

# **I-7021, I-7022, I-7024, M-7022, M-7024 and M-7028 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**

ICP DAS assumes no liability for damages resulting from the use of this product. ICP DAS reserves the right to change this manual at any time without notification. The information furnished by ICP DAS is believed to be accurate and reliable. However, no responsibility is assumed by ICP DAS for its use, or for any infringements of patents or other rights of third parties resulting from its use.

## **Copyright**

Copyright 1999 - 2009 ICP DAS. All rights reserved.

## **Trademark**

The names used for identification only may be registered trademarks of their respective companies.

Date: 2020/4/1

# Table of Contents

1. Introduction .....	6
1.1 More Information .....	8
1.2 Terminal Assignment .....	9
1.3 Specifications .....	12
1.4 Block Diagrams .....	15
1.4.1 Block Diagram for the I-7021 and I-7021P .....	15
1.4.2 Block Diagram for the I-7022 and M-7022 .....	15
1.4.3 Block Diagram for the I-7024, M-7024 and M-7024L .....	16
1.4.4 Block Diagram for the I-7024R and M-7024R .....	16
1.4.5 Block Diagram for the M-7024U .....	17
1.4.6 Block Diagram for the M-7028 .....	17
1.5 Dimensions .....	18
1.5.1 Modules without Frame Ground .....	18
1.5.2 Modules with Frame Ground .....	19
1.6 Jumper Settings .....	20
1.6.1 I-7021 and I-7021P Jumper Settings .....	20
1.6.2 I-7022 and M-7022 Jumper Settings .....	22
1.6.3 M-7024U Jumper Setting .....	24
1.6.4 M-7028 Jumper Setting .....	25
1.7 Wiring .....	26
1.7.1 Wiring diagram for the I-7021, I-7021P, I-7022 and M-7022 .....	26
1.7.2 Wiring diagram for the I-7024, I-7024R, M-7024, M-7024L and M-7024R .....	26
1.7.3 Wiring diagram for the M-7024U .....	27
1.7.4 Wiring diagram for the M-7028 .....	27
1.7.5 Wiring Recommendations .....	27
1.8 Quick Start .....	28
1.9 Default Settings .....	30
1.10 Calibration .....	31
1.11 Configuration Tables .....	39
1.12 M-7000 Notes .....	45
1.12.1 Protocol Switching .....	45
1.12.2 INIT Mode .....	46

1.13 Mounting.....	47
1.13.1 Din-Rail Mounting.....	47
1.13.2 Piggyback Mounting.....	49
1.13.3 Wall Mounting.....	50
1.14 Technical Support.....	51
2. DCON Protocol.....	52
2.1 %AANNTTCCFF.....	58
2.2 #AA(Data).....	61
2.3 #AAN.....	63
2.4 #AAN(Data).....	65
2.5 \$AA0.....	68
2.6 \$AA0N.....	70
2.7 \$AA1.....	72
2.8 \$AA1N.....	74
2.9 \$AA2.....	76
2.10 \$AA3VV.....	78
2.11 \$AA3NVV.....	80
2.12 \$AA4.....	82
2.13 \$AA4N.....	84
2.14 \$AA5.....	86
2.15 \$AA6.....	88
2.16 \$AA6.....	90
2.17 \$AA6N.....	92
2.18 \$AA7.....	94
2.19 \$AA7N.....	96
2.20 \$AA7N.....	98
2.21 \$AA8.....	100
2.22 \$AA8N.....	102
2.23 \$AA9N.....	104
2.24 \$AA9NTS.....	106
2.25 \$AAB.....	108
2.26 \$AACN.....	110
2.27 \$AAF.....	112
2.28 \$AAI.....	113
2.29 \$AAM.....	115
2.30 \$AAP.....	116
2.31 \$AAPN.....	118
2.32 \$AAS1.....	120

2.33 ~AAO(Name).....	122
2.34 ~** .....	124
2.35 ~AA0.....	125
2.36 ~AA1.....	127
2.37 ~AA2.....	129
2.38 ~AA3Evv.....	131
2.39 ~AA4.....	133
2.40 ~AA4.....	135
2.41 ~AA4N.....	137
2.42 ~AA5.....	139
2.43 ~AA5N.....	141
2.44 ~AA5PPSS.....	143
2.45 @AABB.....	145
2.46 @AABBHH.....	147
2.47 @AACECN.....	149
2.48 @AADI.....	151
2.49 @AADODD.....	153
2.50 @AARECN.....	155
3. Modbus RTU Protocol .....	157
3.1 01 (0x01) Read Coils .....	158
3.2 02 (0x02) Read Discrete Inputs .....	159
3.3 03 (0x03) Read Output Channels .....	160
3.4 04 (0x04) Read Input Channels .....	161
3.5 05 (0x05) Write Single Coil.....	162
3.6 06 (0x06) Write Single Register .....	163
3.7 15 (0x0F) Write Multiple Coils .....	164
3.8 16 (0x10) Write Multiple Registers.....	165
3.9 M-7022 Address Mappings .....	166
3.10 M-7024/M-7024L Address Mappings.....	168
3.11 M-7024R Address Mappings.....	170
3.12 M-7024U Address Mappings.....	173
3.13 M-7028 Address Mappings .....	177
4. Troubleshooting .....	179
4.1 Communicating with the module.....	180
A. Appendix .....	181
A.1 INIT Mode .....	181
A.2 Dual Watchdog Operation .....	183
A.3 Module Output Status .....	184

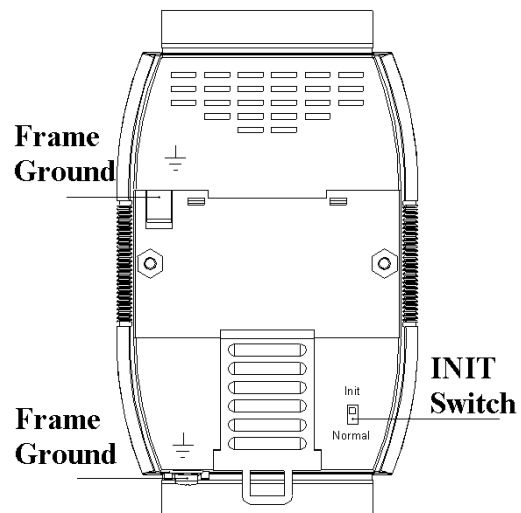
A.4 Reset Status .....	185
A.5 Analog Output .....	186
A.6 Slew Rate Control .....	188
A.7 Analog Output Read-back.....	189
A.8 Frame Ground .....	190

# 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-7024L, M-7024R, M-7024U and M-7028 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 M-7024L is a 4-channel analog output module with 12-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. The M-7028 is a 8-channel analog output module with 12-bit resolution.

## 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>.

- 1.1 The 7000 Series Overview
- 1.2 Related Documentation for the 7000 Series
- 1.3 Common Features of the 7000 Series
- 1.4 The 7000 Series System Network Configuration
- 1.5 7000 Dimensions



# 1.2 Terminal Assignment

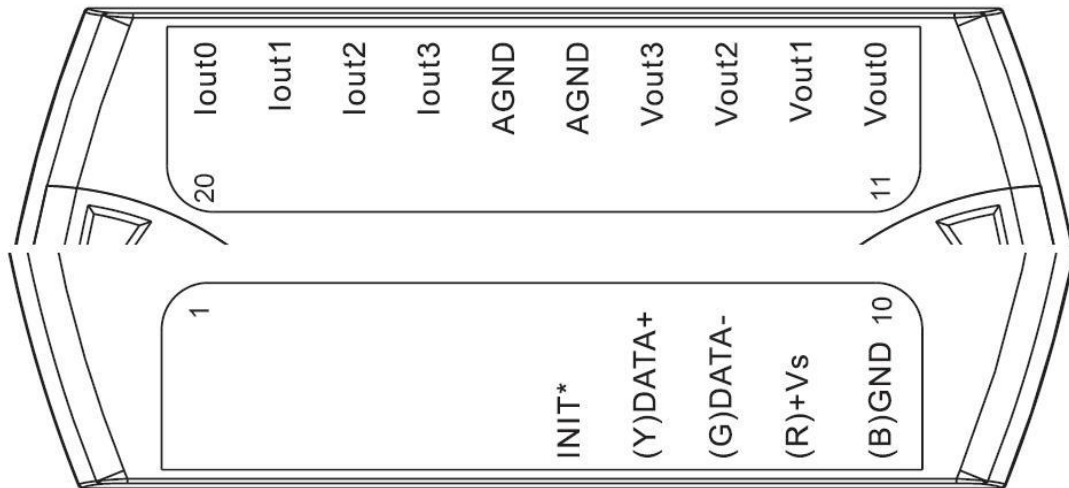
## 7021/7021P



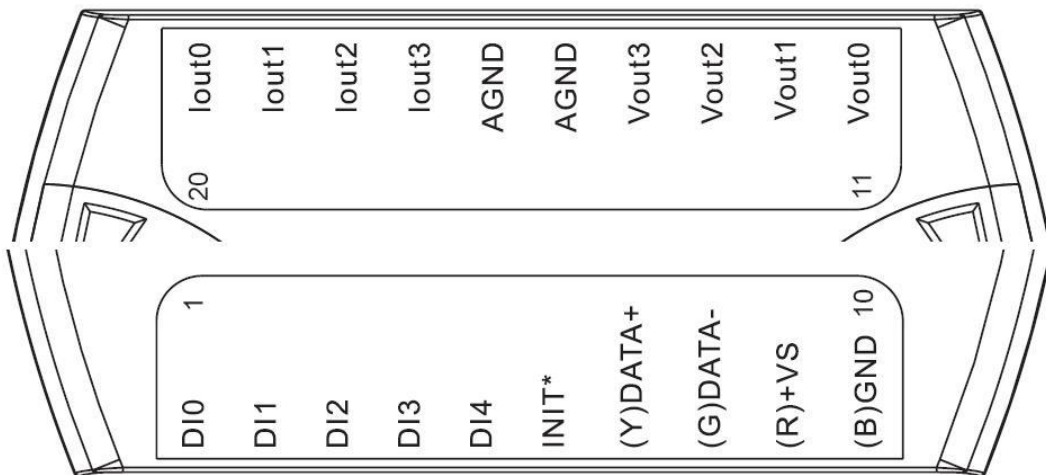
## 7022



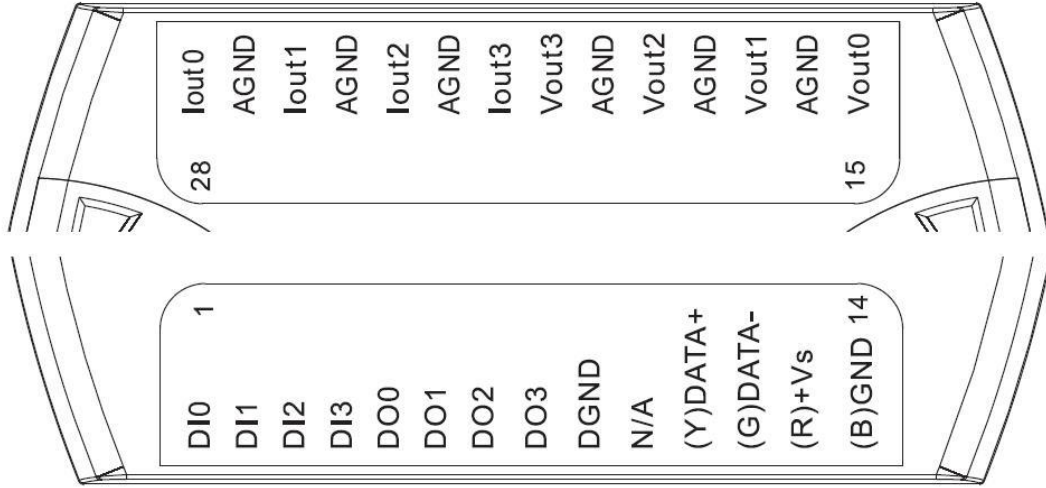
## 7024/7024L



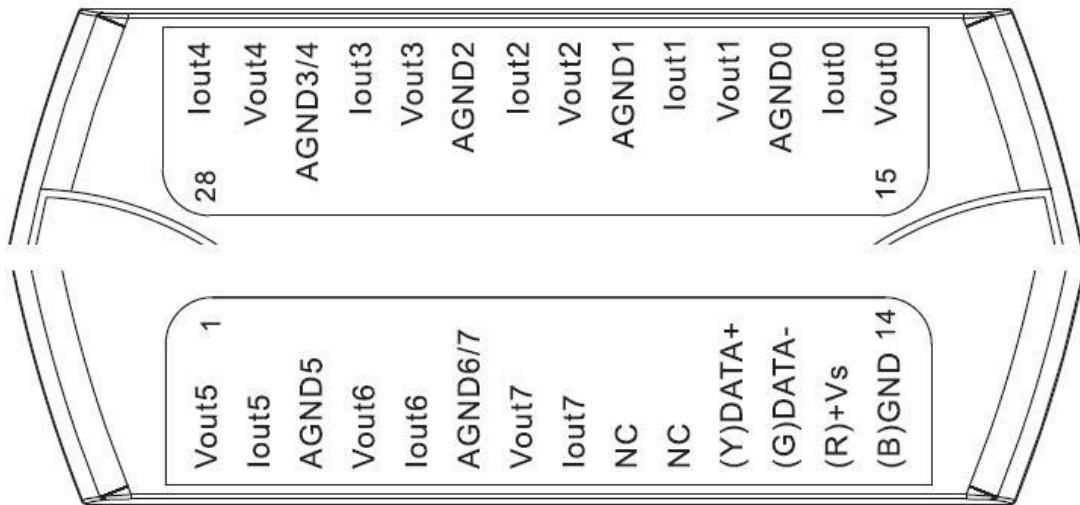
## 7024R



## 7024U



## 7028



## 1.3 Specifications

	I-7021/I-7021P	I-7022/M-7022	I-7024/M-7024/ M-7024L
<b>Analog Output</b>			
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 for I-7024 and M-7024 12-bit for M-7024L
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 <sub>DC</sub>	3000 V <sub>DC</sub>	3000 V <sub>DC</sub>
Modbus RTU		M-7022	M-7024/M-7024L
<b>Power</b>			
Requirements	+10 to +30 V <sub>DC</sub>	+10 to +30 V <sub>DC</sub>	+10 to +30 V <sub>DC</sub>
Consumption	1.8 W	3.0 W	2.4 W (I-7024/M-7024) 2.7 W (M-7024L)
<b>Temperature Range</b>			
Operating	-25°C to +75°C	-25°C to +75°C	-25°C to +75°C
Storage	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C

