# tM-AD 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.

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# 1. Introduction

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

The tM series feature a new design for the frame ground and INIT switch as shown in the figure. The frame ground provides enhanced static protection (ESD) abilities and ensures the module is more reliable. The INIT switch allows easier access to INIT mode. Please refer to Sections A.1 and A.3 for more details.




The common features of the tM-AD series are as follows:

1. 2500V DC inter-module isolation
2. 16-bit sigma-delta ADC to provide excellent accuracy
3. Software calibration



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The tM-AD2 is a 2-channel single-ended voltage and current input module.
The tM-AD5 is a 5-channel differential voltage input module.
The tM-AD5C is a 5-channel differential current input module.
The tM-AD8 is an 8-channel single-ended voltage input module.
The tM-AD8C is an 8-channel single-ended current input module.

The tM-AD series are designed for industrial plant environments and have special input circuits to provide 120VDC continuous overload protection.



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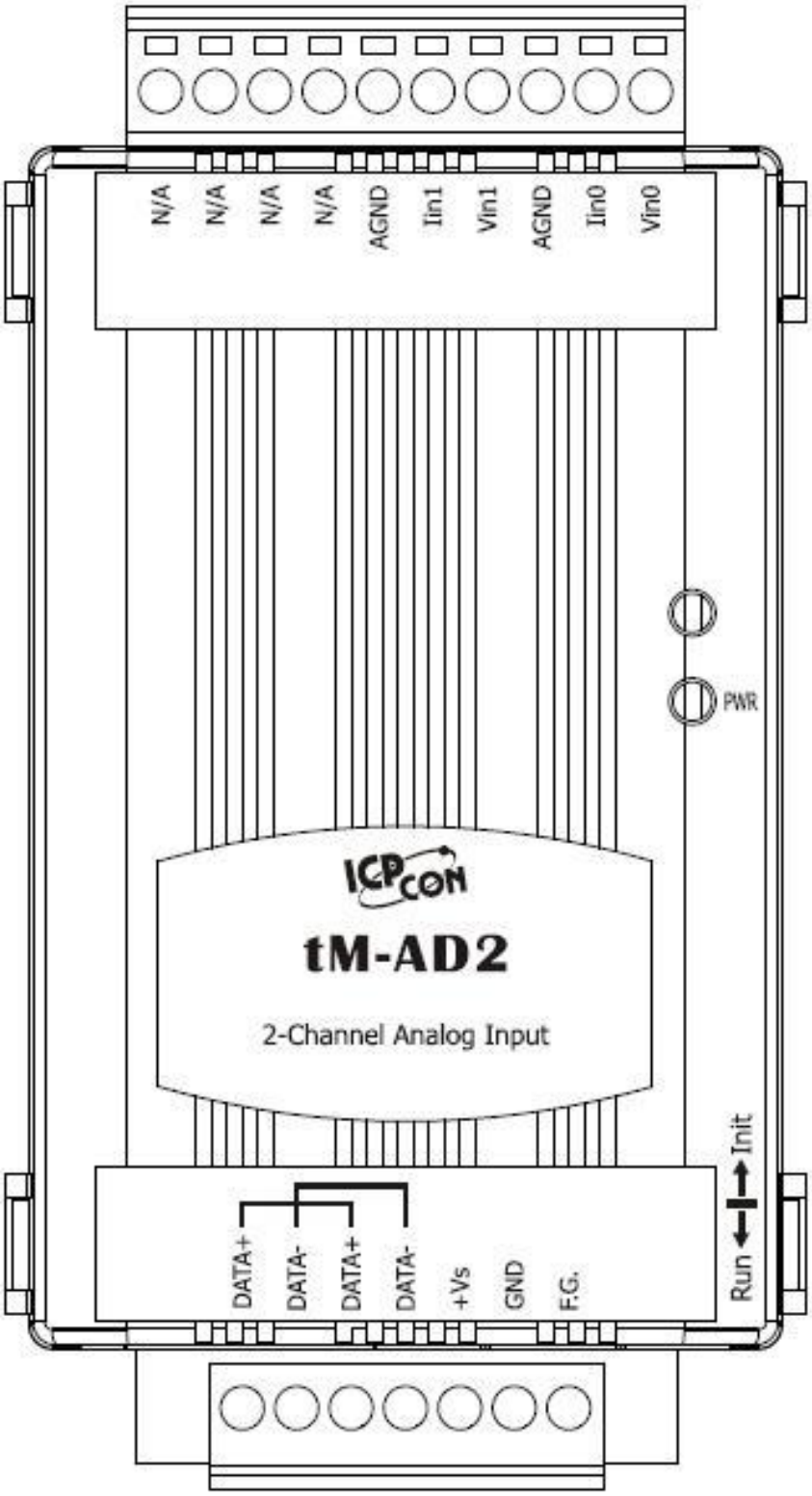
## 1.1 More Information

- For details of **INIT mode** operation, please refer to Section A.1 INIT Mode.
- For details of **module watchdog** and **host watchdog**, please refer to Section A.2 Dual Watchdog Operation.
- For details of **ESD protection** and **grounding**, please refer to Section A.3 Frame Ground.



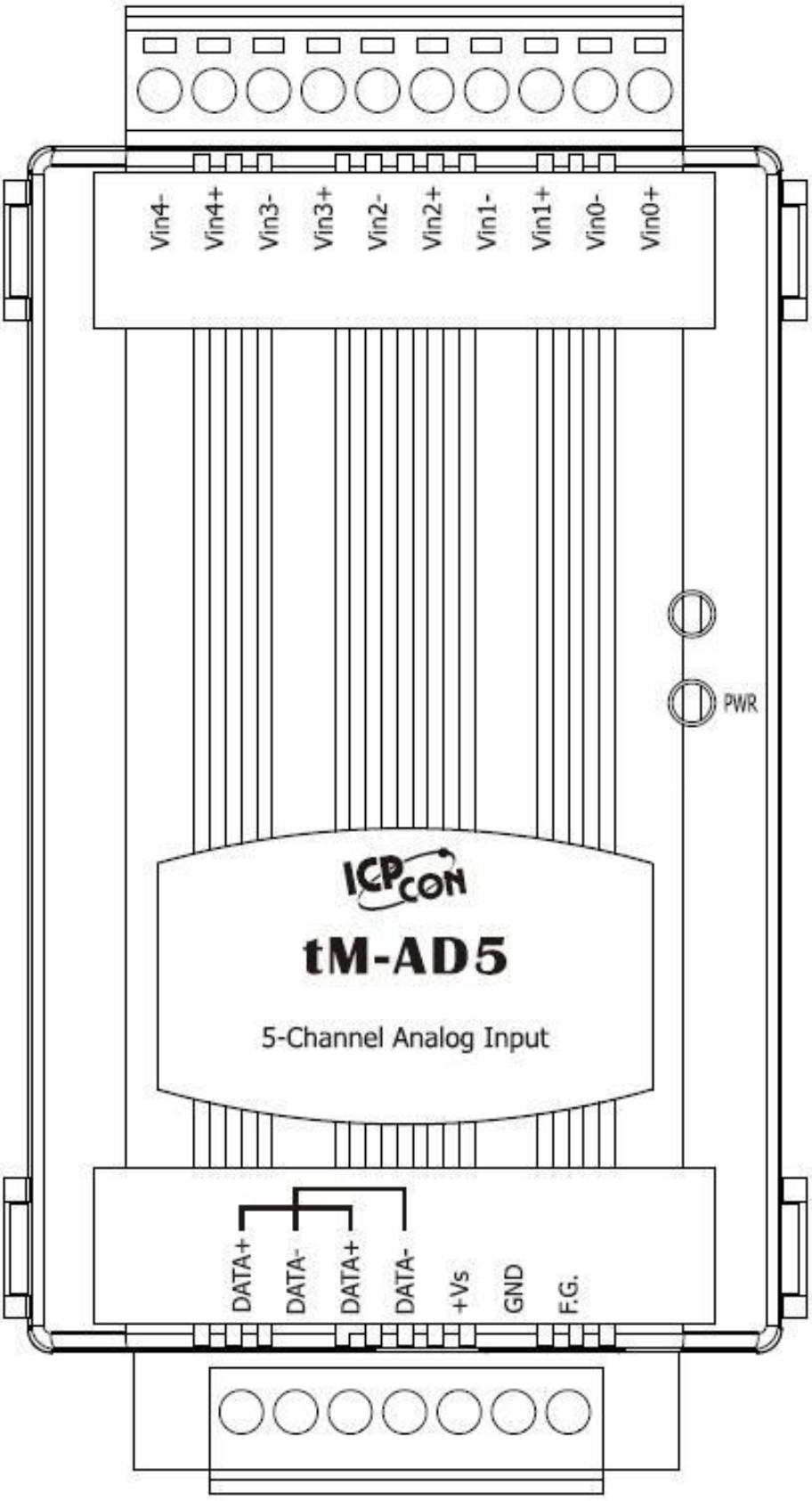
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# 1.2 Terminal Assignment



