AA1N, Section 2.11 $AA3NVV

Related Topics:

Section 1.10 Calibration

Note:

This command is only applicable to the I-7022 and M-7022.

2.20 $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, zero based

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 1.11 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: $0172 Response: !01+10.000

Reads the power-on analog output value of channel 2 of the module 01 and the module returns +10.000.

Related Commands:

Section 2.13 $AA4N

Note:

This command is only applicable to the I-7024, I-7024R, M-7024, M-7024R and M-7024U.

2.21 $AA8

Description:

Reads the current analog output value.

Syntax:

$AA8[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be read (00 to FF)
8	Command to read the current analog output value

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 1.11 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: $012 Response: !01320614

Reads the configuration of module 01 and the module returns a response of 0 to 10V range, 9600 bps, 1V/second slew rate and engineering data format.

Command: #0110.000 Response: >

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

Command: $016 Response: !0110.000

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

Command: $018 Response: !0101.000

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

Related Commands:

Section 2.2 #AA(Data), Section 2.15 $AA6

Related Topics:

Section 1.11 Configuration Tables, Section A.6 Slew Rate Control, Section A.7 Analog Output Read-back

Note:

This command is only applicable to the I-7021/21P.

2.22 $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, zero based

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 1.11 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: $012 Response: !01320614

Reads the configuration of module 01 and the module returns a response of 0 to 10V range, 9600 bps, 1V/second slew rate and engineering data format.

Command: #012+10.000 Response: >

Sets the output of channel 2 of the module 01 to +10.000 and the module returns a valid response.

Command: $0162 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: $0182 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 2.4 #AAN(Data), Section 2.17 $AA6N

Related Topics:

Section 1.11 Configuration Tables, Section A.6 Slew Rate Control, Section A.7 Analog Output Read-back

Note:

This command is only applicable to the I-7022, I-7024, I-7024R, M-7022, M-7024, M-7024R and M-7024U.

2.23 $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, zero based

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 1.11 for details.
S	Analog output slew rate, see Section 1.11 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.

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 2.24 $AA9NTS

Related Topics:

Section 1.11 Configuration Tables

Note:

This command is only applicable to the I-7022, M-7022 and M-7024U.

2.24 $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, zero based
T	Analog output type, see Section 1.11 for details.
S	Analog output slew rate, see Section 1.11 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.

Examples:

Command: $019121 Response: !01

Sets the configuration of channel 1 for module 01 to 0 to 10V range and 0.625V/second slew rate and returns a valid response.

Related Commands:

Section 2.23 $AA9N

Related Topics:

Section 1.11 Configuration Tables

Notes:

This command is only applicable to the I-7022, M-7022 and M-7024U.

2.25 $AAB

Description:

Diagnoses the current output wire opening and voltage output short circuit status of the analog outputs.

Syntax:

$AAB[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be read (00 to FF)
B	Command to diagnose the analog outputs

Response:

Valid command: **!AAHH[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)
HH	Represents the diagnostic results of every analog output channel (00 to 0F), where bit 0 corresponds to channel 0, bit 1 corresponds to channel 1, etc. When the bit is 1, it means that the channel is either wire opening for current output or short circuit for voltage output. If the bit is 0 it means that the channel is normal.

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: $01B Response: $0102

Diagnoses the analog outputs of module 01. The module returns a valid response and channel 1 is either wire opening for current output or short circuit for voltage output.

Note:

This command is only applicable to the M-7024U.

2.26 $AACN

Description:

Clears the digital input counter value of a specified channel.

Syntax:

$AACN[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be cleared (00 to FF)
C	Command to clear the digital input counter value
N	The channel to be cleared, zero based

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: #032 Response: !0300103

Reads counter data from channel 2 of module 03 and the returned counter value is 103.

Command: $03C2 Response: !03

Clears the counter value of channel 2 of module 03 and returns a valid response.

Command: #032 Response: !0300000

Reads counter data from channel 2 of module 03 and the returned counter value is 3.

Related Commands:

Section 2.3 #AAN, Section 2.47 @AACECN, Section 2.50 @AARECN

Notes:

1. This command is only applicable to the I-7024R and M-7024R.
2. For I-7024R and M-7024R with firmware version A2.3 and later, it is recommended to use @AACECN command to clear the digital input status.

2.27 $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.

2.28 $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.