### 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°C unless otherwise stated.

	<b>I-7024R</b>	<b>M-7024R</b>	<b>M-7024U</b>
<b>Analog Output</b>			
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
<b>Digital Input</b>			
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
<b>Digital Output</b>			
Channels			4
Output Type			Open Collector
Sink/Source			Sink
Load Voltage			+3.5 V <sub>DC</sub> ~ +50 V <sub>DC</sub>
Max. Load Current			700 mA/Channel
Isolation	3000 V <sub>DC</sub>	3000 V <sub>DC</sub>	2500 V <sub>DC</sub>
Modbus RTU	No	Yes	Yes
<b>Power</b>			
Requirements	+10 to +30 V <sub>DC</sub>	+10 to +30 V <sub>DC</sub>	+10 to +30 V <sub>DC</sub>
Consumption	3.2 W	3.2 W	4.5 W
<b>Temperature Range</b>			
Operating	-25°C to +75°C	-25°C to +75°C	-25°C to +75°C
Storage	-40°C to +85°C	-40°C to +85°C	-40°C to +85°C

**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°C unless otherwise stated.

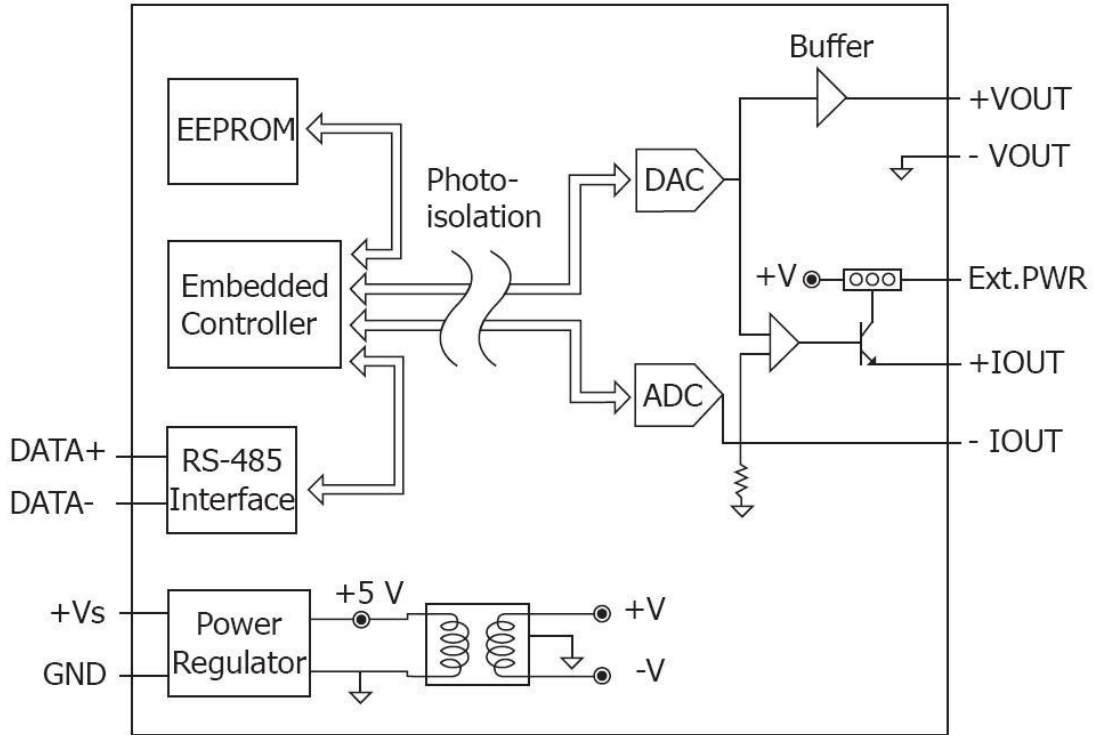
	<b>M-7028</b>		
<b>Analog Output</b>			
Output Channels	8		
Output Type	mA, V		
Accuracy	±0.1% of FSR		
Resolution	12-bit		
Read-back Accuracy	NA		
Programmable Output Slope	0.125 ~ 1024 mA/s 0.0625 ~ 512 V/s		
Current Load Resistance	500 ohm		
Isolation	3000 V <sub>DC</sub>		
Modbus RTU	Yes		
<b>Power</b>			
Requirements	+10 to +30 V <sub>DC</sub>		
Consumption	4.3 W		
<b>Temperature Range</b>			
Operating	-25°C to +75°C		
Storage	-40°C to +85°C		

**Notes:**

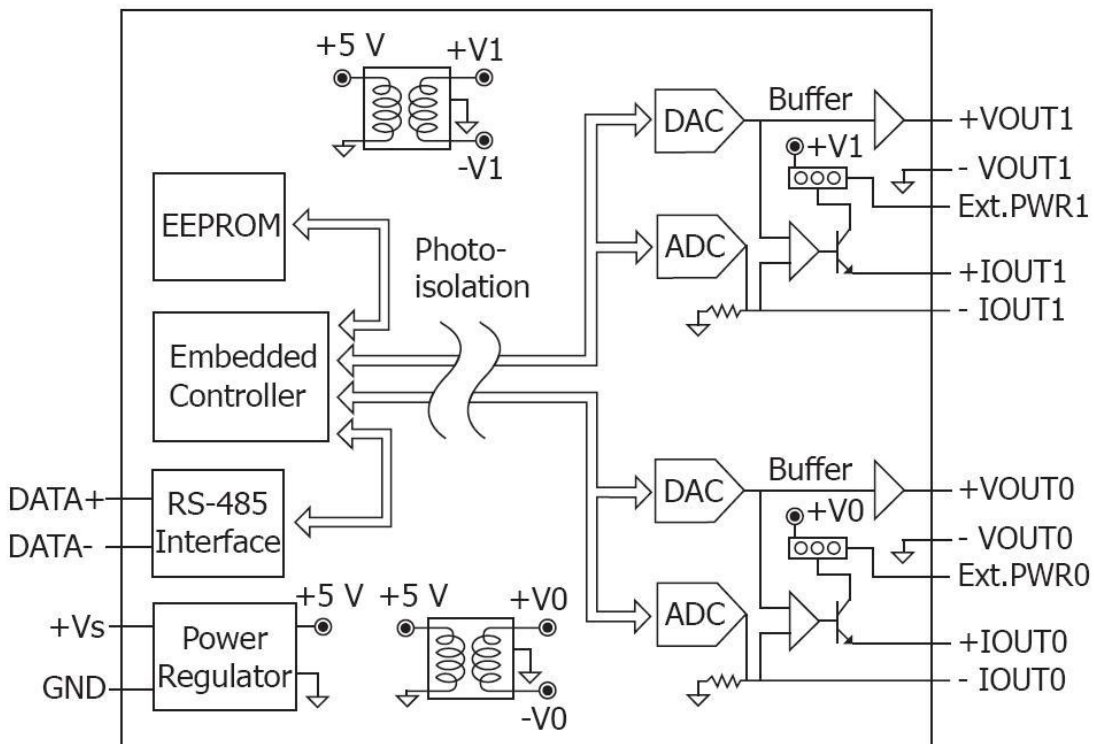
1. A warm up period of 30 minutes is recommended in order to achieve the complete performance results described in the specifications.
2. The specifications are typical at 25°C unless otherwise stated.

# 1.4 Block Diagrams

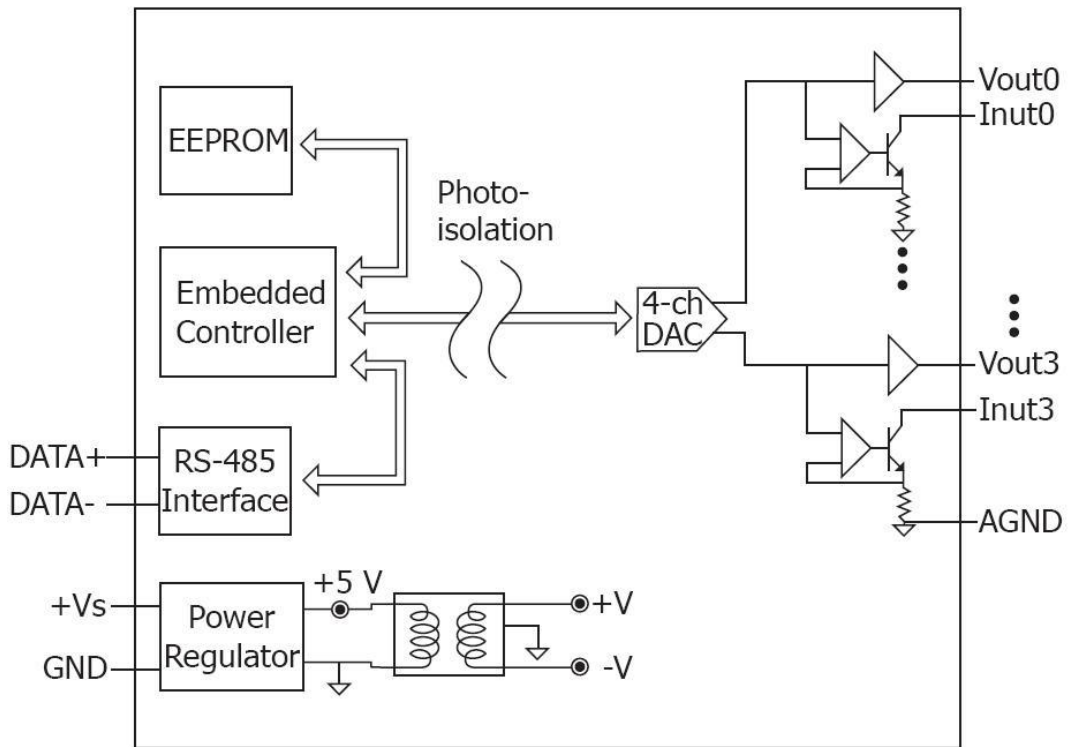
## 1.4.1 Block Diagram for the I-7021 and I-7021P



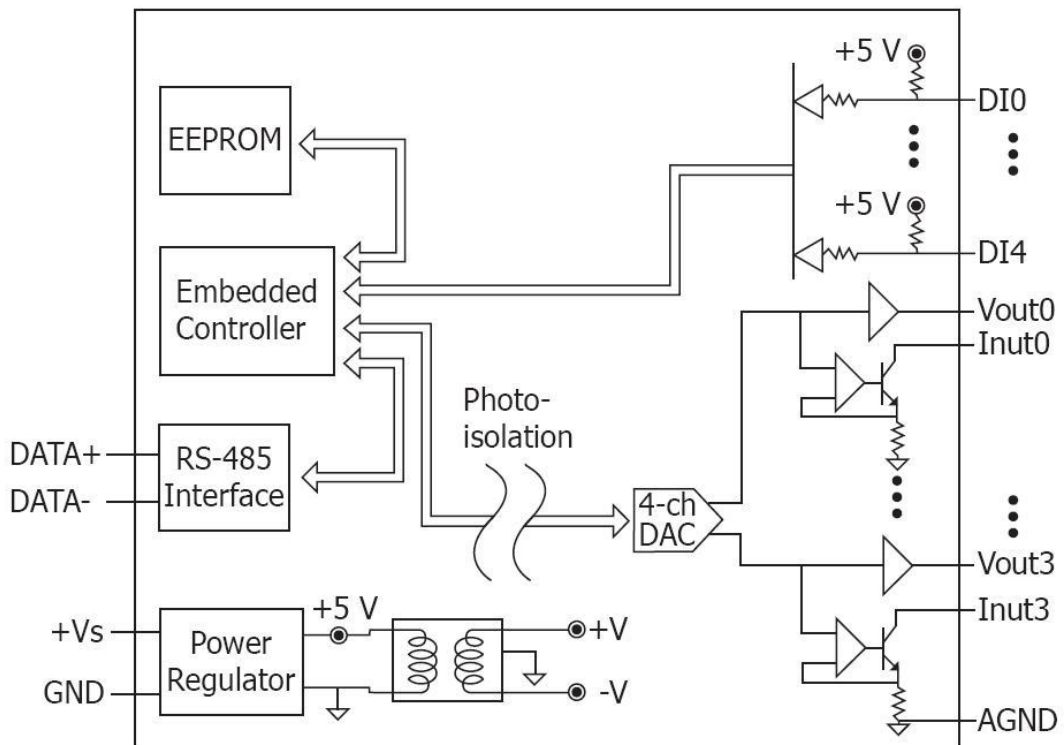
## 1.4.2 Block Diagram for the I-7022 and M-7022