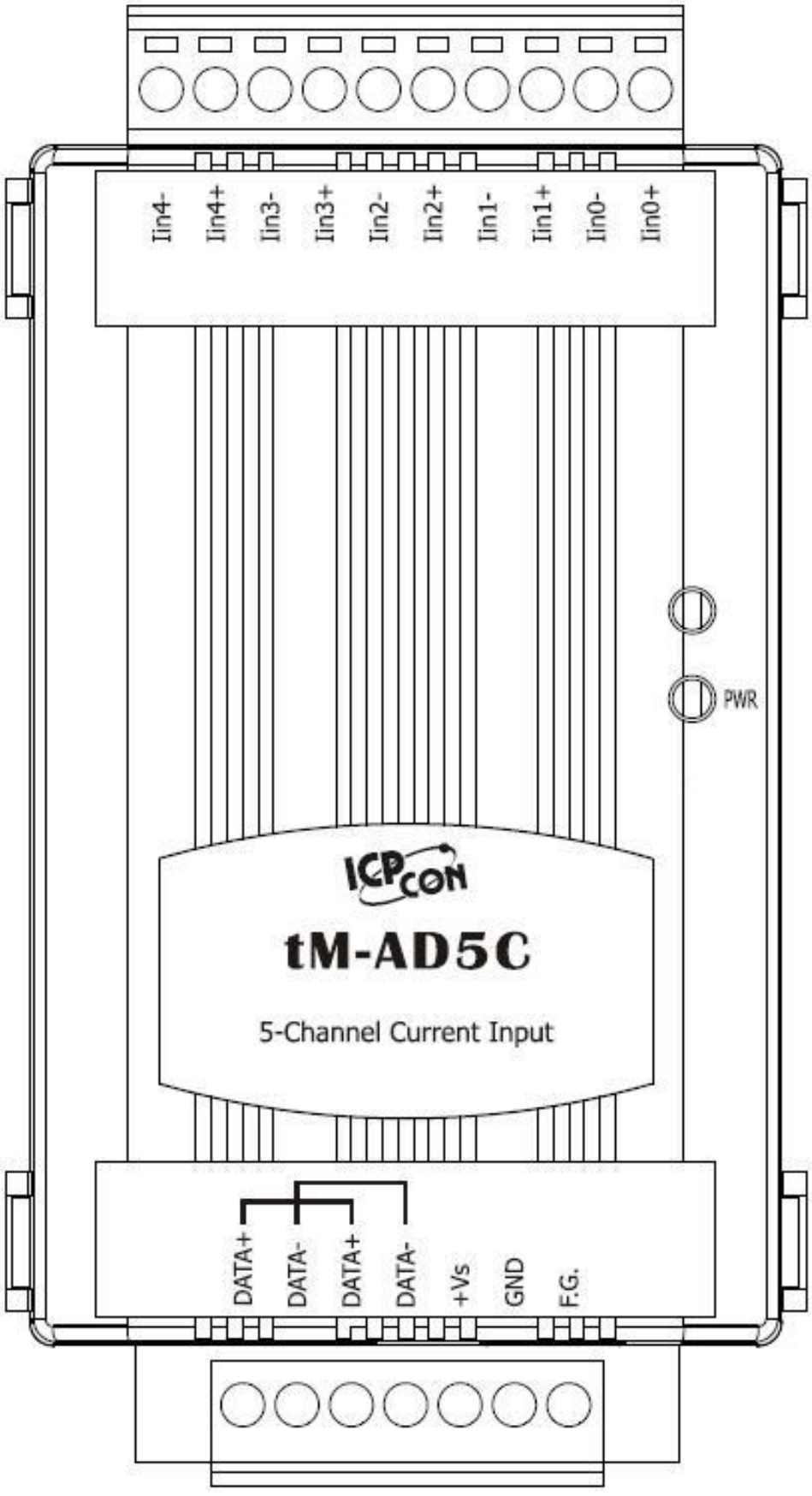



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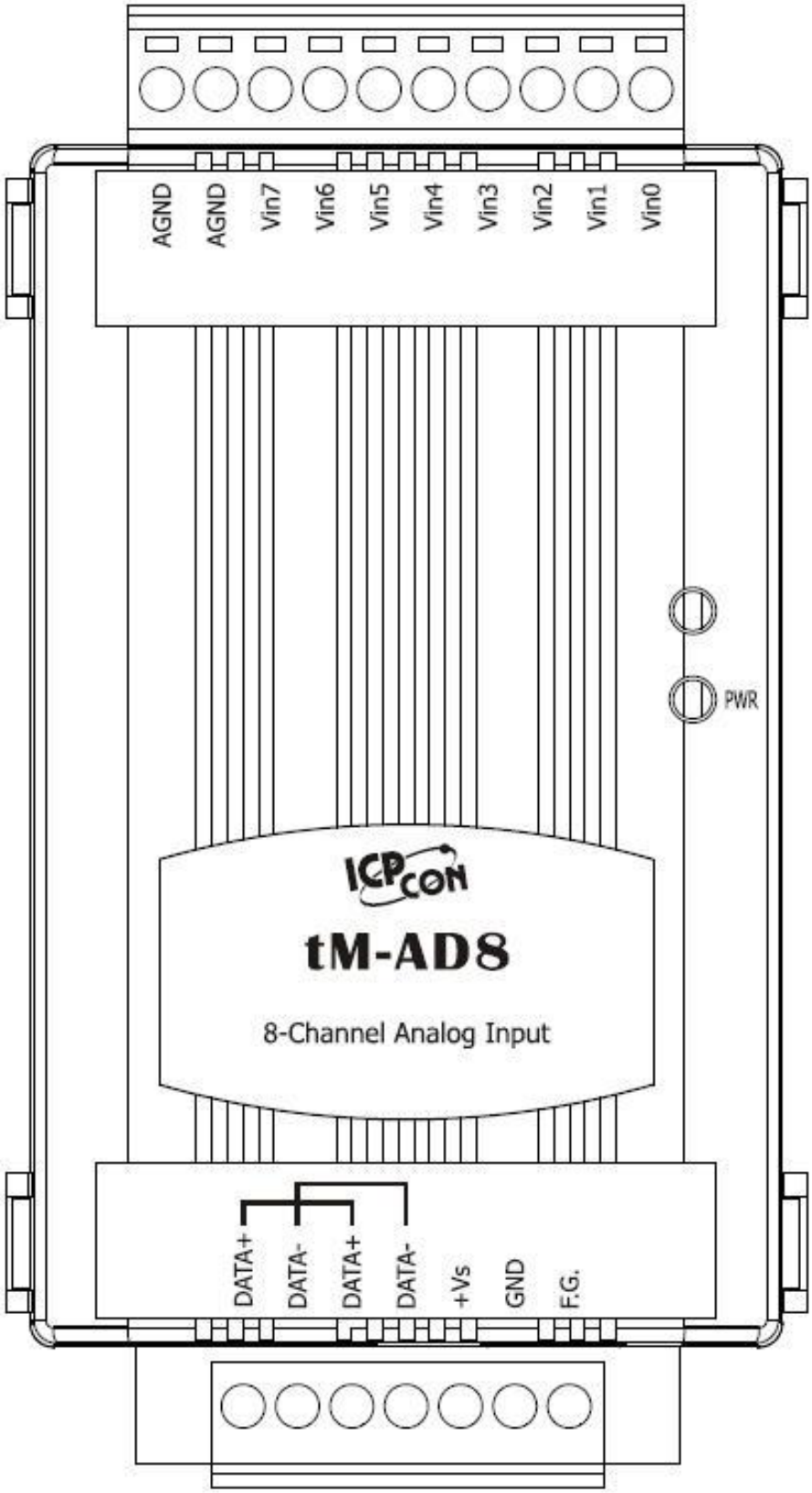