Examples:

Command: $01I Response: !010

Reads the INIT status of module 01. The response shows that the INIT terminal is connected to the GND terminal.

2.29 $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 2.33 ~AAO(Name)

2.30 $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
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

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 2.31 $AAPN

Note:

This command is only applicable to the M-7022, M-7024, M-7024R and M-7024U.

2.31 $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 Before using this command, the rear slide switch must be in the INIT position for M-7024U, or the INIT * terminal should be connected to the GND terminal for M-7022, M-7024 and M-7024R, 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.

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 2.30 $AAP

Related Topics:

Section A.1 INIT Mode

Note:

This command is only applicable to the M-7022, M-7024, M-7024R and M-7024U.

2.32 $AAS1

Description:

Reloads the factory calibration parameters.

Syntax:

$AAS1[CHKSUM](CR)

$	Delimiter character
AA	Address of the module to be reloaded (00 to FF)
S1	Command to reload the factory calibration parameters

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: $01S1 Response: !01

Reloads the factory calibration parameters for module 01 and returns a valid response.

Related Commands:

Section 2.6 $AA0N, Section 2.8 $AA1N

Note:

This command is only applicable to the M-7024U.

2.33 ~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.

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 2.29 $AAM

2.34 ~**

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 2.35 ~AA0, Section 2.36 ~AA1, Section 2.37 ~AA2, Section 2.38 ~AA3EVV

Related Topics:

Section A.2 Dual Watchdog Operation

2.35 ~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.

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 2.34 ~**, Section 2.36 ~AA1, Section 2.37 ~AA2, Sec 2.38 ~AA3EVV

Related Topics:

Section A.2 Dual Watchdog Operation

2.36 ~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.

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 2.34 ~**, Section 2.35 ~AA0, Section 2.37~AA2, Section 2.38~AA3EVV

Related Topics:

Section A.2 Dual Watchdog Operation

2.37 ~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.

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 2.34 ~**, Section 2.35 ~AA0, Section 2.36 ~AA1, Section 2.38 ~AA3EVV

Related Topics:

Section A.2 Dual Watchdog Operation

2.38 ~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.

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 2.34 ~**, Section 2.35 ~AA0, Section 2.36 ~AA1, Section 2.37 ~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.

2.39 ~AA4

Description:

Reads the safe analog output value 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 safe analog output value

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 1.11 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: ~014 Response: !0105.000

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

Related Commands:

Section 2.34 ~**, Section 2.35 ~AA0, Section 2.36 ~AA1, Section 2.38 ~AA3EVV, Section 2.42 ~AA5

Related Topics:

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

Note:

This command is only applicable to the I-7021 and I-7021P.

2.40 ~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.

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 2.34 ~**, Section 2.35 ~AA0, Section 2.36 ~AA1, Section 2.38 ~AA3EVV, Section 2.44 ~AA5PPSS

Related Topics:

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

Note:

This command is only applicable to the M-7024U.

2.41 ~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, zero based

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 1.11 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: ~0141 Response: !0105.000

Reads the safe analog output value of channel 1 of module 01 and returns 05.000.

Related Commands:

Section 2.34 ~**, Section 2.35 ~AA0, Section 2.36 ~AA1, Section 2.38 ~AA3EVV, Section 2.43 ~AA5N

Related Topics:

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

Note:

This command is only applicable to the I-7022, I-7024, I-7024R, M-7022, M-7024, M-7024R and M-7024U.

2.42 ~AA5

Description:

Sets the current analog output value as the safe analog output value.

Syntax:

~AA5[CHKSUM](CR)

~	Delimiter character
AA	Address of the module to be set (00 to FF)
5	Command to set the safe analog output 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.

Examples:

Command: ~015 Response: !01

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

Related Commands:

Section 2.34 ~**, Section 2.35 ~AA0, Section 2.36 ~AA1, Section 2.38 ~AA3EVV, Section 2.39 ~AA4

Related Topics:

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

Note:

This command is only applicable to the I-7021 and I-7021P.

2.43 ~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, zero based

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: ~0151 Response: !01

Sets the safe analog output value of channel 1 of module 01 and returns a valid response.

Related Commands:

Section 2.34 ~**, Section 2.35 ~AA0, Section 2.36 ~AA1, Section 2.38 ~AA3EVV, Section 2.41 ~AA4N

Related Topics:

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

Note:

This command is only applicable to the I-7022, I-7024, I-7024R, M-7022, M-7024, M-7024R and M-7024U.