### 1.4.3 Block Diagram for the I-7024, M-7024 and M-7024L

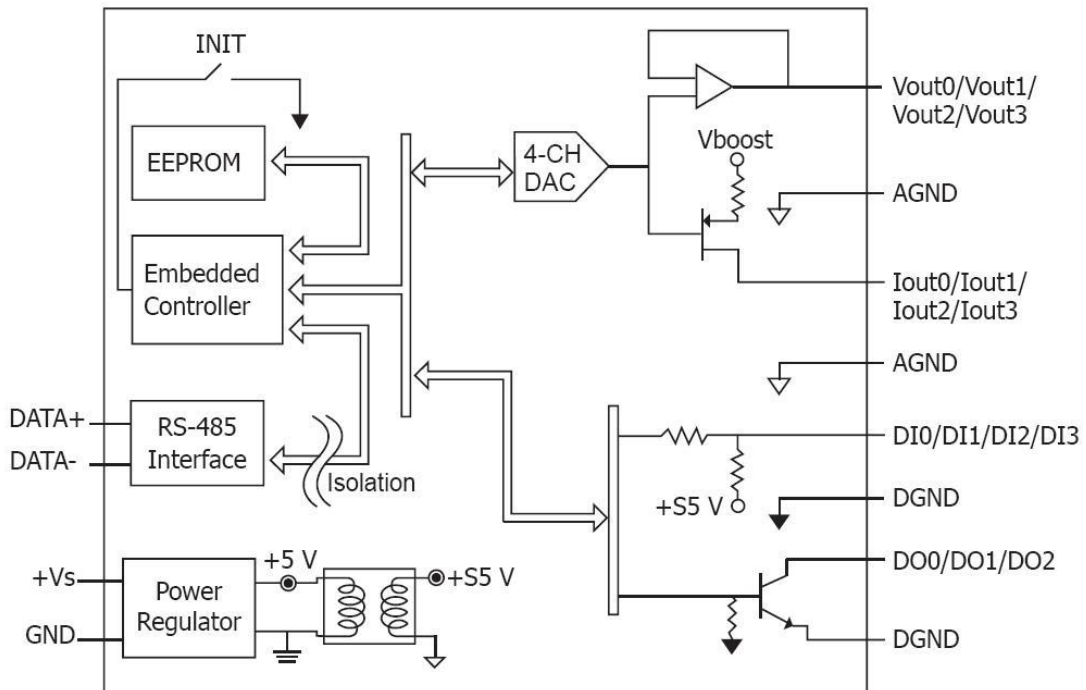


### 1.4.4 Block Diagram for the I-7024R and M-7024R

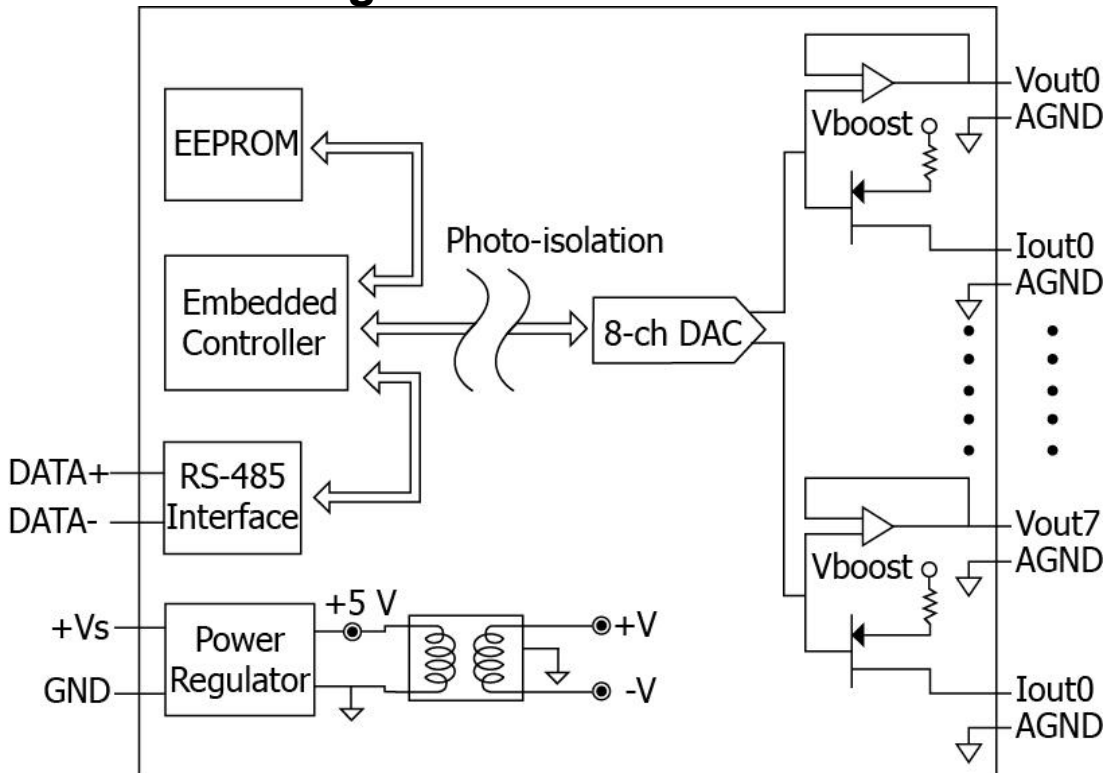




### 1.4.5 Block Diagram for the M-7024U



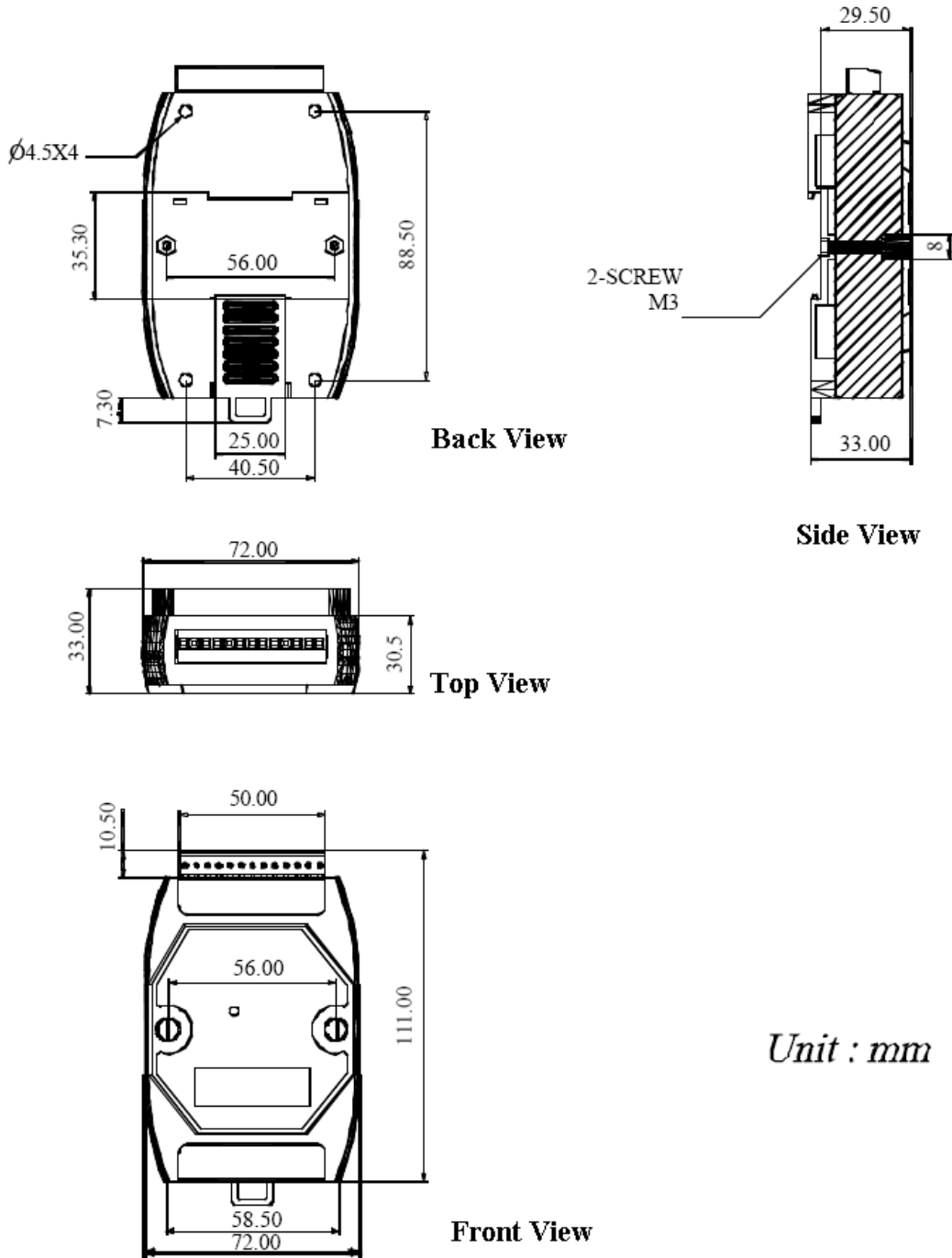
### 1.4.6 Block Diagram for the M-7028



# 1.5 Dimensions

## 1.5.1 Modules without Frame Ground

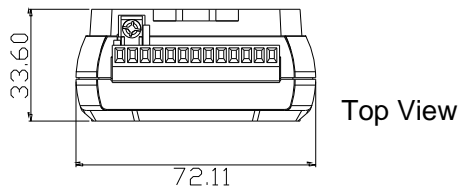
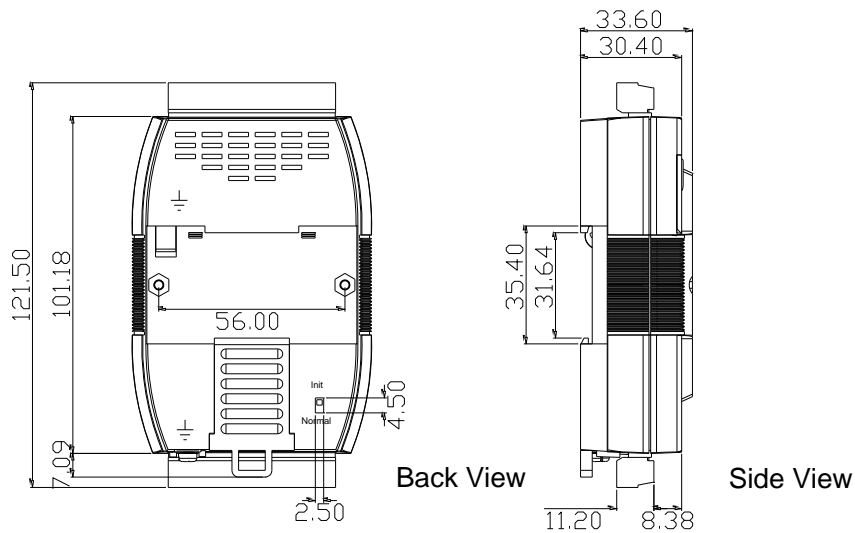
The dimensions of the I-7021, I-7021P, I-7022, and M-7022 are as shown below.



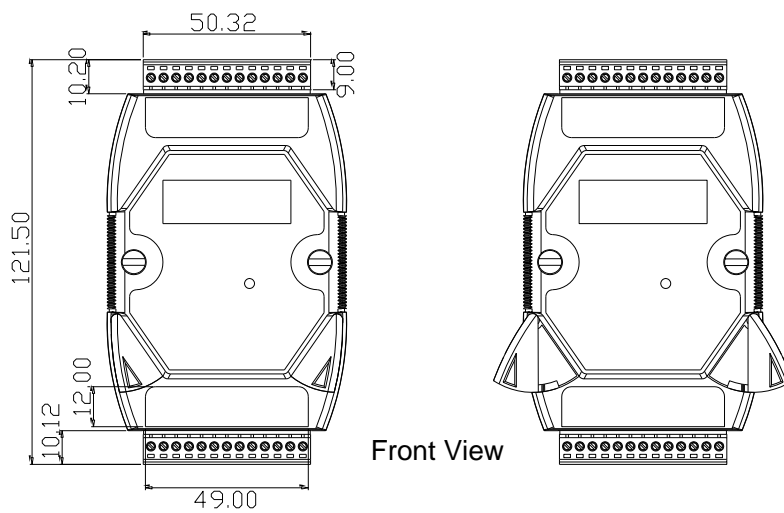
*Unit : mm*

## 1.5.2 Modules with Frame Ground

The dimensions of the I-7024, M-7024, M-7024L, I-7024R, M-7024R, M-7024U and M-7028 are as shown below.