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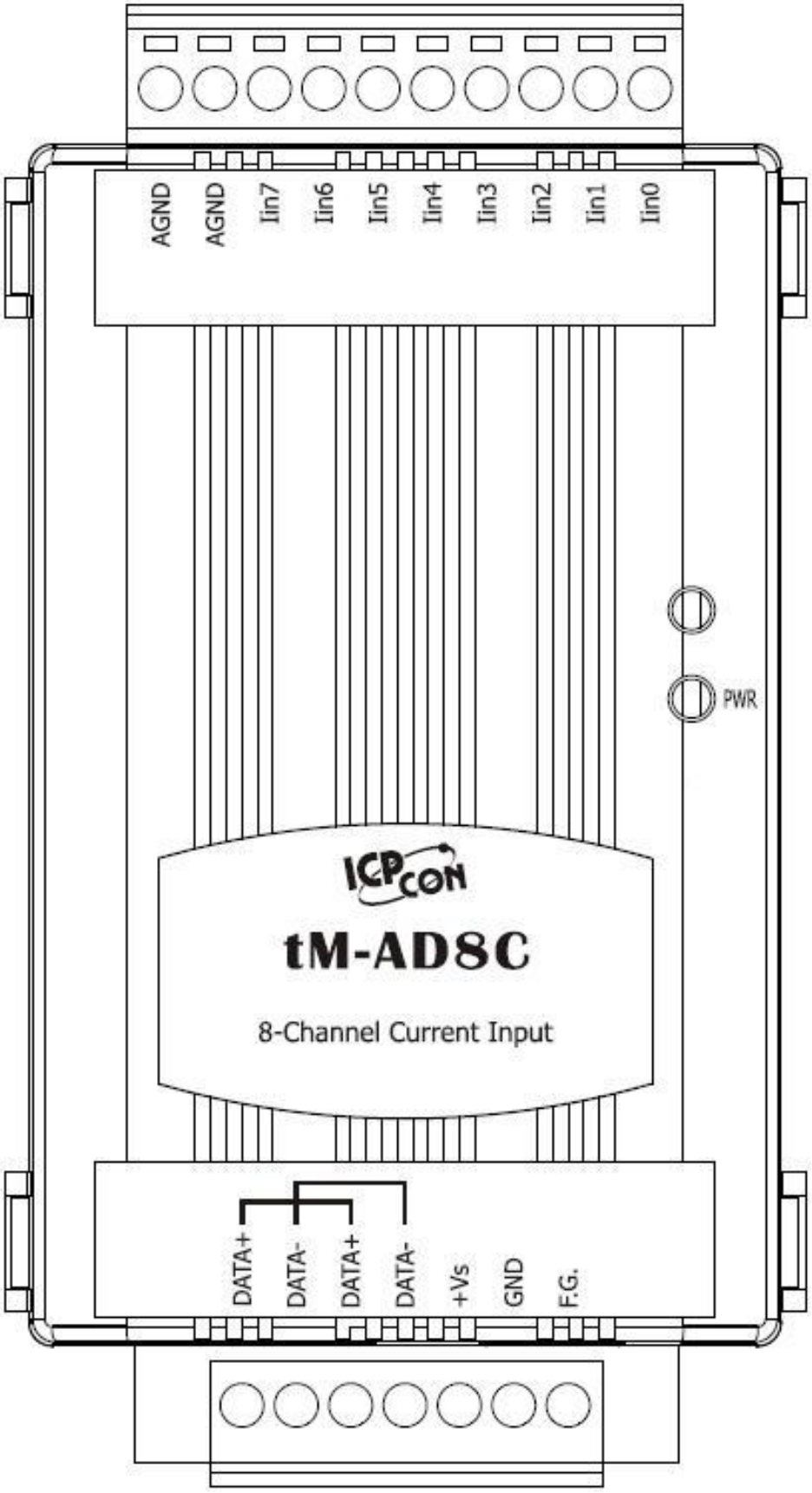



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## 1.3 Specifications

| | **tM-AD2** | |
|---|---|---|
| **Analog Input** | | |
| Input Channels | 2 single-ended | |
| Input Type | 0~500 mV, 0~1 V,<br>0~2.5 V, 0~5 V, 0~10 V,<br>0~20 mA, 4~20 mA | |
| Resolution | 14 bits (normal)<br>12 bits (fast) | |
| Sampling Rate | 10 samples/sec (normal)<br>200 samples/sec (fast) | |
| Accuracy | ±0.1% (normal)<br>±0.5% (fast) | |
| Zero Drift | 20μV/℃ | |
| Span Drift | 25ppm/℃ | |
| Input Impedance | 10MΩ (voltage)<br>125Ω (current) | |
| Voltage overload Protection | ±120VDC | |
| Isolation | 2500V DC | |
| Modbus RTU/ASCII | Yes | |
| **EMS Protection** | | |
| ESD (IEC 61000-4-2) | ±4 kV Contact for Each Terminal<br>±8 kV Air for Random Point | |
| EFT (IEC 61000-4-4) | ±4 kV for Power | |
| **Power** | | |
| Requirement | +10 to +30V DC | |
| Consumption | 0.7W | |
| **Temperature Range** | | |
| Operating | -25℃ to +75℃ | |
| Storage | -30℃ to +75℃ | |

**Note**: A warm up period of 30 minutes is recommended in order to achieve the complete performance results described in the specifications.



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| | tM-AD5 | tM-AD5C |
|---|---|---|
| **Analog Input** | | |
| Input Channels | 5 differential | 5 differential |
| Input Type | +/-1 V, +/-2.5 V, +/-5 V, +/-10 V | 0~20 mA, 4~20 mA, +/-20 mA |
| Resolution | 14 bits (normal)<br>12 bits (fast) | 14 bits (normal)<br>12 bits (fast) |
| Sampling Rate | 10 samples/sec (normal)<br>200 samples/sec (fast) | 10 samples/sec (normal)<br>200 samples/sec (fast) |
| Accuracy | ±0.1% (normal)<br>±0.5% (fast) | ±0.1% (normal)<br>±0.5% (fast) |
| Zero Drift | 20μV/℃ | 20μV/℃ |
| Span Drift | 25ppm/℃ | 25ppm/℃ |
| Input Impedance | 20MΩ | 125Ω |
| Voltage overload Protection | ±120VDC | |
| Isolation | 2500V DC | 2500V DC |
| Modbus RTU/ASCII | Yes | Yes |
| **EMS Protection** | | |
| ESD (IEC 61000-4-2) | ±4 kV Contact for Each Terminal<br>±8 kV Air for Random Point | ±4 kV Contact for Each Terminal<br>±8 kV Air for Random Point |
| EFT (IEC 61000-4-4) | ±4 kV for Power | ±4 kV for Power |
| Surge (IEC 61000-4-5) | ±3 kV for Power | ±3 kV for Power |
| **Power** | | |
| Requirement | +10 to +30V DC | +10 to +30V DC |
| Consumption | 1.0W | 1.0W |
| **Temperature Range** | | |
| Operating | -25℃ to +75℃ | -25℃ to +75℃ |
| Storage | -30℃ to +75℃ | -30℃ to +75℃ |

**Note**: A warm up period of 30 minutes is recommended in order to achieve the complete performance results described in the specifications.