2.44 ~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.

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 2.34 ~**, Section 2.35 ~AA0, Section 2.36 ~AA1, Section 2.38 ~AA3EVV, Section 2.40 ~AA4

Related Topics:

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

Note:

This command is only applicable to the M-7024U.

2.45 @AABB

Description:

Reads the retained analog output channel status of a module. For a retained analog output channel, its power on value will be the same as the value before power off.

Syntax:

@AABB[CHKSUM](CR)

@	Delimiter character
AA	Address of the module to be read (00 to FF)
BB	Command to read the retained analog output channel status

Response:

Valid command : **!AAHH[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)
HH	A two-digit hexadecimal value, where bit 0 corresponds to channel 0, bit 1 corresponds to channel 1, etc. When the bit is 1, it denotes that the analog output channel is retained, and 0 denotes that the analog output channel is not retained.

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: @01BB Response: !0103

Reads retained analog output channel status of module 01 and the returned value is 03 which means both analog output channel 0 and 1 are retained.

Related Commands:

Section 2.46 @AABBHH

Note:

This command is only applicable to the M-7024U.

2.46 @AABBHH

Description:

Sets the retained analog output channel status of a module. For a retained analog output channel, its power on value will be the same as the value before power off.

Syntax:

@AABBHH[CHKSUM](CR)

@	Delimiter character
AA	Address of the module to be set (00 to FF)
BB	Command to set the retained analog output channel status
HH	A two-digit hexadecimal value, where bit 0 corresponds to channel 0, bit 1 corresponds to channel 1, etc. When the bit is 1, it denotes that the analog output channel is retained, and 0 denotes that the analog output channel is not retained.

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: @01BB02 Response: !01

Sets the analog output channel 1 of module 01 to be retained and returns a valid response.

Related Commands:

Section 2.45 @AABB

Note:

This command is only applicable to the M-7024U.

2.47 @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, zero based.

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: @03REC1 Response: !0300103

Reads data from channel 1 of module 03 and the returned counter value is 103.

Command: @03CEC1 Response: !03

Clears the counter value of channel 1 of module 03 and returns a valid response.

Command: @03REC1 Response: !0300000

Reads counter data from channel 1 of module 03 and the returned counter value is 0.

Related Commands:

Section 2.50 @AARECN

Note:

1. This command is only applicable to the I-7024R/ M-7024R firmware version A2.3 and later and M-7024U.
2. It is recommended to use this command to clear the digital counter for I-7024R/M-7024R with firmware version A2.3 and later.

2.48 @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. It is 00 for I-7024R/M-7024R.
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

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 2.49 @AADODD

Note:

1. This command is only applicable to the I-7024R/ M-7024R with firmware version A2.3 and later and M-7024U.
2. It is recommended to use this command to read the digital input status for I-7024R/M-7024R with firmware version A2.3 and later.

2.49 @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.

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 2.48 @AADI

Notes:

1. 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.

2. This command is only applicable to the M-7024U.

2.50 @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, zero based.

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.

Examples:

Command: @03REC1 Response: !0300103

Reads data from channel 1 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 2.47 @AACECN

Note:

1. This command is only applicable to the I-7024R/ M-7024R with firmware version A2.3 and later and M-7024U.
2. It is recommended to use this command to read the digital counter value for I-7024R/M-7024R with firmware version A2.3 and later.

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.

M-7000 series modules support the Modbus RTU protocol. The communication Baud Rates range from 1200bps to 115200bps. The number of data bits is fixed to 8. For M-7022 firmware version B102 and later, M-7024 firmware version B202 and later, M-7024R and M-7024U, the parity can be none, even or odd. For M-7022 other versions and M-7024 other versions, the parity and stop bits are fixed as no parity and 1 stop bit. 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.

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	0x0000~0x0003 for M-7024U DO read back value
04 ~ 05	Number of output channel	2 Bytes	0x0001 ~ 0x0004 for M-7024U

Note: This function is only available to the M-7024U.

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

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 to 0x24 for M-7024R 0x20 to 0x23 for M-7024U where 0x20 corresponds to channel 0, 0x21 corresponds to channel 1, etc
04 ~ 05	Number of input channels	2 Bytes	1 to 5 for M-7024R 1 to 4 for M-7024U

Note: This function is only available to the M-7024R and M-7024U.