Unit : mm

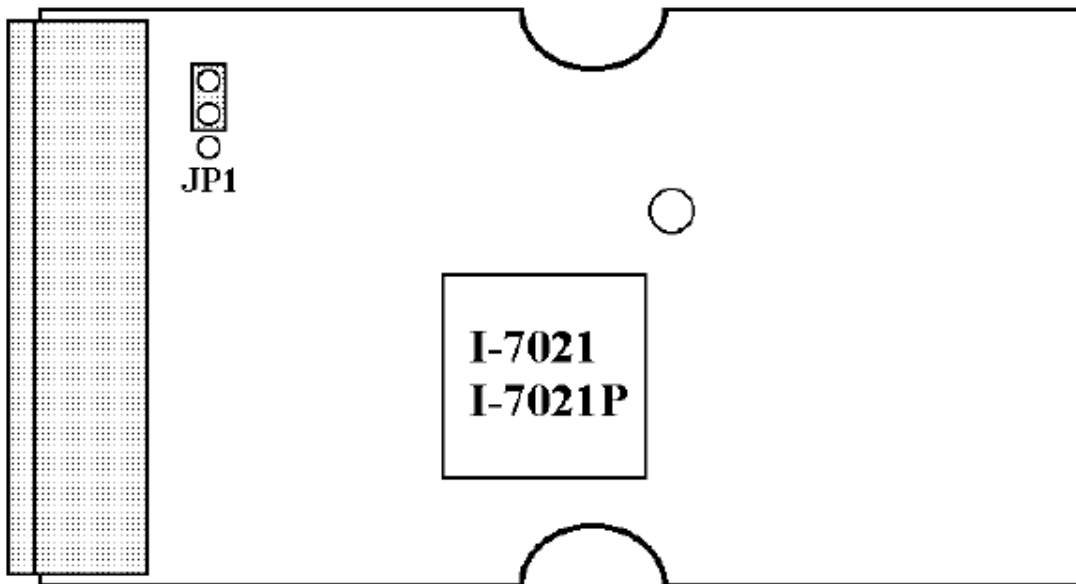


# 1.6 Jumper Settings

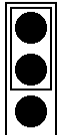
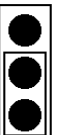
Note: To access the jumpers, the cover must be opened.

## 1.6.1 I-7021 and I-7021P Jumper Settings

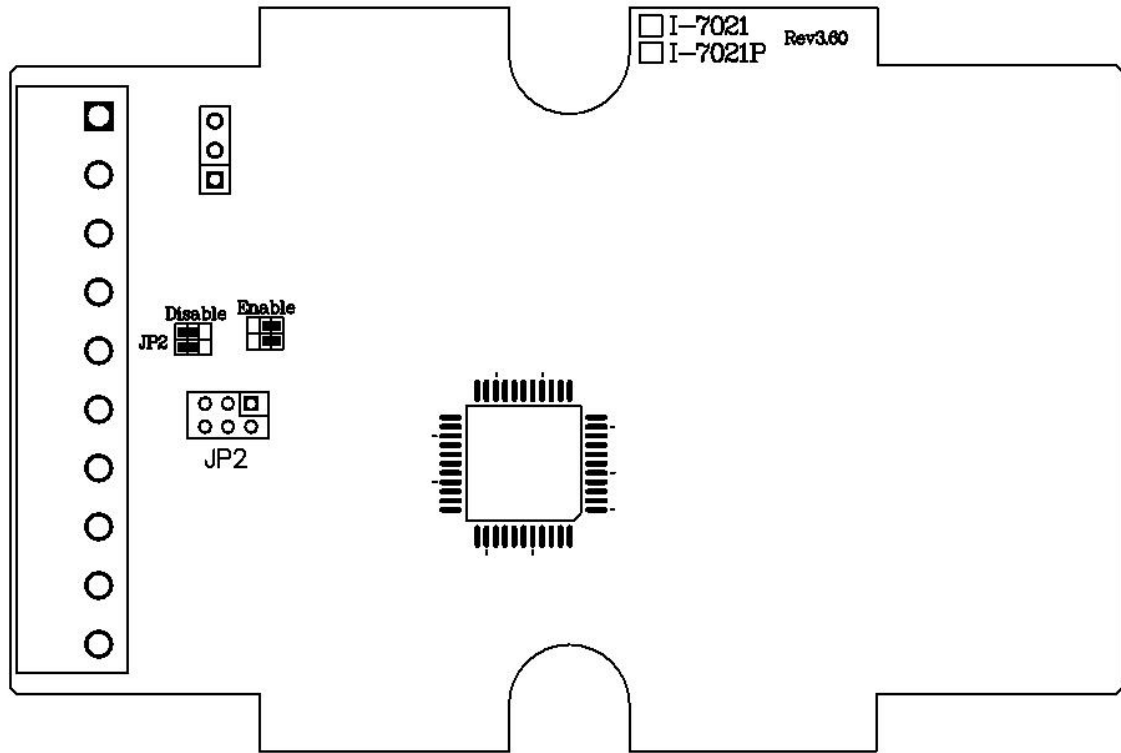
For the I-7021 and I-7021P modules, the power supply for current output can be either internal or external. The power supply is selected using the JP1 jumper. The position of the JP1 jumper is shown in the figure below.



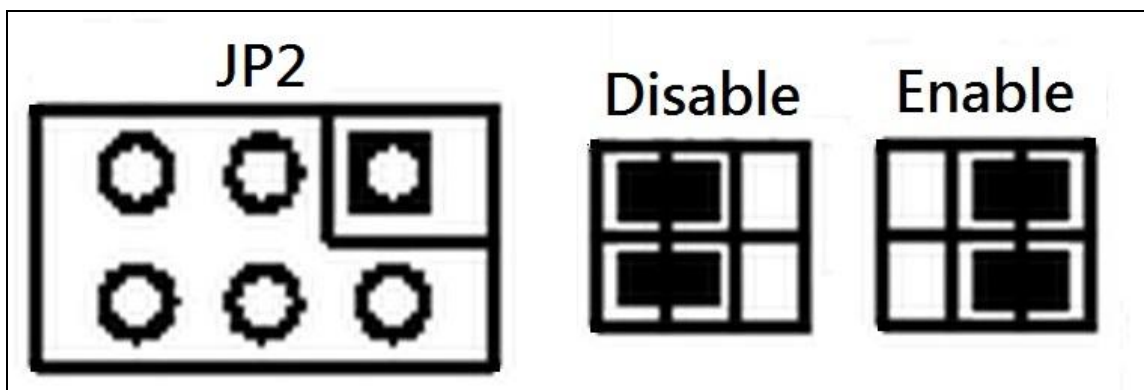
The settings for the JP1 jumper are as follows.

 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.

For the I-7021 and I-7021P PCB version 3.60 and later, there is jumper to enable the RS-485 bias as shown in the following figure.

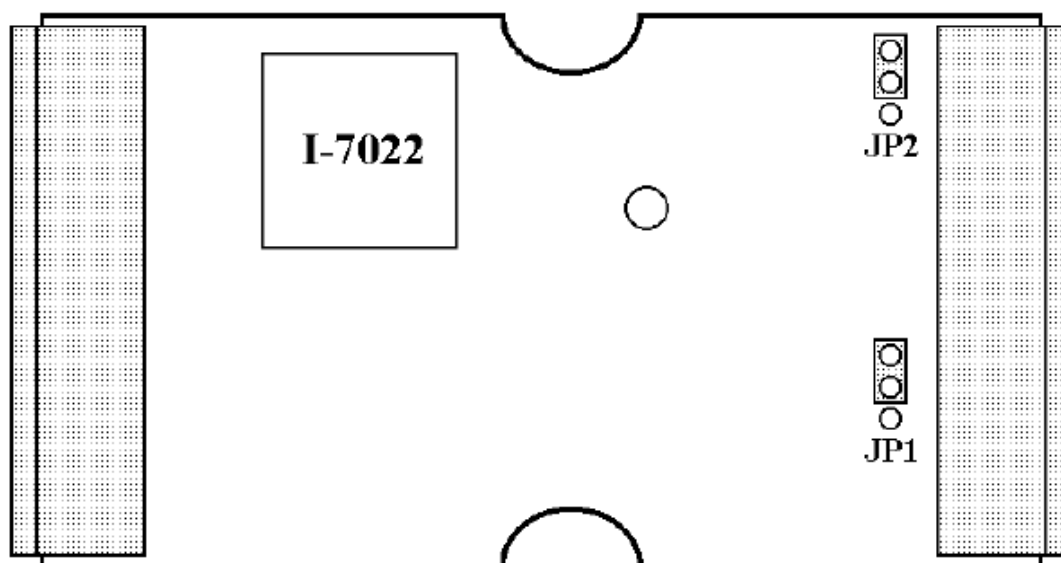


The JP2 jumper is used to disable/enable the RS-485 bias and the settings for the JP2 jumper are as follows.


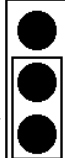


## 1.6.2 I-7022 and M-7022 Jumper Settings

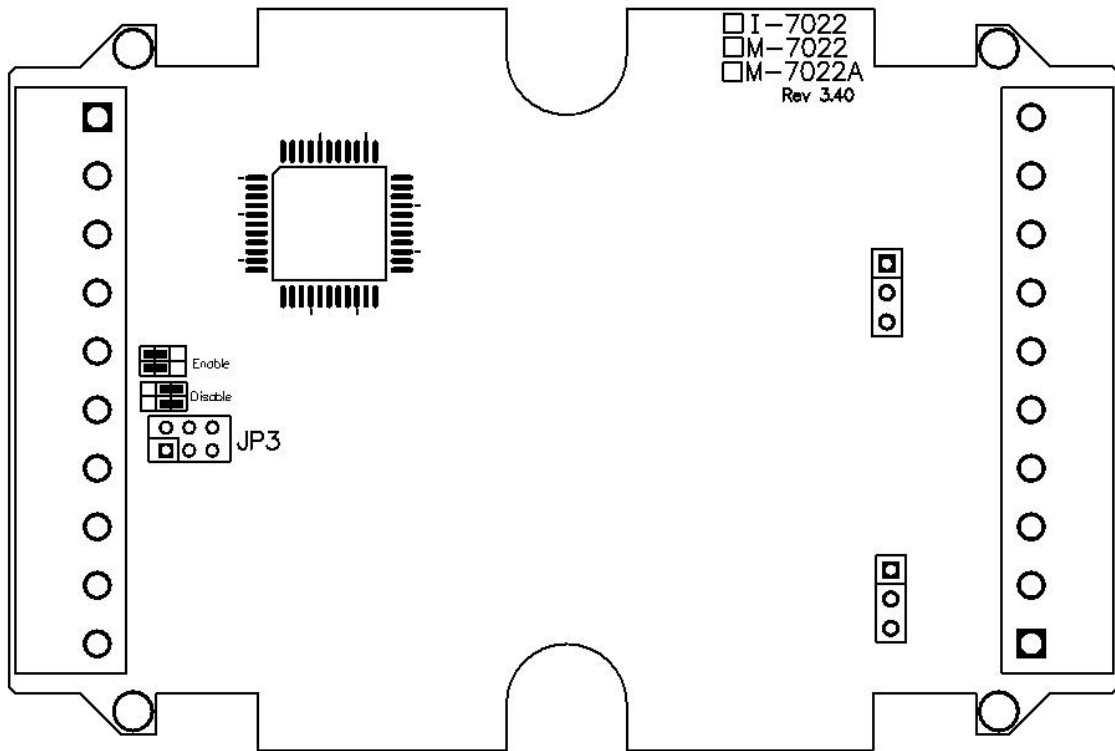
For the I-7022 and M-7022 modules, the power supply for current output can be either internal or external. The power supply is selected using the JP1 jumper for channel 0 and JP2 for channel 1. The positions of the JP1 and JP2 jumpers are shown in the figure below.



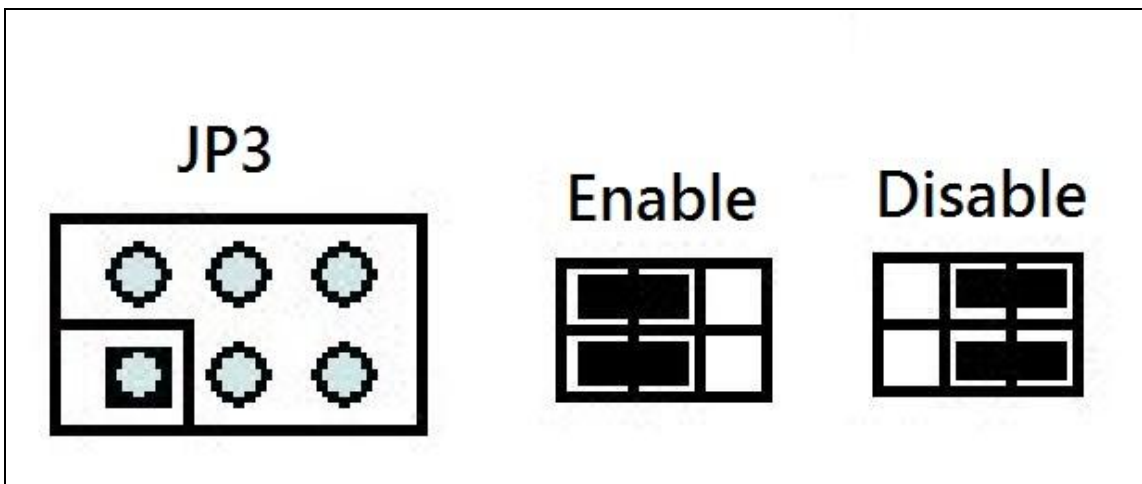
The settings for the JP1 and JP2 jumpers are as follows.

	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.

For the I-7022 and M-7022 PCB version 3.40 and later, there is jumper to enable the RS-485 bias as shown in the following figure.