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| | tM-AD8 | tM-AD8C |
|---|---|---|
| **Analog Input** | | |
| Input Channels | 8 single-ended | 8 single-ended |
| Input Type | 0~500 mV, 0~1 V,<br>0~2.5 V, 0~5 V, 0~10 V | 0~20 mA, 4~20 mA |
| Resolution | 14 bits (normal)<br>12 bits (fast) | 14 bits (normal)<br>12 bits (fast) |
| Sampling Rate | 10 samples/sec (normal)<br>200 samples/sec (fast) | 10 samples/sec (normal)<br>200 samples/sec (fast) |
| Accuracy | ±0.1% (normal)<br>±0.5% (fast) | ±0.1% (normal)<br>±0.5% (fast) |
| Zero Drift | 20μV/℃ | 20μV/℃ |
| Span Drift | 25ppm/℃ | 25ppm/℃ |
| Input Impedance | 10MΩ | 125Ω |
| Voltage overload Protection | ±120VDC | |
| Isolation | 2500V DC | 2500V DC |
| Modbus RTU/ASCII | Yes | Yes |
| **EMS Protection** | | |
| ESD (IEC 61000-4-2) | ±4 kV Contact for Each Terminal<br>±8 kV Air for Random Point | ±4 kV Contact for Each Terminal<br>±8 kV Air for Random Point |
| EFT (IEC 61000-4-4) | ±2 kV for Power | ±2 kV for Power |
| Surge (IEC 61000-4-5) | ±3 kV for Power | ±3 kV for Power |
| **Power** | | |
| Requirement | +10 to +30V DC | +10 to +30V DC |
| Consumption | 0.7W | 0.7W |
| **Temperature Range** | | |
| Operating | -25℃ to +75℃ | -25℃ to +75℃ |
| Storage | -30℃ to +75℃ | -30℃ to +75℃ |

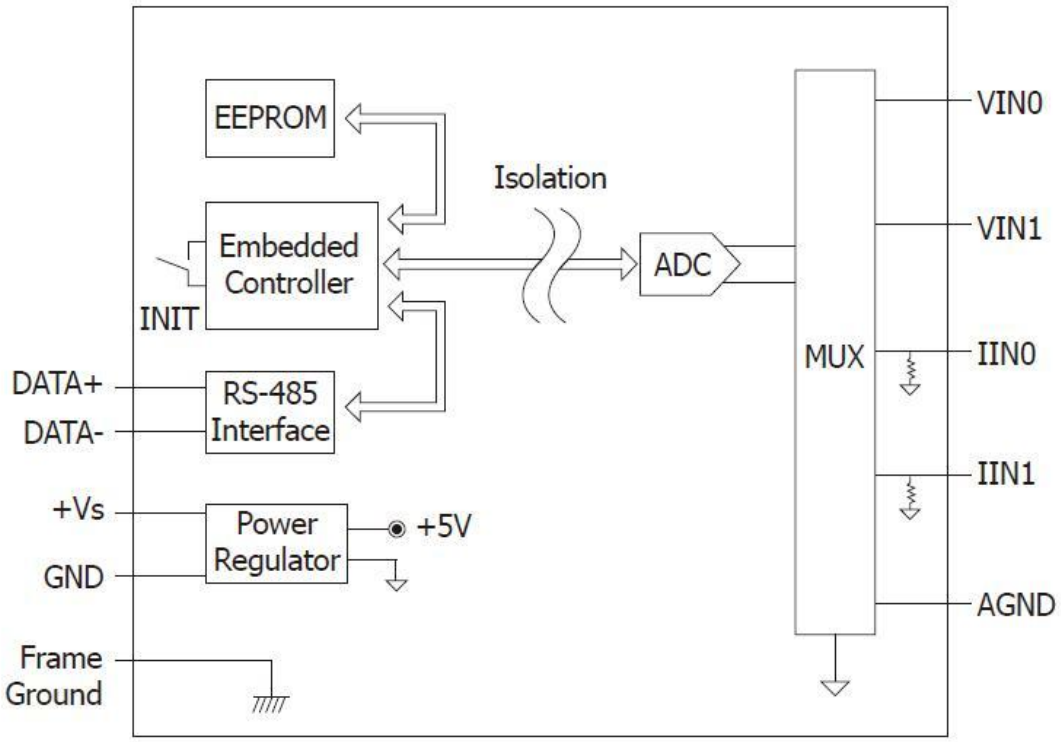
**Note**: A warm up period of 30 minutes is recommended in order to achieve the complete performance results described in the specifications.



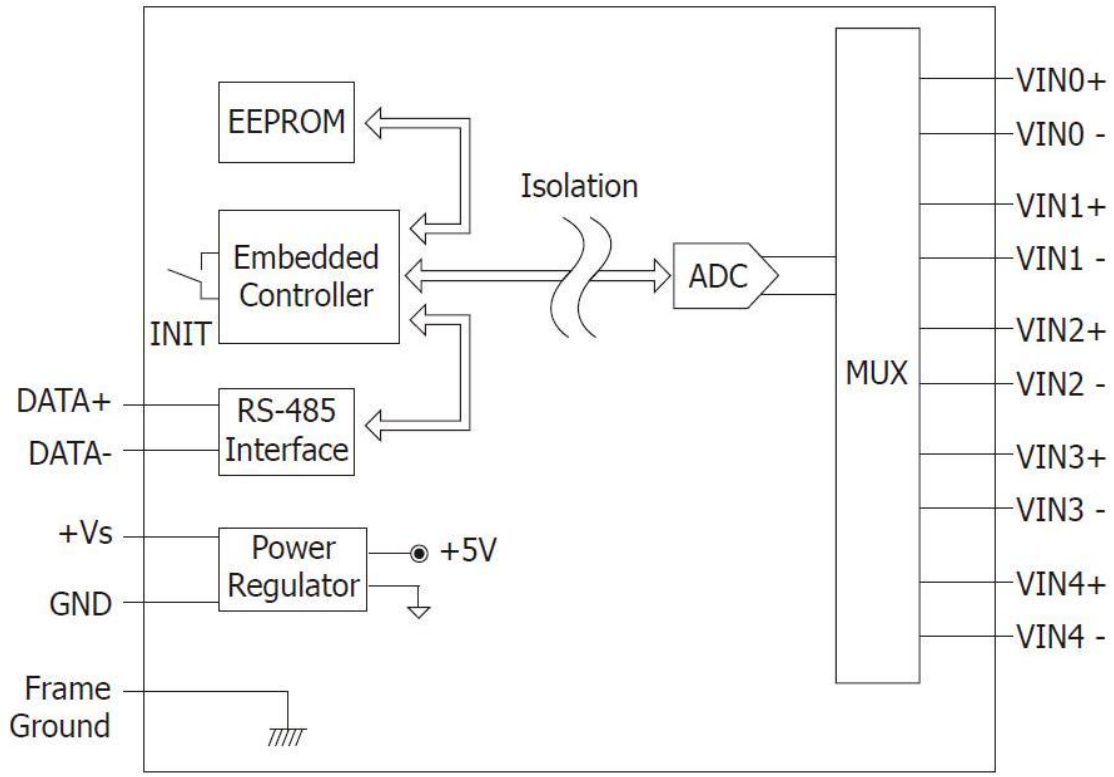
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# 1.4 Block Diagrams