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

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 ~ 0x0001 for M-7022 0x0000 ~ 0x0003 for M-7024 0x0000 ~ 0x0003 for M-7024R 0x0000 ~ 0x0003 for M-7024U
04 ~ 05	Number of output channels (N)	2 Bytes	0x0001 ~ 0x0002 for M-7022 0x0001 ~ 0x0004 for M-7024 0x0001 ~ 0x0004 for M-7024R 0x0001 ~ 0x0004 for M-7024U

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

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 to 0x0084 for M-7024R 0x0080 to 0x0083 for M-7024U
04 ~ 05	Number of input channels (N)	2 Bytes	1 to 5 for M-7024R. 1 to 4 for M-7024U.

Note: This function is only available to the M-7024R and M-7024U.

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

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 ~ 0x0003 for M-7024U
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.

Note: This function is only available to the M-7024U.

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.

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 ~ 0x0001 for M-7022 0x0000 ~ 0x0003 for M-7024 0x0000 ~ 0x0003 for M-7024R 0x0000 ~ 0x0003 for M-7024U
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.

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 ~ 0x0003 for M-7024U
04 ~ 05	Number of output channels	2 Bytes	0x0001 ~ 0x0004 for M-7024U
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.

Note: This function is only available to the M-7024R

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.

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 ~ 0x0001 for M-7022 0x0000 ~ 0x0003 for M-7024 0x0000 ~ 0x0003 for M-7024R 0x0000 ~ 0x0003 for M-7024U
04 ~ 05	Number of output channels (N)	2 Bytes	0x0001 ~ 0x0002 for M-7022 0x0001 ~ 0x0004 for M-7024 0x0001 ~ 0x0004 for M-7024R 0x0001 ~ 0x0004 for M-7024U
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.

3.9 M-7022 Address Mappings

Address	Description	Attribute
40001 ~ 40002	Analog output value	R/W
40065 ~ 40066	Analog output read back	R
40097 ~ 40098	Safe output value	R/W
40193 ~ 40194	Power on output value	R/W
40257 ~ 40258	Type code	R/W
40289 ~ 40290	Slew rate	R/W

The following registers are supported by firmware version B102 and later.

Address	Description	Attribute
40481	Firmware version (low word)	R
40482	Firmware version (high word)	R
40483	Module name (low word)	R
40484	Module name (high word)	R
40485	Module address, valid range: 1 ~ 247	R/W
40486	Bits 5:0 Baud rate, 0x03 ~ 0x0A Code 0x03 0x04 0x05 0x06 Baud 1200 2400 4800 9600 Code 0x07 0x08 0x09 0x0A Baud 19200 38400 57600 115200 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	R/W

Address	Description	Attribute
40488	Modbus response delay time in ms, valid range: 0 ~ 30	R/W
40489	Host watchdog timeout value, 0 ~ 255, in 0.1s	R/W
40492	Host watchdog timeout count, write 0 to clear	R/W
00257	Protocol, 0: DCON, 1: Modbus RTU	R/W
00258	Modbus Protocol, 0:RTU. 1: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
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

Output Types

Type Code	Output Range	Data Format	Max	Min
0	0 ~ 20 mA	Engineering	20000	0
		Hexadecimal	0FFFh	0000h
1	4 ~ 20 mA	Engineering	20000	4000
		Hexadecimal	0FFFh	0000h
2	0 ~ 10 V	Engineering	10000	0
		Hexadecimal	0FFFh	0000h
4	0 ~ 5 V	Engineering	5000	0
		Hexadecimal	0FFFh	0000h

Notes: Engineering data format and type code 4 are supported by firmware version B102 and later.

3.10 M-7024 Address Mappings

For M-7024 firmware version B202 and later, the address mappings are as follows.