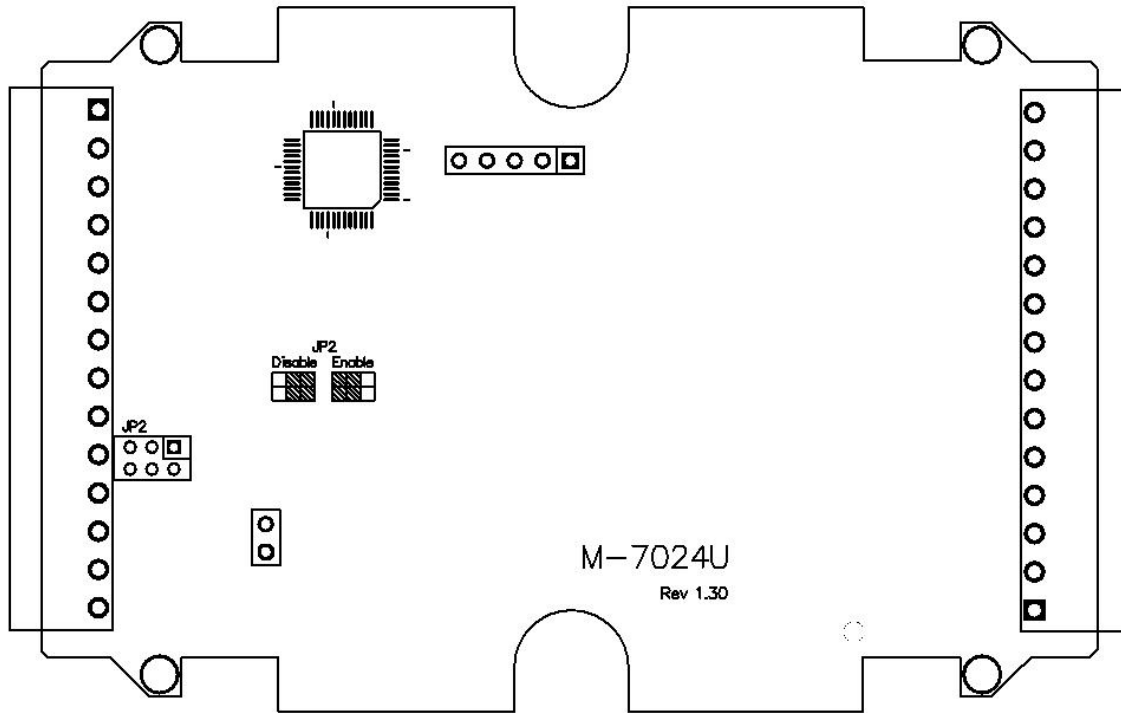


The JP3 jumper is used to disable/enable the RS-485 bias and the settings for the JP3 jumper are as follows.

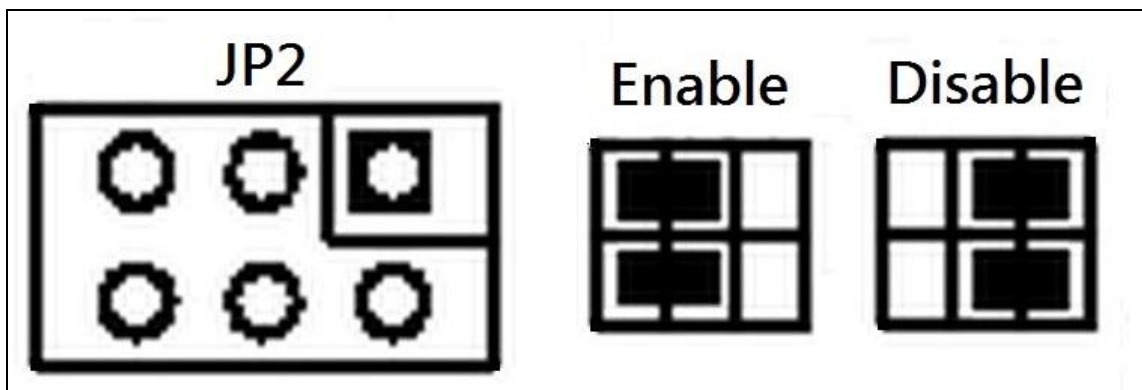


### 1.6.3 M-7024U Jumper Setting

For the M-7024U PCB version 1.30 and later, there is jumper to enable the RS-485 bias as shown in the following figure.



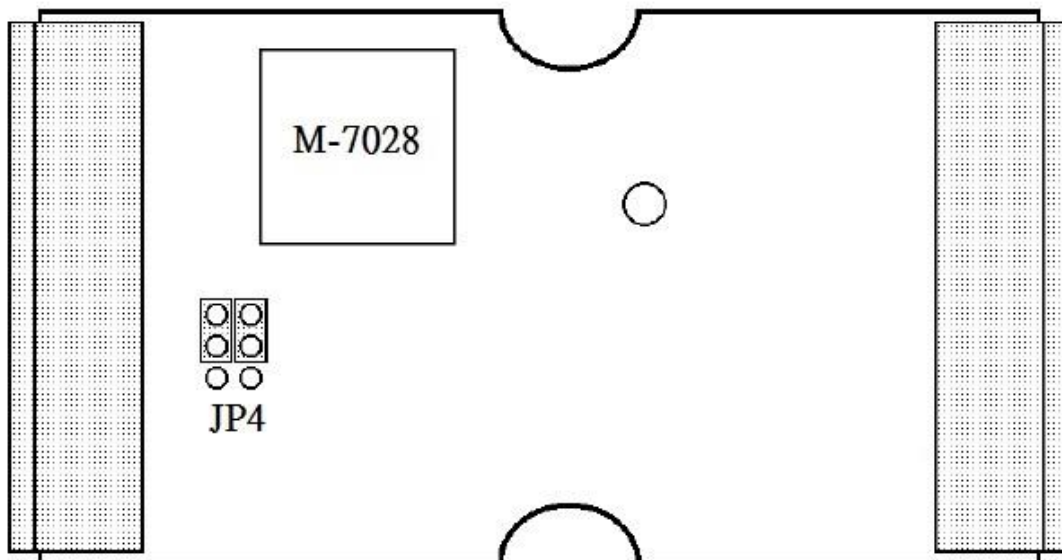
The JP2 jumper is used to disable/enable the RS-485 bias and the settings for the JP2 jumper are as follows.



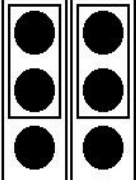
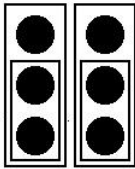


## 1.6.4 M-7028 Jumper Setting

For the M-7028 modules, the JP4 jumper can be used to enable providing the RS-485 bias. The position of the JP4 jumper is shown in the figure below.

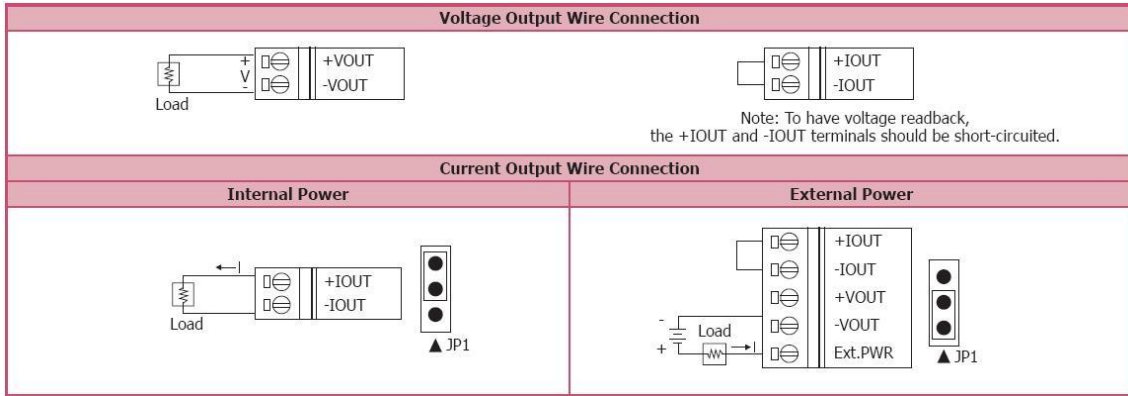


The settings for the JP4 jumper is as follows.

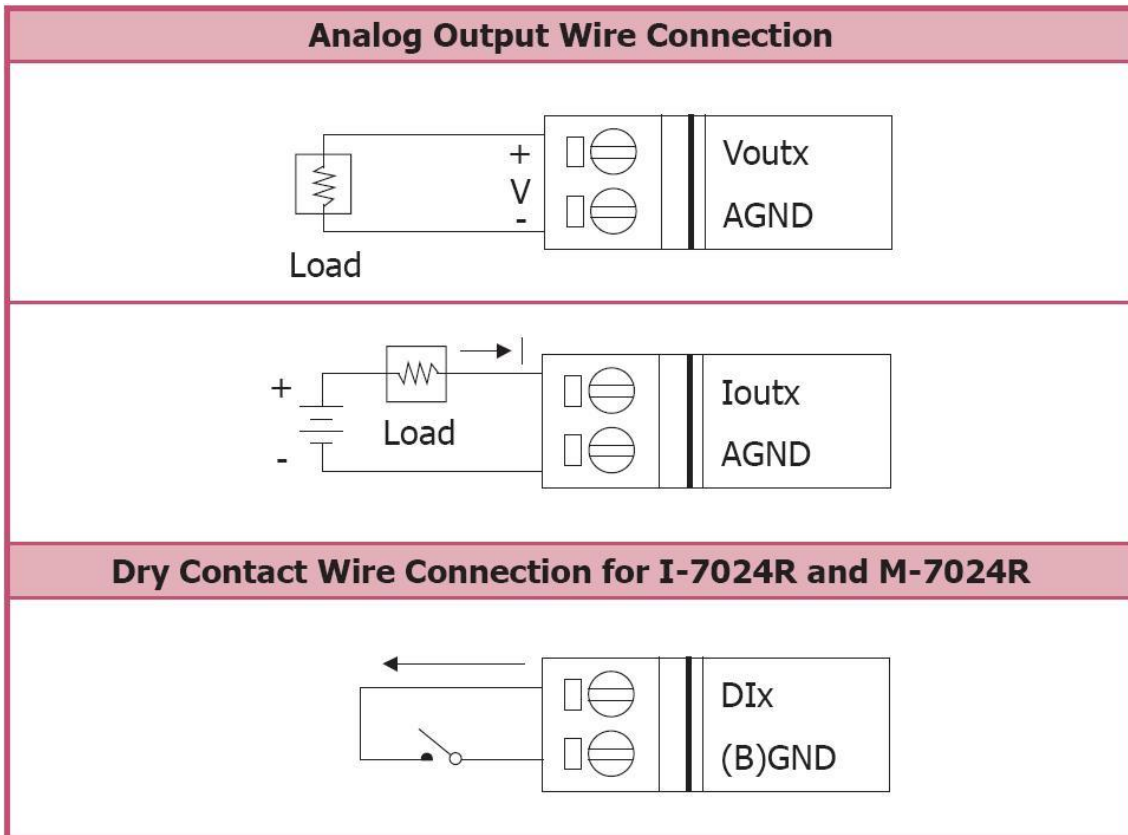
	Disable RS-485 bias. (factory default)
	Enable RS-485 bias.

# 1.7 Wiring

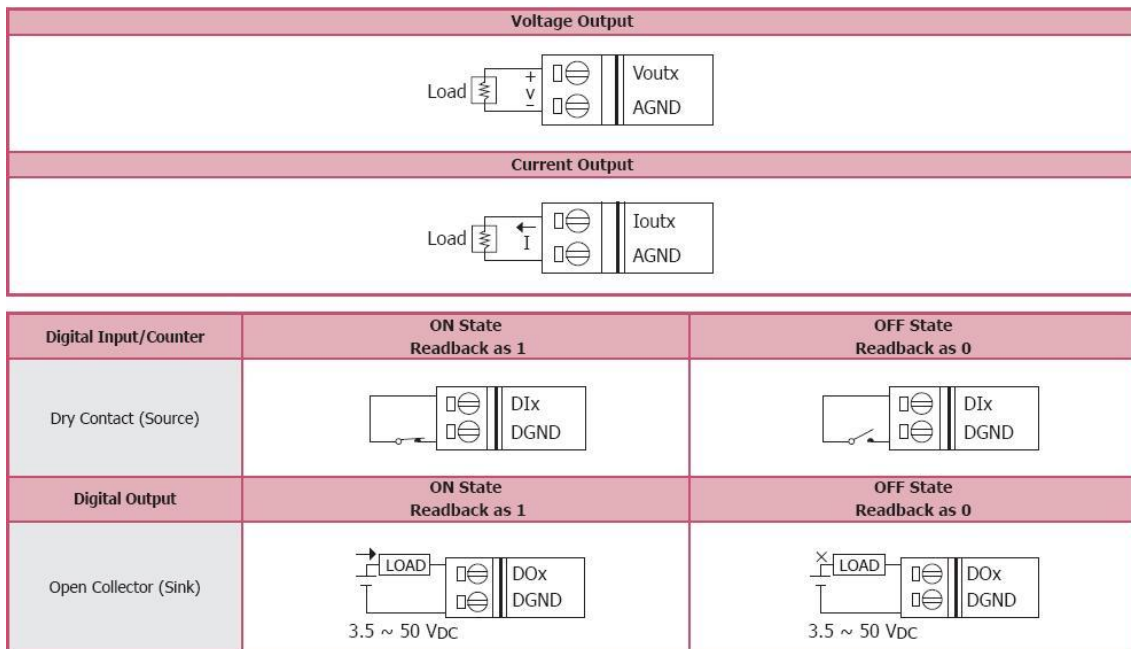
## 1.7.1 Wiring diagram for the I-7021, I-7021P, I-7022 and M-7022