## 1.4.1 Block diagram for the tM-AD2



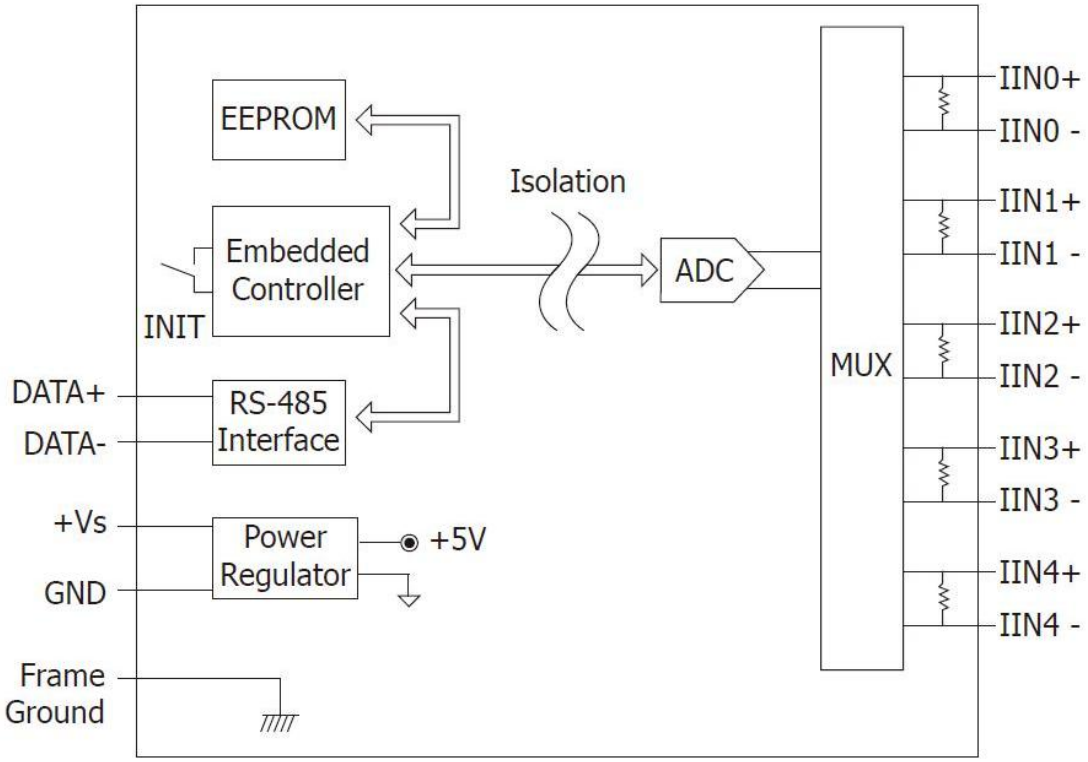

## 1.4.2 Block diagram for the tM-AD5



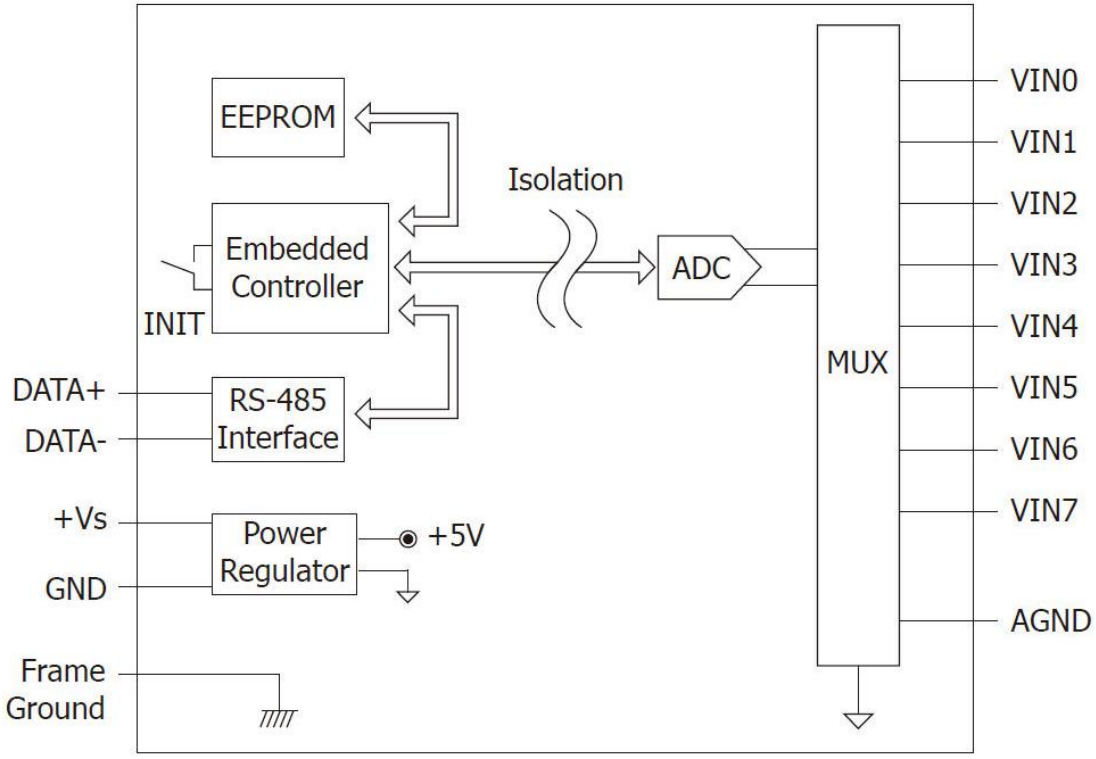



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## 1.4.3 Block diagram for the tM-AD5C