<table>
<tr><th>Address</th><th>Description</th><th>Attribute</th></tr>
<tr><td>40001 ~ 40004</td><td>Analog output value</td><td>R/W</td></tr>
<tr><td>40065 ~ 40068</td><td>Analog output read back</td><td>R</td></tr>
<tr><td>40097 ~ 40100</td><td>Safe output value</td><td>R/W</td></tr>
<tr><td>40193 ~ 40196</td><td>Power on output value</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)</td><td>R</td></tr>
<tr><td>40484</td><td>Module name (high word)</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>40487</td><td>Type code</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>
</table>

Address	Description	Attribute
40492	Host watchdog timeout count, write 0 to clear	R/W
40494	Slew rate	R/W
00257	Protocol, 0: DCON, 1: Modbus RTU	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
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

Output Types

Type Code	Output Range	Data Format	Max	Min
30	0 ~ 20 mA	Engineering	20000	0
		Hexadecimal	3FFFh	0000h
31	4 ~ 20 mA	Engineering	20000	4000
		Hexadecimal	3FFFh	0000h
32	0 ~ 10 V	Engineering	10000	0
		Hexadecimal	3FFFh	0000h
33	-10 ~ 10 V	Engineering	10000	-10000
		Hexadecimal	3FFFh	C000h
34	0 ~ 5 V	Engineering	5000	0
		Hexadecimal	3FFFh	0000h
35	-5 ~ 5 V	Engineering	5000	-5000
		Hexadecimal	3FFFh	C000h

3.11 M-7024R Address Mappings

<table>
<tr><th>Address</th><th>Description</th><th>Attribute</th></tr>
<tr><td>40001 ~ 40004</td><td>Analog output value</td><td>R/W</td></tr>
<tr><td>40065 ~ 40068</td><td>Analog output read back</td><td>R</td></tr>
<tr><td>40097 ~ 40100</td><td>Safe output value</td><td>R/W</td></tr>
<tr><td>40129 ~ 40133</td><td>Counter value of digital input</td><td>R</td></tr>
<tr><td>40193 ~ 40196</td><td>Power on output value</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)</td><td>R</td></tr>
<tr><td>40484</td><td>Module name (high word)</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>40487</td><td>Type code</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>

Address	Description	Attribute
40494	Slew rate	R/W
00033 ~ 00037	Digital input value	R
00065 ~ 00069	High latched value of DI	R
00097 ~ 00101	Low latched value of DI	R
00257	Protocol, 0: DCON, 1: Modbus RTU	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 DI	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 ~ 00517	Write 1 to clear DI counter value	W

Output Types

Type Code	Output Range	Data Format	Max	Min
30	0 ~ 20 mA	Engineering	20000	0
		Hexadecimal	3FFFh	0000h
31	4 ~ 20 mA	Engineering	20000	4000
		Hexadecimal	3FFFh	0000h
32	0 ~ 10 V	Engineering	10000	0
		Hexadecimal	3FFFh	0000h
33	-10 ~ 10 V	Engineering	10000	-10000
		Hexadecimal	3FFFh	C000h
34	0 ~ 5 V	Engineering	5000	0
		Hexadecimal	3FFFh	0000h
35	-5 ~ 5 V	Engineering	5000	-5000
		Hexadecimal	3FFFh	C000h

3.12 M-7024U Address Mappings

<table>
<tr><th>Address</th><th>Description</th><th>Attribute</th></tr>
<tr><td>30065 ~ 30068
40065 ~ 40068</td><td>Analog output read back of channel 0 to 3</td><td>R</td></tr>
<tr><td>30129 ~ 30132
40129 ~ 40132</td><td>Counter value of digital input channel 0 to 3</td><td>R</td></tr>
<tr><td>40001 ~ 40004</td><td>Analog output value of channel 0 to 3</td><td>R/W</td></tr>
<tr><td>40097 ~ 40100</td><td>Safe analog output value of channel 0 to 3</td><td>R/W</td></tr>
<tr><td>40193 ~ 40196</td><td>Power on analog output value of channel 0 to 3</td><td>R/W</td></tr>
<tr><td>40257 ~ 40260</td><td>Analog output type code of channel 0 to 3</td><td>R/W</td></tr>
<tr><td>40289 ~ 40292</td><td>Analog output slew rate of channel 0 to 3</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>
</table>

Address	Description	Attribute
40488	Modbus response delay time in ms, valid range: 0 ~ 30	R/W
40489	Host watchdog timeout value, 0 ~ 255, in 0.1s	R/W
40492	Host watchdog timeout count, write 0 to clear	R/W
00033 ~ 00046 10033 ~ 10046	Digital input value of channel 0 to 3	R
00065 ~ 00068 10065 ~ 10068	High latched value of DI	R
00073 ~ 00076 10073 ~ 10076	High latched value of DO	R
00097 ~ 00100 10097 ~ 10100	Low latched value of DI	R
00105 ~ 00108 10105 ~ 10108	Low latched value of DO	R
00225 ~ 00228 10225 ~ 10228	Status of current output open wire or voltage output short circuit	R