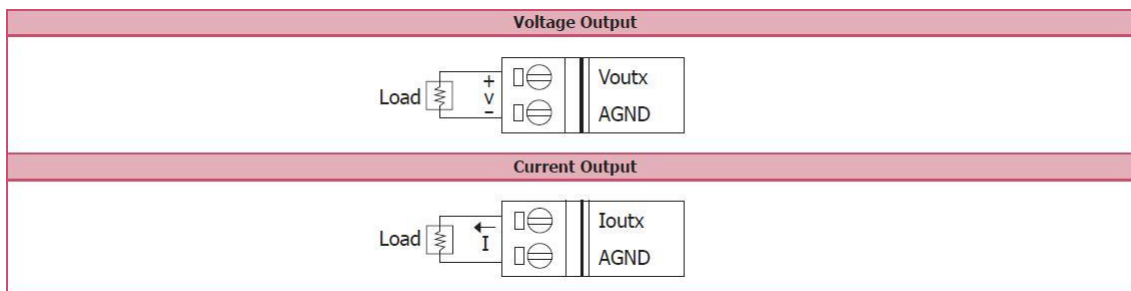
## 1.7.2 Wiring diagram for the I-7024, I-7024R, M-7024, M-7024L and M-7024R



## 1.7.3 Wiring diagram for the M-7024U



## 1.7.4 Wiring diagram for the M-7028



## 1.7.5 Wiring Recommendations

- Use 26-12 AWG wire for signal connections.
- Strip the wire to a length of  $7 \pm 0.5$  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, M-7024U and M-7028. 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-7024L, M-7024R, M-7024U and M-7028 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

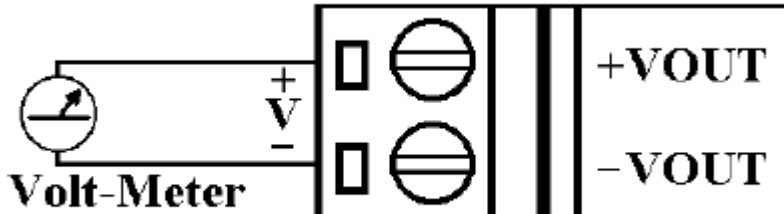
1. Set the jumper JP1 to select internal power and connect a current meter to the current output terminal of the module. If there is no current meter then you can use a voltage meter with a shunt resistor of 250 ohm and 0.1%. The current (I) can be calculated using the equation,  $I = V \text{ (voltage)}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



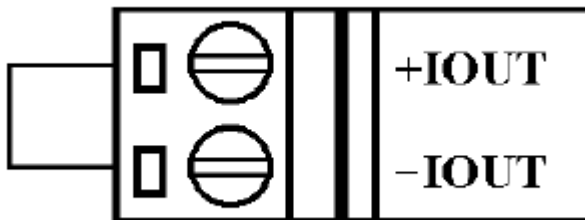
2. Warm up the module for at least 30 minutes.
3. Set the type code to 30, 0 ~ 20 mA. Refer to Section 2.1 for details.
4. Send command to output 4 mA. Refer to Section. 2.2 for details.
5. Repeat to send the trim command and check the meter until the meter's reading is nearest to 4 mA. Refer to Section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

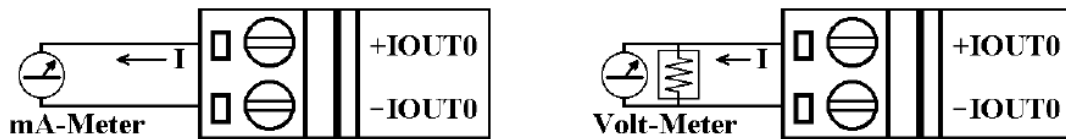


2. Warm up the module for at least 30 minutes.
3. Set the type code to 32, 0 ~ 10 V. Refer to Section 2.1 for details.
4. Send command to output 10 V. Refer to Section. 2.2 for details.
5. Repeat to send the trim command and check the meter until the meter's reading is nearest to 10 V. Refer to Section 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,  $I = V \text{ (voltage)} / 250$ .



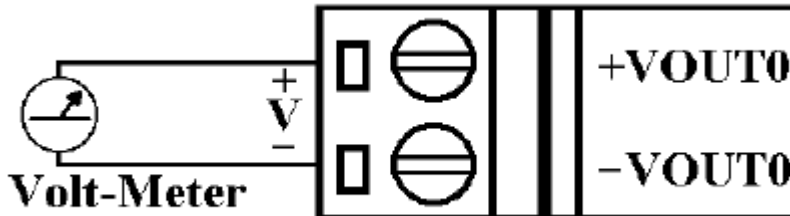
2. Warm up the module for at least 30 minutes.
3. Set the type code to 0, 0 ~ 20 mA. Refer to Section 2.24 for details.
4. Send command to output 4 mA. Refer to Section. 2.4 for details.
5. Repeat to send the trim command and check the meter until the meter's reading is nearest to 4 mA. Refer to Section 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:

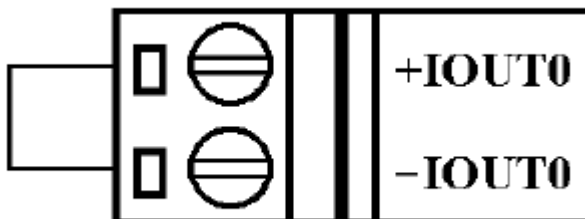
The M-7022 must be switched to the DCON protocol mode before calibrating. Refer to Sections 1.12.1 and 3.3.4 for details of the switching protocol.

## 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



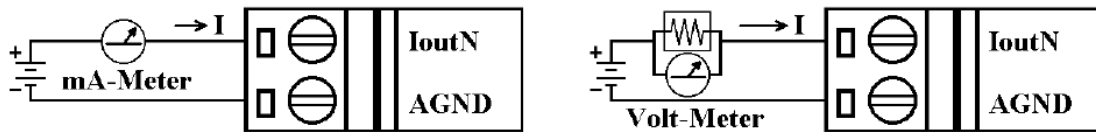
2. Warm up the module for at least 30 minutes.
3. Set the type code to 2, 0 ~ 10 V. Refer to Section 2.24 for details.
4. Send command to output 10 V. Refer to Section. 2.15 for details.
5. Repeat to send the trim command and check the meter until the meter's reading is nearest to 10 V. Refer to Section 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 (for firmware version A2.9 and earlier)

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.



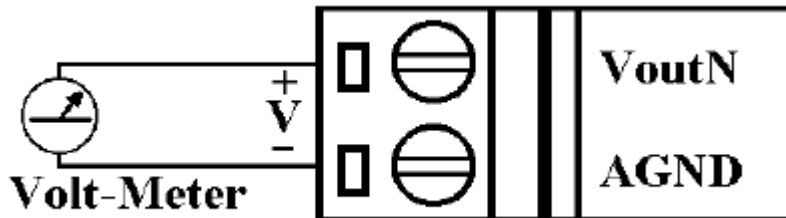
2. Warm up the module for at least 30 minutes.
3. Set the type code to 30, 0 ~ 20 mA. Refer to Section 2.1 for details.
4. Send command to output 0 mA. Refer to Section. 2.4 for details.
5. Repeat to send the trim command and check the meter until the meter's reading is nearest to 0 mA. Refer to Section 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 (for firmware version A2.9 and earlier)

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.

## **I-7024/M-7024 with firmware version A3.0 and later, M-7024L, M-7024U and M-7028 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-7024, M-7024L, M-7024U and M-7028 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 I-7024/M-7204 with firmware version A3.0 and later, M-7024L, M-7024U and M-7028:

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
7028	All

## 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 and M-7028 only

### Note:

1. Type 30, 31, and 32 are only applicable to the I-7021, I-7021P, I-7024, I-7024R, M-7024, M-7024L and M-7024R.
2. Types 33, 34 and 35 are only applicable to the I-7024, I-7024R, M-7024, M-7024L and M-7024R.
3. For I-7022 and M-7022, this field must be set to 3F.  
For M-7024U and M-7028, this field must be set to 00.



## Data Format Setting (FF)

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

Key	Description																																																						
DF	<p>Data format</p> <p>00: Engineering unit</p> <p>01*: % of FSR (full scale range)</p> <p>10*: 2's complement hexadecimal</p> <p>Note: the data format 01 and 10 are only available to the I-7021/21P, I-7022, M-7022, M-7024U and M-7028</p>																																																						
SR	<p>Slew rate for I-7021, I-7021P, I-7024, I-7024R, M-7024, M-7024L and M-7024R</p> <table border="1"> <thead> <tr> <th></th> <th>V/s</th> <th>mA/s</th> <th></th> <th>V/s</th> <th>mA/s</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>Note: the setting 1111 is for I-7024, I-7024R, M-7024, M-7024L and M-7024R only</p> <p>0 for I-7022, M-7022, M-7024U and M-7028</p>		V/s	mA/s		V/s	mA/s	0000	immediate		1000	8.0	16.0	0001	0.0625	0.125	1001	16.0	32.0	0010	0.125	0.25	1010	32.0	64.0	0011	0.25	0.5	1011	64.0	128.0	0100	0.5	1.0	1100	128.0	256.0	0101	1.0	2.0	1101	256.0	512.0	0110	2.0	4.0	1110	512.0	1024.0	0111	4.0	8.0	1111	1024.0	2048.0
	V/s	mA/s		V/s	mA/s																																																		
0000	immediate		1000	8.0	16.0																																																		
0001	0.0625	0.125	1001	16.0	32.0																																																		
0010	0.125	0.25	1010	32.0	64.0																																																		
0011	0.25	0.5	1011	64.0	128.0																																																		
0100	0.5	1.0	1100	128.0	256.0																																																		
0101	1.0	2.0	1101	256.0	512.0																																																		
0110	2.0	4.0	1110	512.0	1024.0																																																		
0111	4.0	8.0	1111	1024.0	2048.0																																																		
CS	<p>Checksum setting</p> <p>0: Disabled</p> <p>1: Enabled</p>																																																						

## 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, M-7024L 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 and M-7028

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, M-7204U and M-7028

### 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, M-7028 and I-7022/M-7022 firmware version B1.2 and later.
2. The type code 3 and 5 are only available to M-7024U and M-7028.

### 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:

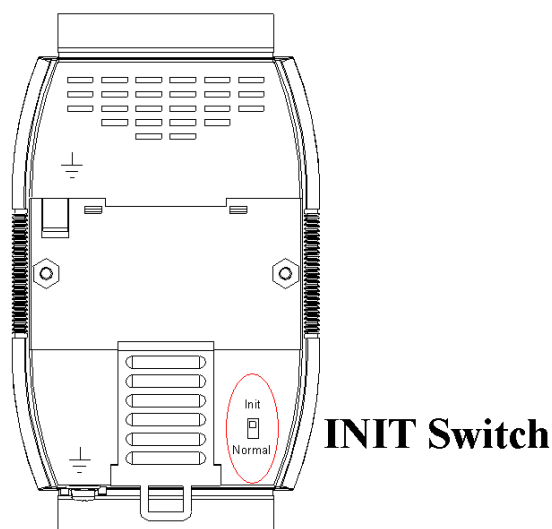
1. Sends the \$AAPN command and set N to a value of 1. Note that the INIT\* terminal should be connected to the GND terminal, or the slide switch on the rear side of the module should be set to the INIT position. See Section 2.31 for details.
2. After a power-on reset, the communication protocol will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

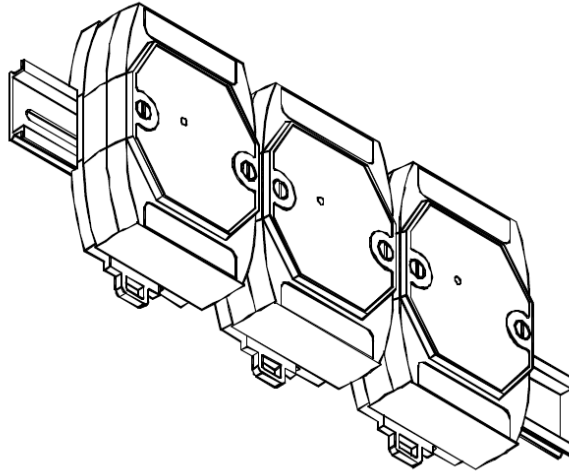
1. Address: 00
2. Baud Rate: 9600 bps
3. No checksum
4. Protocol: DCON

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 %AANNTTCFF, (see Section 2.1) and \$AAPN, (see Section 2.31). The new communication settings will be effective after the next power-on reset.



# 1.13 Mounting

## 1.13.1 Din-Rail Mounting



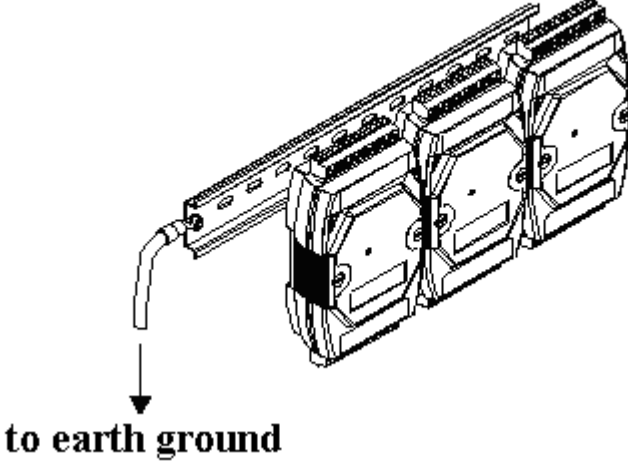
There are three new DIN rail models available. Each is made of stainless steel, which is stronger than those made of aluminum. There is a screw at one end and a ring terminal is included so that it can be easily connected to the earth ground. The three new DIN rail models are as follows.