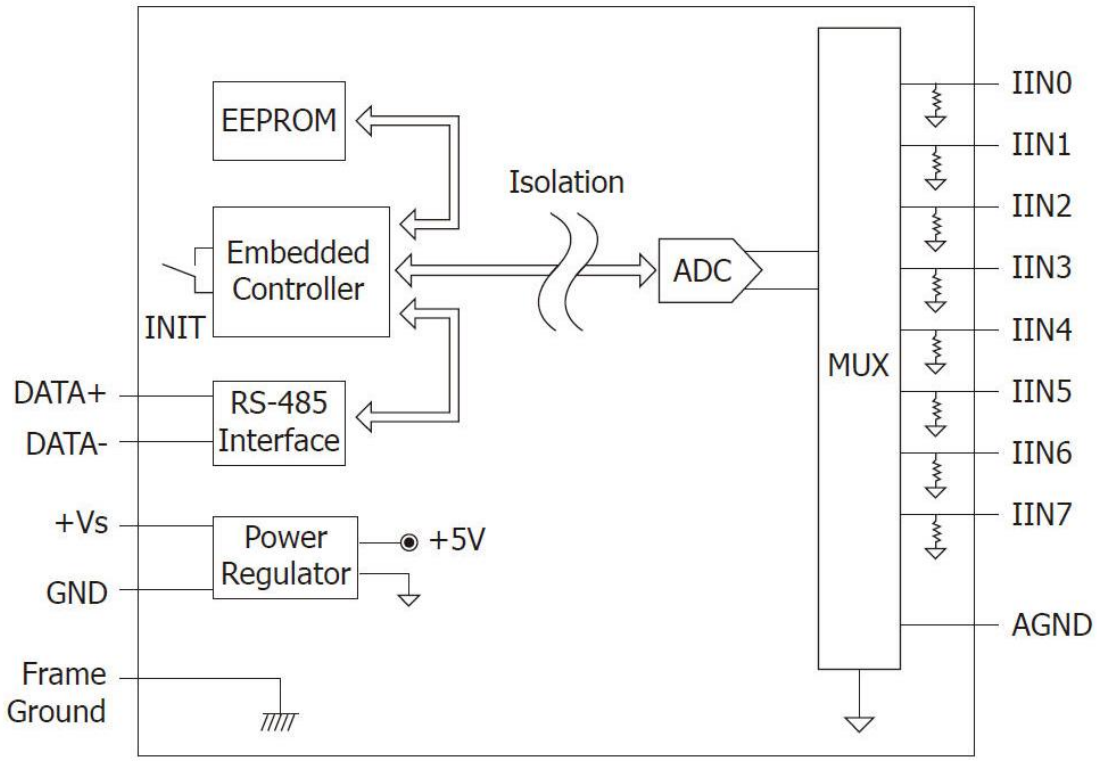

## 1.4.4 Block diagram for the tM-AD8






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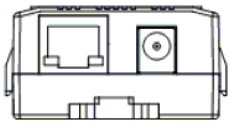
## 1.4.5 Block diagram for the tM-AD8C



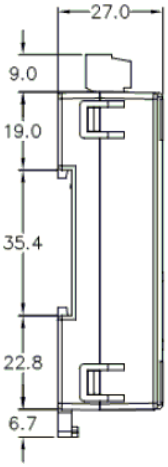



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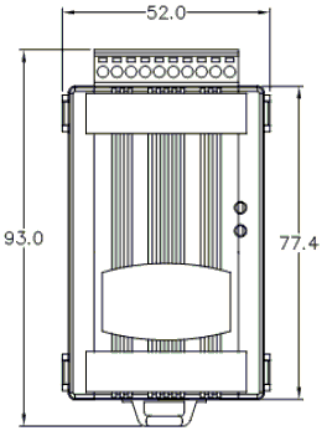
# 1.5 Dimensions



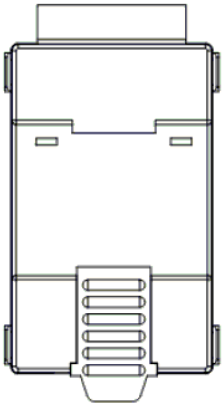
Top View



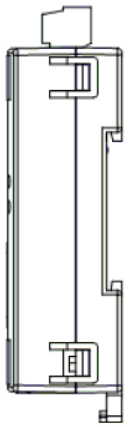

Left Side View



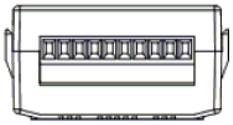

Front View



Back View



Right Side View



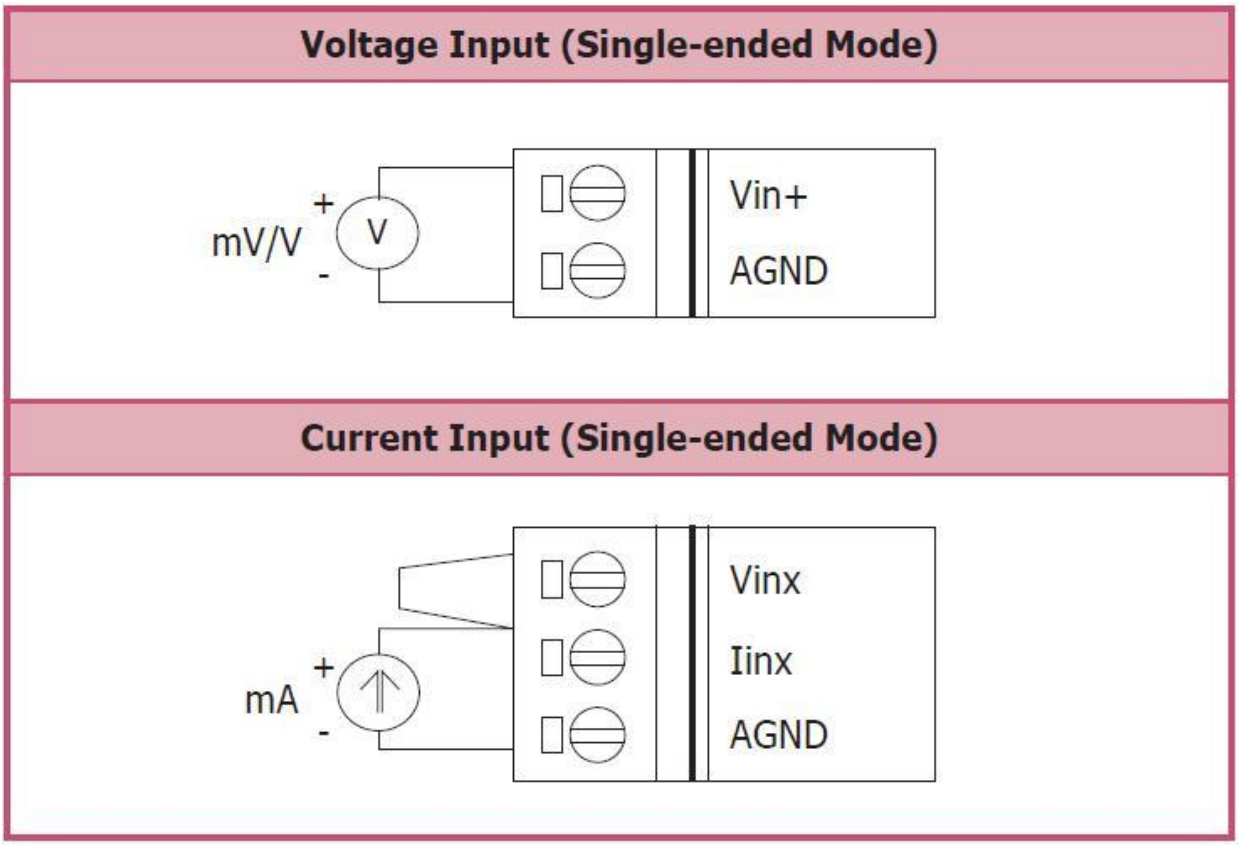
Bottom View



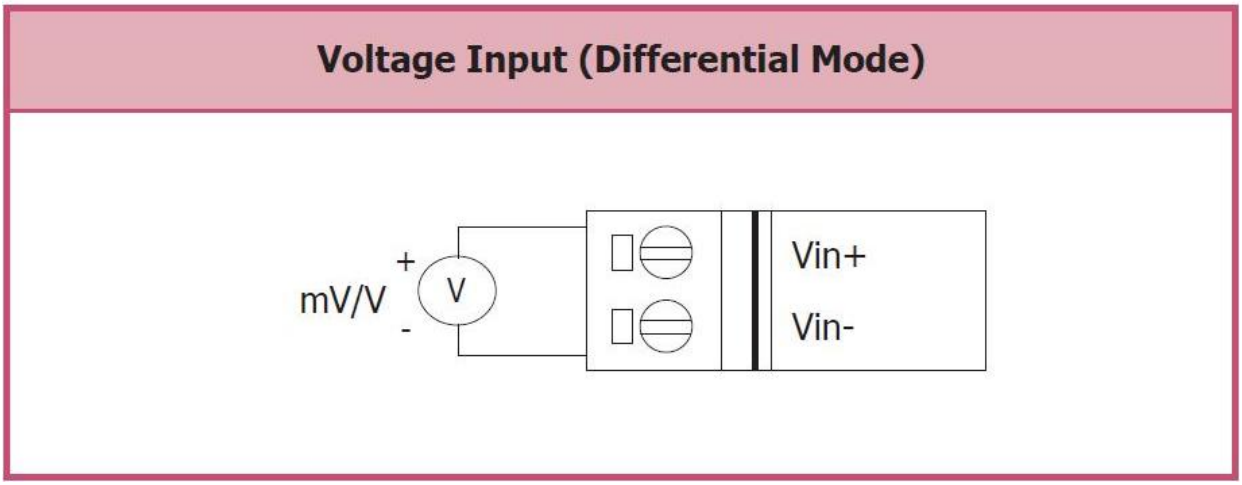
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# 1.6 Wiring Diagrams