Address	Description	Attribute
00001 ~ 00004	Digital output value of channel 0 to 3	R/W
00129 ~ 00132	Safe value of digital output channel 0 to 3	R/W
00161 ~ 00164	Power on value of digital output channel 0 to 3	R/W
00193 ~ 00196	Counter update trigger edge of digital input channel 0 to 3	R/W
00257	Protocol, 0: DCON, 1: Modbus	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
00272	Write 1 to load factory default calibration parameters	W
00273	Reset status, 1: first read after powered on, 0: not the first read after powered on	R
00513 ~ 00516	Write 1 to clear counter value of digital input channel 0 to 3	W
00769 ~ 00772	Enable retained analog output for channel 0 to 3	R/W

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
3	+/-10 V	Engineering	-10000	+10000
		Hexadecimal	8000h	7FFFh
4	0 V ~ +5 V	Engineering	0	+5000
		Hexadecimal	0000h	FFFFh
5	+/-5 V	Engineering	-5000	+5000
		Hexadecimal	8000h	7FFFh

4. Troubleshooting

If you are having difficulty using the I-7000 or M-7000 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 1.14.

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.

A. Appendix

A.1 INIT Mode

Each I-7000 and M-7000 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 I-7000 and M-7000 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.

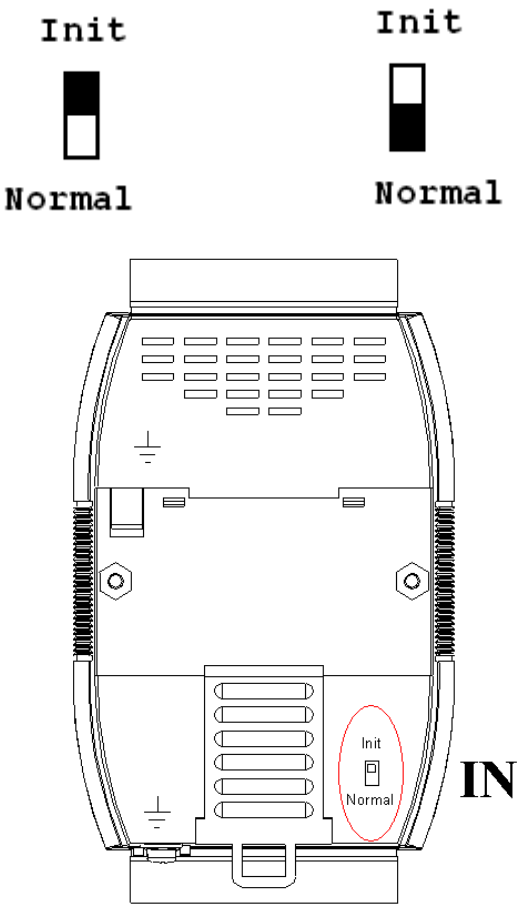
1. Address: 00
2. Baud Rate: 9600 bps
3. No checksum
4. Protocol: DCON

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 2.31 for details.

Originally, the INIT mode is accessed by connecting the INIT* terminal to the GND terminal. New I-7000 and M-7000 modules have the INIT switch located on the rear 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.



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.

I-7000 and M-7000 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.

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.

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.

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 the ~AA5 command for the I-7021 and I-7021P, and by the ~AA5N command for the I-7022, M-7022, I-7024, I-7024R, M-7024, M-7024R and M-7024U. The power-on value is set by the $AA4 command for the I-7021 and I-7021P, and by the $AA4N command for the I-7022, M-7022, I-7024, I-7024R, M-7024, M-7024R and M-7024U.

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

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 I-7021, I-7021P, I-7022, M-7022, I-7024, I-7024R, M-7024, M-7024R and M-7024U 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 I-7021, I-7021P, I-7022, M-7022, I-7024, I-7024R, M-7024, M-7024R and M-7024U modules update the analog output every 10 ms. The analog output is updated smoothly until it reaches the specified output value.

A.7 Analog Output Read-back

The I-7021/21P, I-7022 and M-7022 modules have the analog-to-digital converter that can be used to monitor the analog output signal and provide the analog output read-back. If the difference between the specified analog output value and the analog output read-back value is large, then it could be improper wire connection or load.