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

to earth ground

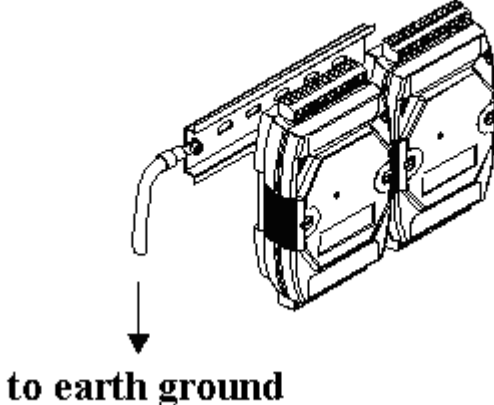
A perspective diagram of a DIN rail with five modules mounted on it. A ring terminal is attached to the rail, and a wire is connected to it. An arrow points from the wire to the text "to earth ground".

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

The diagram shows three DRS-240 modules mounted on a DIN rail. A wire is connected to the rail, and an arrow points down from the wire with the text "to earth ground".

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

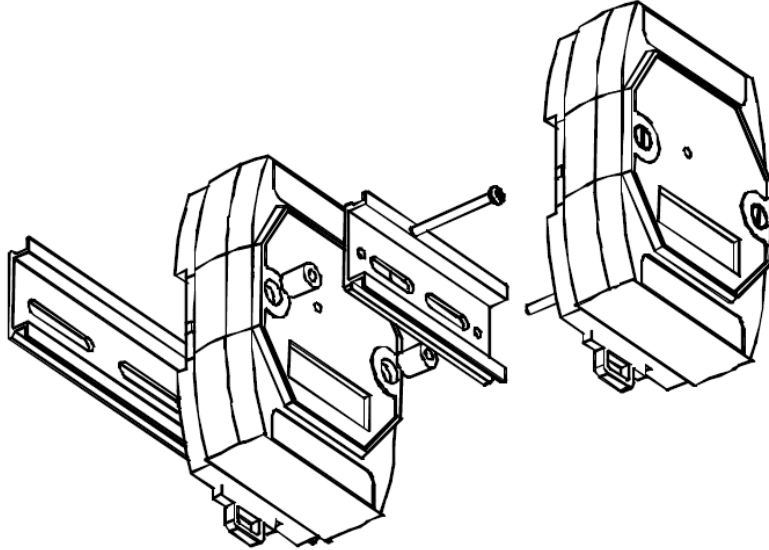
The diagram shows two DRS-125 modules mounted on a DIN rail. A wire is connected to the rail, and an arrow points down from the wire with the text "to earth ground".

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

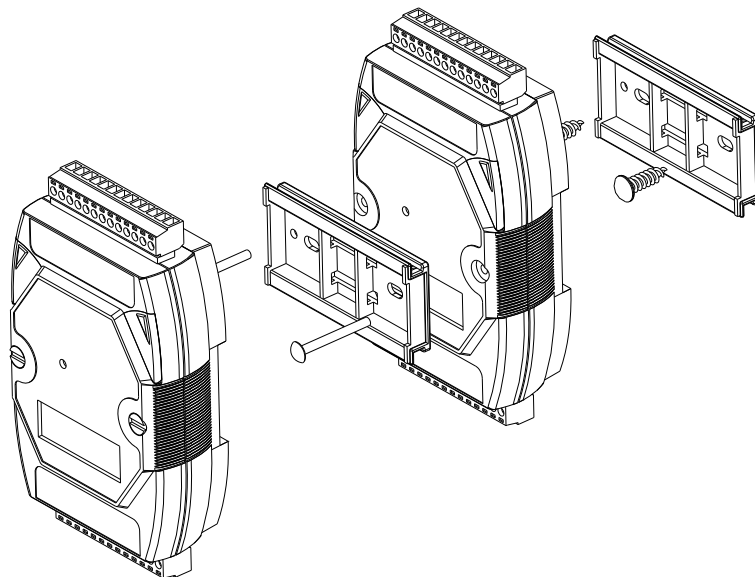


## 1.13.2 Piggyback Mounting

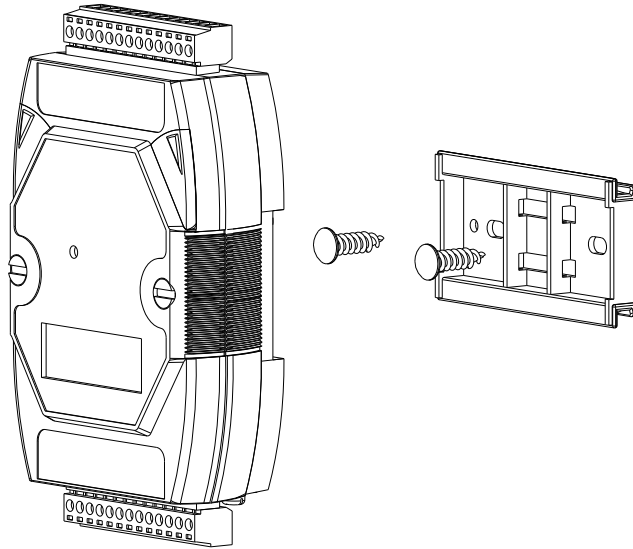
For I-7021, I-7021P, I-7022, and M-7022 modules



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](mailto:service@icpdas.com)

Website: [http://www.icpdas.com.tw/contact\\_us/contact\\_us.html](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:

<b>Leading Character</b>	<b>Module Address</b>	<b>Command</b>	<b>[CHKSUM]</b>	<b>CR</b>
--------------------------	-----------------------	----------------	-----------------	-----------

### Response Format:

<b>Leading Character</b>	<b>Module Address</b>	<b>Data</b>	<b>[CHKSUM]</b>	<b>CR</b>
--------------------------	-----------------------	-------------	-----------------	-----------

**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.

<b>General Command Sets</b>			
<b>Command</b>	<b>Response</b>	<b>Description</b>	<b>Section</b>
%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

<b>I-7021/21P Analog Output Command Sets</b>			
<b>Command</b>	<b>Response</b>	<b>Description</b>	<b>Section</b>
#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

<b>I-7022/M-7022 Analog Output Command Sets</b>			
<b>Command</b>	<b>Response</b>	<b>Description</b>	<b>Section</b>
#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

<b>I-7024/I-7024R/M-7024/M-7024L/M-7024R Analog Output Command Sets</b>			
<b>Command</b>	<b>Response</b>	<b>Description</b>	<b>Section</b>
#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

<b>M-7024U Analog Output Command Sets</b>			
<b>Command</b>	<b>Response</b>	<b>Description</b>	<b>Section</b>
#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

<b>M-7028 Analog Output Command Sets</b>			
<b>Command</b>	<b>Response</b>	<b>Description</b>	<b>Section</b>
#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

<b>I-7024R/M-7024R Digital Input Command Sets</b>			
<b>Command</b>	<b>Response</b>	<b>Description</b>	<b>Section</b>
#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.			

<b>M-7024U Digital Input and Output Command Sets</b>			
<b>Command</b>	<b>Response</b>	<b>Description</b>	<b>Section</b>
@AACECN	!AA	Resets the counter data of a digital channel	2.47
@AADI	!AA000II	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



<b>Host Watchdog Command Sets</b>			
<b>Command</b>	<b>Response</b>	<b>Description</b>	<b>Section</b>
~**	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 %AANNTTCFF

### Description:

Sets the configuration of an analog output module.

### Syntax:

**%AANNTTCFF[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, M-7024U and M-7028, this field should be set to 3F, 00 for M-7024U and M-7208, 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, M-7024U and M-7208, 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.

**I-7021, I-7021P, I-7022, I-7024, I-7024R**  
**M-7022, M-7024, M-7024L, M-7024R, M-7024U, M-7028**

---

**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 @ACECN, 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, M-7024L 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.

I-7022, I-7024, I-7024R

M-7022, M-7024, M-7024L, M-7024R, M-7024U, M-7028

---

### **Examples for M-7024U and M-7208:**

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 %AANNTCCFF, 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-7024L, M-7024R,  
M-7024U and M-7028.

## 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

## **I-7021, I-7021A, I-7021P**

---

### **Related Topics:**

Section 1.10 Calibration

### **Note:**

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

I-7022, I-7024, I-7024R

M-7022, M-7022A, M-7024, M-7024L, M-7024R, M-7024U, M-7028

---

## 2.6 \$AA0N

### Description:

I-7022/M-7022	Performs 4 mA calibration
I-7024/I-7024R/M-7024/M-7024R firmware version A2.9 and earlier	Performs 0 mA or -10 V calibration
M-7022A/M-7024L/M-7024U/ M-7028, I-7024/I-7024R/M-7024/ M-7024R firmware version A3.0 and later	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.

**I-7022, I-7024, I-7024R**

**M-7022, M-7022A, M-7024, M-7024L, M-7024R, M-7024U, M-7028**

---

**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-7024L, M-7024R, M-7024U and M-7028.

## 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



## **I-7021, I-7021A, I-7021P**

---

### **Related Topics:**

Section 1.10 Calibration

### **Note:**

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

I-7022, I-7024, I-7024R

M-7022, M-7022A, M-7024, M-7024L, M-7024R, M-7024U, M-7028

---

## 2.8 \$AA1N

### Description:

I-7022/M-7022	Performs 20 mA calibration
I-7024/I-7024R/M-7024/M-7024R firmware version A2.9 and earlier	Performs 20 mA or +10 V calibration
M-7022A/M-7024L/M-7024U/ M-7028, I-7024/I-7024R/M-7024/ M-7024R firmware version A3.0 and later	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.

**I-7022, I-7024, I-7024R**

**M-7022, M-7022A, M-7024, M-7024L, M-7024R, M-7024U, M-7028**

---

**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-7024L, M-7024R, M-7024U and M-7028.

## 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: **!AATTCFF[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, M-7024U and M-7028, this field is to  
3F and 00 for M-7024U and M-7028, 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.



## 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, M-7022 and M-7028, 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)



**I-7022, I-7024, I-7024R**

**M-7022, M-7024, M-7024L, M-7024R, M-7024U, M-7028**

---

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-7024L, M-7024R, M-7024U and M-7028.



**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.

**I-7022, I-7024, I-7024R**

**M-7022, M-7024, M-7024L, M-7024R, M-7024U, M-7028**

---

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-7024L, M-7024R, M-7024U and M-7028.

## 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.

**I-7021, I-7021P, I-7022, I-7024, I-7024R**  
**M-7022, M-7024, M-7024L, M-7024R, M-7024U, M-7028**

---

**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.

**I-7024R**  
**M-7024R**

---

**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.

I-7022, I-7024, I-7024R

M-7022, M-7024, M-7024L, M-7024R, M-7024U, M-7028

---

### **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-7024L, M-7024R, M-7024U and M-7028.

## 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

## I-7021, I-7021P

---

### **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



**I-7022, M-7022**

---

**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.



## 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.



## 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.

I-7022, I-7024, I-7024R

M-7022, M-7024, M-7024L, M-7024R, M-7024U, M-7028

---

### **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-7024L, M-7024R, M-7024U and M-7028.

## 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.



**I-7022**  
**M-7022, M-7024U, M-7028**

---

**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, M-7024U and M-7028.

## 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.

**I-7022**  
**M-7022, M-7024U, M-7028**

---

**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, M-7024U and M-7028.

## 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 for M-7024U and 00 to FF for M-7028), 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 and M-7028.

## 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.







## 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.

**I-7021, I-7021P, I-7022, I-7024, I-7024R**  
**M-7022, M-7024, M-7024L, M-7024R, M-7024U, M-7028**

---

**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-7024L, M-7024R, M-7024U and M-7028.

## 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 and M-7028, 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-7024L, M-7024R, M-7024U and M-7028.

## 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 I-7024/M-7024/I-7024R/M-7024R firmware version A3.0 and later, M-7024L, M-7024U and M-7028.

## 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.

**I-7021, I-7021P, I-7022, I-7024, I-7024R  
M-7022, M-7024, M-7024L, M-7024R, M-7024U, M-7028**

---

**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.

**I-7021, I-7021P, I-7022, I-7024, I-7024R  
M-7022, M-7024, M-7024L, M-7024R, M-7024U, M-7028**

---

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.

**I-7021, I-7021P, I-7022, I-7024, I-7024R  
M-7022, M-7024, M-7024L, M-7024R, M-7024U, M-7028**

---

### **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.

**I-7021, I-7021P, I-7022, I-7024, I-7024R**  
**M-7022, M-7024, M-7024L, M-7024R, M-7024U, M-7028**

---

**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 ~AA3E VV

### Description:

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

### Syntax:

**~AA3E VV[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.	

**I-7022, I-7024, I-7024R**

**M-7022, M-7024, M-7024L, M-7024R, M-7024U, M-7028**

---

**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-7024L, M-7024R,  
M-7024U and M-7028.

## 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 ~AA3EVB, 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.

**I-7022, I-7024, I-7024R**  
**M-7022, M-7024, M-7024L, M-7024R, M-7024U, M-7028**

---

**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-7024L, M-7024R,  
M-7024U and M-7028.

## 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 @AAECN

### Description:

Clears the digital input counter of a specified channel.