## 1.6.1 Wiring diagram for the tM-AD2




## 1.6.2 Wiring diagram for the tM-AD5

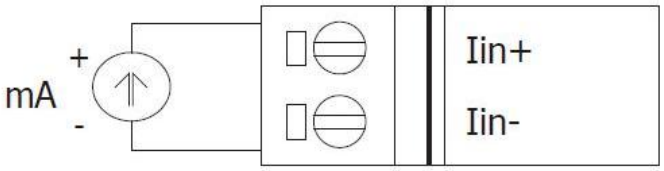





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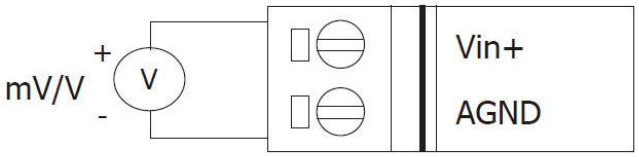
## 1.6.3 Wiring diagram for the tM-AD5C

**Current Input**



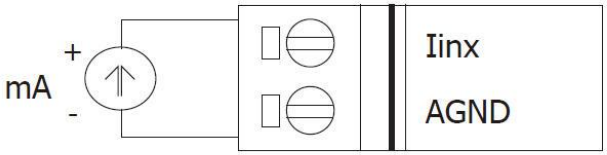

## 1.6.4 Wiring diagram for the tM-AD8

**Voltage Input (Single-ended Mode)**




## 1.6.5 Wiring diagram for the tM-AD8C

**Current Input (Single-ended Mode)**






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### 1.6.6 Wiring Recommendations

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



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## 1.7 Quick Start

Please refer to the Quick Start Guide for tM series AIO.



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## 1.8 Default Settings

Default settings for the tM AD modules are as follows:

- Protocol: Modbus RTU
- Module Address: 01
- Analog Input Type:
  type code 08, -10V to 10V, for tM-AD2, tM-AD5 and tM-AD8
  type code 0D, -20mA to 20mA, for tM-AD5C and tM-AD8C
- Baud Rate: 9600 bps



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## 1.9 Calibration

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

The calibration procedure is as follows:

1. Warm up the module for 30 minutes.
2. Set the type code to the type you want to calibrate. Refer to Sections 2.1 and 2.11 for details.
3. Enable calibration. Refer to Section 2.18 for details.
4. Apply the zero calibration voltage/current.
5. Send the zero calibration command. Refer to Sections 2.5 and 2.7 for details.
6. Apply the span calibration voltage/current.
7. Send the span calibration command. Refer to Sections 2.4 and 2.6 for details.
8. Repeat steps 3 to 7 three times.

**Notes:**

1. Connect the calibration voltage/current to channel 0 for tM-AD5 and tM-AD8 series. For tM-AD2, each channel must be calibrated separately.
2. Calibration voltages and currents are shown below.
3. The modules must be switched to the DCON protocol mode before calibrating. Refer to Section 3.3.4 and 3.4 for details of the switching protocol.



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Calibration voltages/current used by the tM-AD series:

| Type Code | 05 | 08 | 09 | 0A | 0B | 0D |
|---|---|---|---|---|---|---|
| Zero Input | 0V | 0V | 0V | 0V | 0mV | 0mA |
| Span Input | +2.5V | +10V | +5V | +1V | +500mV | +20mA |



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## 1.10 Configuration Tables

### Baud Rate Setting (CC)

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| Data | | Baud | | | | | |

| Key | Description |
|---|---|
| Baud | Baud Rate<br>03: 1200<br>04: 2400<br>05: 4800<br>06: 9600<br>07: 19200<br>08: 38400<br>09: 57600<br>0A: 115200 |
| Data | Data Format<br>0: eight data bits, no parity, and one stop bit<br>1: eight data bits, no parity, and two stop bit<br>2: eight data bits, even parity, and one stop bit<br>3: eight data bits, odd parity, and one stop bit |



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## Analog Input Type Setting (TT)

| Type Code | Analog Input Type | Range | Module |
|---|---|---|---|
| 05 | +/-2.5V | -2.5V ~ 2.5V | tM-AD5 |
| | 0 to +2.5V | 0V ~ 2.5V | tM-AD2, tM-AD8 |
| 06 | +/-20mA | -20mA ~ 20mA | tM-AD5C |
| | 0 to +20mA | 0mA ~ 20mA | tM-AD2, tM-AD8C |
| 07 | +4 to +20mA | 4mA ~ 20mA | tM-AD2, tM-AD5C, tM-AD8C |
| 08 | +/-10V | -10V ~ 10V | tM-AD5 |
| | 0 to +10V | 0V ~ 10V | tM-AD2, tM-AD8 |
| 09 | +/-5V | -5V ~ 5V | tM-AD5 |
| | 0 to +5V | 0V ~ 5V | tM-AD2, tM-AD8 |
| 0A | +/-1V | -1V ~ 1V | tM-AD5 |
| | 0 to +1V | 0V ~ 1V | tM-AD2, tM-AD8 |
| 0B | 0 to +500mV | 0mV ~ 500mV | tM-AD2, tM-AD8 |
| 0D | +/-20mA | -20mA ~ 20mA | tM-AD5C |
| | 0 to +20mA | 0mA ~ 20mA | tM-AD2, tM-AD8C |
| 1A | 0 to +20mA | 0mA ~ 20mA | tM-AD2, tM-AD5C, tM-AD8C |



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## Data Format Setting (FF)

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| RS | CS | MS | RS | | | DF | |

| Key | Description |
|---|---|
| DF | Data format<br>00: Engineering unit<br>01: % of FSR (full scale range)<br>10: 2’s complement hexadecimal |
| MS | Mode setting<br>0: Normal mode (14 bits)<br>1: Fast mode (12 bits) |
| CS | Checksum setting<br>0: Disabled<br>1: Enabled |
| RS | Reserved. |

**Notes**:

1. The reserved bits should be zero.
2. The % of FSR data format is only applicable to the DCON protocol.
3. The checksum setting is only applicable to the DCON protocol.