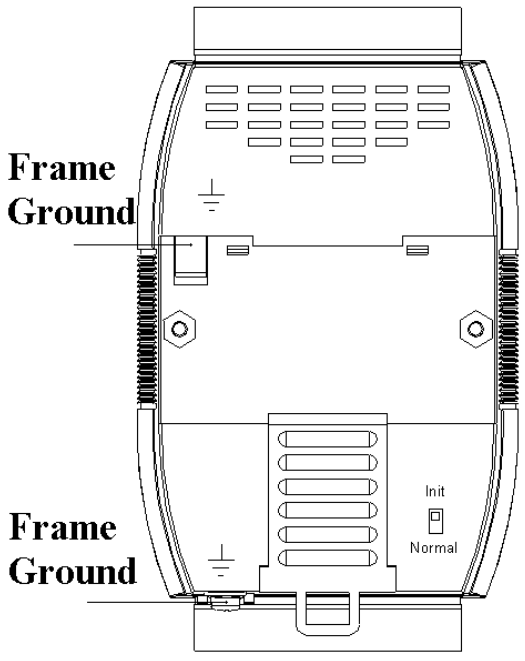
The I-7024, I-7024R, M-7024, M-7024R and M-7024U modules do not have the analog-to-digital converter to monitor the analog output signal. However, they can respond the value that is set to the digital-to-analog converter. This value cannot be used to check improper wire connection and load.

A.8 Frame Ground

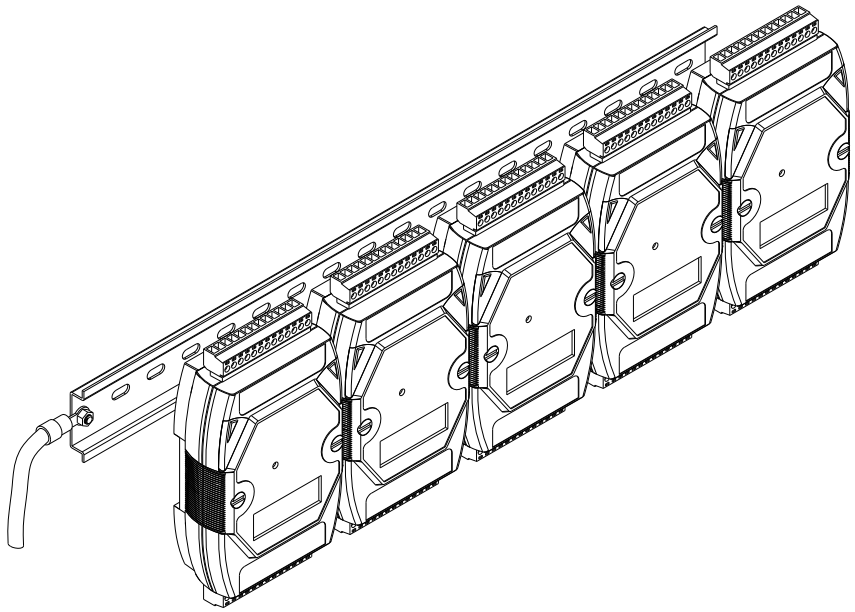
Electronic circuits are constantly vulnerable to ESD which become worse in a continental climate area. Some I-7000, and all M-7000, modules feature a new design for the frame ground. The frame ground provides a path for bypassing ESD, which provides enhanced static protection (ESD) abilities and ensures the module is more reliable.

Either of the following options will provide a better protection for the module:

1. If the module is DIN rail mounted, connect the DIN rail to the earth ground because the DIN rail is contacted with the upper frame ground as shown in the figure below.
2. Alternatively, connect the lower frame ground terminal, as shown in the figure below, to a wire and connected the wire to the earth ground.



New DIN rail models are available that can easily be connected to the earth ground. Each are 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 as shown in the figure below. Refer to Section 1.13.1 for more information about the new DIN rail models.



A.9 Node Information Area

Each I-7000 and M-7000 module has a built-in EEPROM to store configuration information such as module address, type code, Baud Rate, etc. One minor drawback is that there are no visual indications of the configuration of the module. New I-7000 and M-7000 modules include node information areas that are protected by a cover, as shown below, and can be used to make a written record of the node information, such as module address, Baud Rate, etc. To access the node information areas, first slide the covers outward, as shown in the figure below.