### Syntax:

**@AAECN[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.



## 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 : **!AA000II [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

**I-7024R**  
**M-7024R, M-7024U**

---

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.

**I-7024R**  
**M-7024R, M-7024U**

---

**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 @AAECN

**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-7024L, M-7024R, M-7024U and M-7028, 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-7024L 0x0000 ~ 0x0003 for M-7024R 0x0000 ~ 0x0003 for M-7024U 0x0000 ~ 0x0007 for M-7028
04 ~ 05	Number of output channels (N)	2 Bytes	0x0001 ~ 0x0002 for M-7022 0x0001 ~ 0x0004 for M-7024 0x0001 ~ 0x0004 for M-7024L 0x0001 ~ 0x0004 for M-7024R 0x0001 ~ 0x0004 for M-7024U 0x0001 ~ 0x0008 for M-7028

#### 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-7024L 0x0000 ~ 0x0003 for M-7024R 0x0000 ~ 0x0003 for M-7024U 0x0000 ~ 0x0007 for M-7028
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-7024U

### 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-7024L 0x0000 ~ 0x0003 for M-7024R 0x0000 ~ 0x0003 for M-7024U 0x0000 ~ 0x0007 for M-7028
04 ~ 05	Number of output channels (N)	2 Bytes	0x0001 ~ 0x0002 for M-7022 0x0001 ~ 0x0004 for M-7024 0x0001 ~ 0x0004 for M-7024L 0x0001 ~ 0x0004 for M-7024R 0x0001 ~ 0x0004 for M-7024U 0x0001 ~ 0x0008 for M-7028
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 <table border="1" data-bbox="395 1579 1066 1758"> <tbody> <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> </tbody> </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	Code	0x03	0x04	0x05	0x06	Baud	1200	2400	4800	9600	Code	0x07	0x08	0x09	0x0A	Baud	19200	38400	57600	115200	R/W
Code	0x03	0x04	0x05	0x06																		
Baud	1200	2400	4800	9600																		
Code	0x07	0x08	0x09	0x0A																		
Baud	19200	38400	57600	115200																		

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/M-7024L Address Mappings

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

Address	Description	Attribute																				
40001 ~ 40004	Analog output value	R/W																				
40065 ~ 40068	Analog output read back	R																				
40097 ~ 40100	Safe output value	R/W																				
40193 ~ 40196	Power on output value	R/W																				
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 <table border="1" data-bbox="399 1272 1066 1451"> <tbody> <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> </tbody> </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	Code	0x03	0x04	0x05	0x06	Baud	1200	2400	4800	9600	Code	0x07	0x08	0x09	0x0A	Baud	19200	38400	57600	115200	R/W
Code	0x03	0x04	0x05	0x06																		
Baud	1200	2400	4800	9600																		
Code	0x07	0x08	0x09	0x0A																		
Baud	19200	38400	57600	115200																		
40487	Type code	R/W																				
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																				



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
00272	Write 1 to load factory default calibration parameters. for firmware version A3.0 and later	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

Address	Description	Attribute																				
40001 ~ 40004	Analog output value	R/W																				
40065 ~ 40068	Analog output read back	R																				
40097 ~ 40100	Safe output value	R/W																				
40129 ~ 40133	Counter value of digital input	R																				
40193 ~ 40196	Power on output value	R/W																				
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 <table border="1" data-bbox="399 1209 1066 1384"> <tbody> <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> </tbody> </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	Code	0x03	0x04	0x05	0x06	Baud	1200	2400	4800	9600	Code	0x07	0x08	0x09	0x0A	Baud	19200	38400	57600	115200	R/W
Code	0x03	0x04	0x05	0x06																		
Baud	1200	2400	4800	9600																		
Code	0x07	0x08	0x09	0x0A																		
Baud	19200	38400	57600	115200																		
40487	Type code	R/W																				
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																				

<b>Address</b>	<b>Description</b>	<b>Attribute</b>
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
00272	Write 1 to load factory default calibration parameters. for firmware version A3.0 and later	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

Address	Description	Attribute																				
30065 ~ 30068 40065 ~ 40068	Analog output read back of channel 0 to 3	R																				
30129 ~ 30132 40129 ~ 40132	Counter value of digital input channel 0 to 3	R																				
40001 ~ 40004	Analog output value of channel 0 to 3	R/W																				
40097 ~ 40100	Safe analog output value of channel 0 to 3	R/W																				
40193 ~ 40196	Power on analog output value of channel 0 to 3	R/W																				
40257 ~ 40260	Analog output type code of channel 0 to 3	R/W																				
40289 ~ 40292	Analog output slew rate of channel 0 to 3	R/W																				
40481	Firmware version (low word)	R																				
40482	Firmware version (high word)	R																				
40483	Module name (low word), 0x0070	R																				
40484	Module name (high word), 0x2425	R																				
40485	Module address, valid range: 1 ~ 247	R/W																				
40486	Bits 5:0 Baud rate, 0x03 ~ 0x0A <table border="1" data-bbox="399 1601 1066 1780"> <tbody> <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> </tbody> </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	Code	0x03	0x04	0x05	0x06	Baud	1200	2400	4800	9600	Code	0x07	0x08	0x09	0x0A	Baud	19200	38400	57600	115200	R/W
Code	0x03	0x04	0x05	0x06																		
Baud	1200	2400	4800	9600																		
Code	0x07	0x08	0x09	0x0A																		
Baud	19200	38400	57600	115200																		

<b>Address</b>	<b>Description</b>	<b>Attribute</b>
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

<b>Address</b>	<b>Description</b>	<b>Attribute</b>
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 Output Types

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



### 3.13 M-7028 Address Mappings

Address	Description	Attribute																				
30065 ~ 30072 40065 ~ 40072	Analog output read back of channel 0 to 7	R																				
40001 ~ 40008	Analog output value of channel 0 to 7	R/W																				
40097 ~ 40104	Safe analog output value of channel 0 to 7	R/W																				
40193 ~ 40200	Power on analog output value of channel 0 to 7	R/W																				
40257 ~ 40264	Analog output type code of channel 0 to 7	R/W																				
40289 ~ 40296	Analog output slew rate of channel 0 to 7	R/W																				
40481	Firmware version (low word)	R																				
40482	Firmware version (high word)	R																				
40483	Module name (low word), 0x0070	R																				
40484	Module name (high word), 0x2800	R																				
40485	Module address, valid range: 1 ~ 247	R/W																				
40486	Bits 5:0 Baud rate, 0x03 ~ 0x0A <table border="1" style="margin-left: 20px;"> <tbody> <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> </tbody> </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	Code	0x03	0x04	0x05	0x06	Baud	1200	2400	4800	9600	Code	0x07	0x08	0x09	0x0A	Baud	19200	38400	57600	115200	R/W
Code	0x03	0x04	0x05	0x06																		
Baud	1200	2400	4800	9600																		
Code	0x07	0x08	0x09	0x0A																		
Baud	19200	38400	57600	115200																		
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																				

<b>Address</b>	<b>Description</b>	<b>Attribute</b>
40492	Host watchdog timeout count, write 0 to clear	R/W
00225 ~ 00232 10225 ~ 10232	Status of current output open wire	R
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
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

### Analog Output Types

<b>Type Code</b>	<b>Range</b>	<b>Data Format</b>	<b>Minimum</b>	<b>Maximum</b>
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.
- Ensure that the RS-485 converter provides the bias. The RS-485 converters manufactured by ICP DAS all provide the bias. If the RS-485 converter does not provide the bias and the module is listed in section 1.6, then you can open the cover to adjust the jumper to enable the RS-485 bias.
- 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.

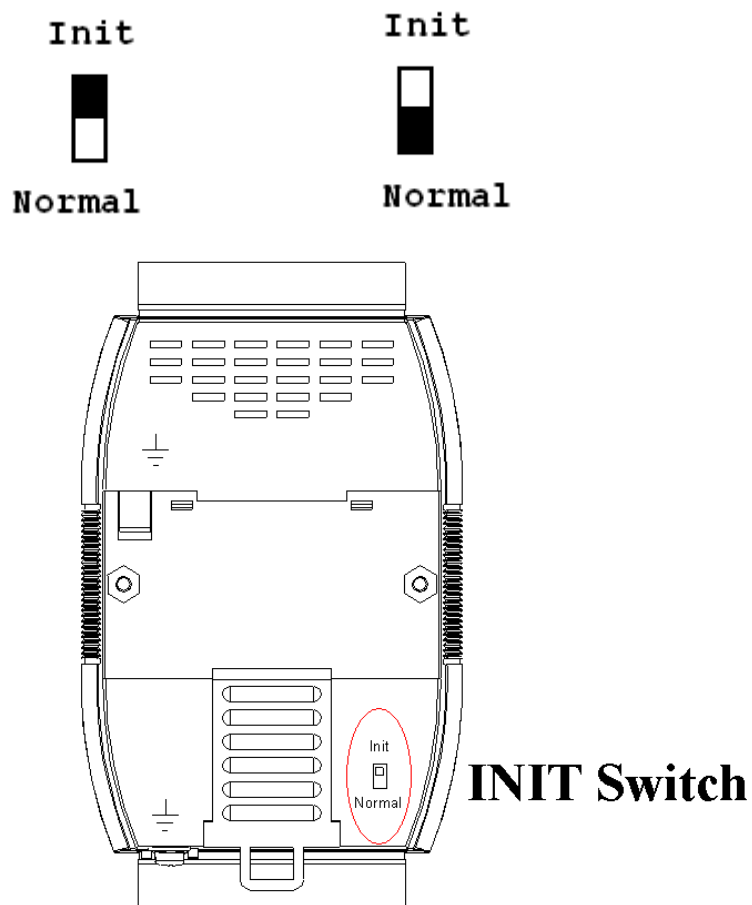
1. Address: 00
2. Baud Rate: 9600 bps
3. No checksum
4. Protocol: DCON

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-7024L, M-7024R, M-7024U and M-7028. 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-7024L, M-7024R, M-7024U and M-7028.

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-7024L, M-7024R, M-7024U and M-7028 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-7024L, M-7024R, M-7024U and M-7028 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.

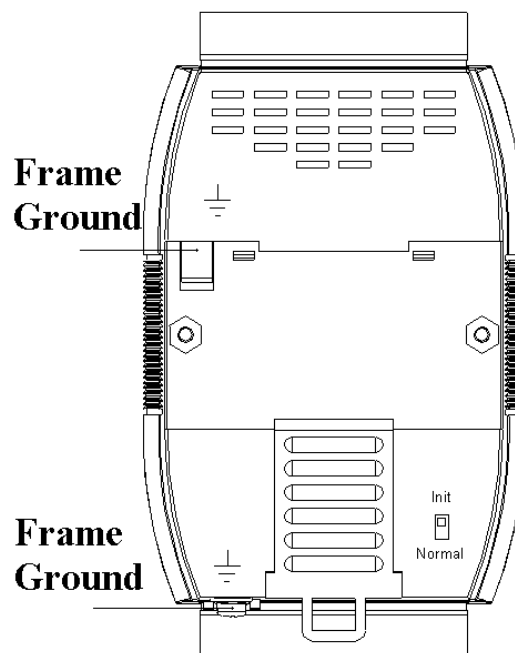
The I-7024, I-7024R, M-7024, M-7024L, M-7024R, M-7024U and M-7028 modules do not have the analog-to-digital converter to monitor the analog output signal. However, they can respond the value that is set to the digital-to-analog converter. This value cannot be used to check improper wire connection and load.

## A.8 Frame Ground

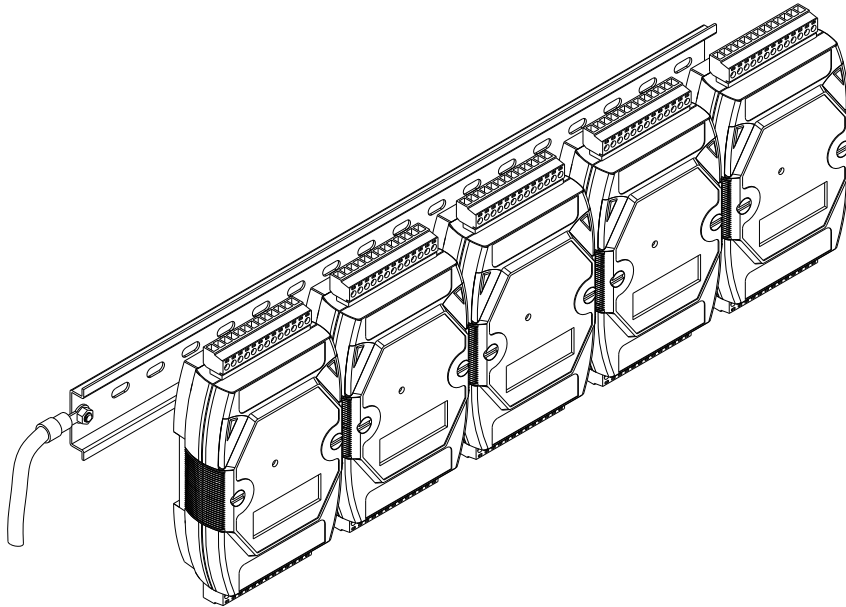
Electronic circuits are constantly vulnerable to ESD which become worse in a continental climate area. Some I-7000, and all M-7000, modules feature a new design for the frame ground. The frame ground provides a path for bypassing ESD, which provides enhanced static protection (ESD) abilities and ensures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



## Revision History

Revision	Date	Changes Made
B2.6	2020/4/1	Modify section 1.6 and 4.1 to include RS-485 bias setting