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# 4. Analog Input Type and Data Format Table

## Notes:

1. The data format of the engineering unit in the following table is for DCON protocol. Refer to Section 3.5 for Modbus protocol.
2. The % of FSR data format is only applicable to the DCON protocol.

| Type Code | Input Type | Data Format | Min. | Max. | Module |
|---|---|---|---|---|---|
| 05 | -2.5 to +2.5V | Engineering unit | -2.5000 | +2.5000 | tM-AD5 |
| | | % of FSR | -100.00 | +100.00 | |
| | | 2's comp HEX | 8000 | 7FFF | |
| | 0 to +2.5V | Engineering unit | +0.0000 | +2.5000 | tM-AD2<br>tM-AD8 |
| | | % of FSR | +000.00 | +100.00 | |
| | | 2's comp HEX | 0000 | 7FFF | |
| 06 | -20 to +20mA | Engineering unit | -20.000 | +20.000 | tM-AD5C |
| | | % of FSR | -100.00 | +100.00 | |
| | | 2's comp HEX | 8000 | 7FFF | |
| | 0 to +20mA | Engineering unit | +00.000 | +20.000 | tM-AD2<br>tM-AD8C |
| | | % of FSR | +000.00 | +100.00 | |
| | | 2's comp HEX | 0000 | 7FFF | |
| 07 | +4 to +20mA | Engineering unit | +04.000 | +20.000 | tM-AD2<br>tM-AD5C<br>tM-AD8C |
| | | % of FSR | +000.00 | +100.00 | |
| | | 2's comp HEX | 0000 | FFFF | |
| 08 | -10 to +10V | Engineering unit | -10.000 | +10.000 | tM-AD5 |
| | | % of FSR | -100.00 | +100.00 | |
| | | 2's comp HEX | 8000 | 7FFF | |
| | 0 to +10V | Engineering unit | +00.000 | +10.000 | tM-AD2<br>tM-AD8 |
| | | % of FSR | +000.00 | +100.00 | |
| | | 2's comp HEX | 0000 | 7FFF | |
| 09 | -5 to +5V | Engineering unit | -5.0000 | +5.0000 | tM-AD5 |
| | | % of FSR | -100.00 | +100.00 | |
| | | 2's comp HEX | 8000 | 7FFF | |
| | 0 to +5V | Engineering unit | +0.0000 | +5.0000 | tM-AD2<br>tM-AD8 |
| | | % of FSR | +000.00 | +100.00 | |
| | | 2's comp HEX | 0000 | 7FFF | |



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| Type Code | Input Type | Data Format | Min. | Max. | Module |
|---|---|---|---|---|---|
| 0A | -1 to +1V | Engineering unit | -1.0000 | +1.0000 | tM-AD5 |
| | | % of FSR | -100.00 | +100.00 | |
| | | 2's comp HEX | 8000 | 7FFF | |
| | 0 to +1V | Engineering unit | +0.0000 | +1.0000 | tM-AD2<br>tM-AD8 |
| | | % of FSR | +000.00 | +100.00 | |
| | | 2's comp HEX | 0000 | 7FFF | |
| 0B | 0 to +500mV | Engineering unit | +000.00 | +500.00 | tM-AD2<br>tM-AD8 |
| | | % of FSR | +000.00 | +100.00 | |
| | | 2's comp HEX | 0000 | 7FFF | |
| 0D | -20 to +20mA | Engineering unit | -20.000 | +20.000 | tM-AD5C |
| | | % of FSR | -100.00 | +100.00 | |
| | | 2's comp HEX | 8000 | 7FFF | |
| | 0 to +20mA | Engineering unit | +00.000 | +20.000 | tM-AD2<br>tM-AD8C |
| | | % of FSR | +000.00 | +100.00 | |
| | | 2's comp HEX | 0000 | 7FFF | |
| 1A | 0 to +20mA | Engineering unit | +00.000 | +20.000 | tM-AD2<br>tM-AD5C<br>tM-AD8C |
| | | % of FSR | +000.00 | +100.00 | |
| | | 2's comp HEX | 0000 | FFFF | |

## 4 ~ 20 mA and 0 ~ 20 mA under range reading with DCON protocol

| | Under Range |
|---|---|
| Engineering Unit | -9999.9 |
| % of FSR | -999.99 |
| 2's Complement HEX | 8000 |

## 4 ~ 20 mA and 0 ~ 20 mA under range reading with Modbus protocol

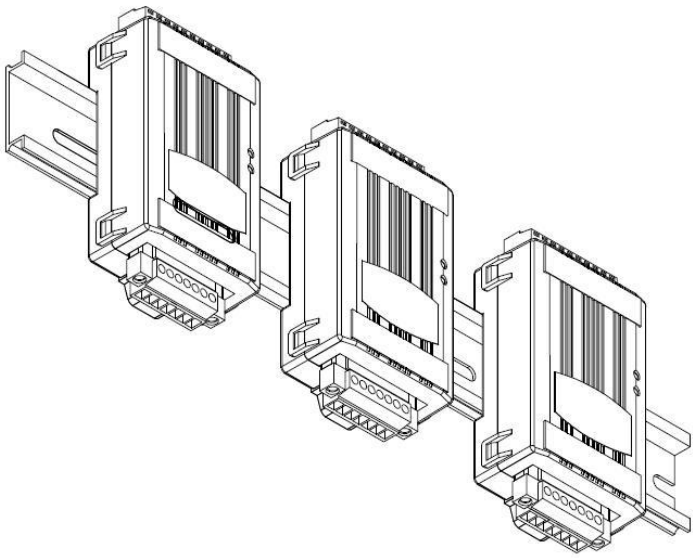
| Under Range |
|---|
| 8000h |



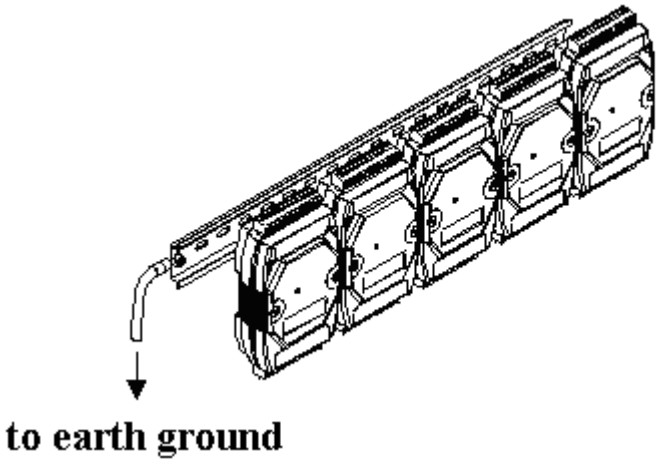
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# 1.11 Mounting

## 1.11.1 DIN Rail Mounting



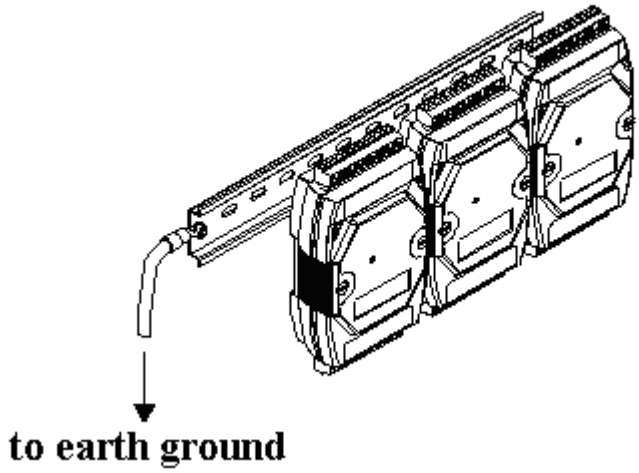
There are three new DIN rail models available. Each are made of stainless steel, which is stronger than those made of aluminum. There is a screw at one end and a ring terminal is included so that it can be easily connected to the earth ground. The three new DIN rail models are as follows.

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

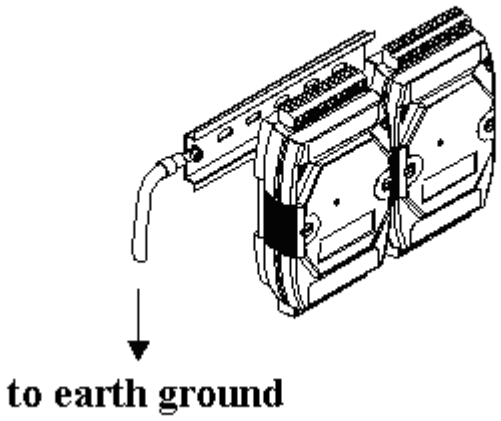


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| DRS-240 | 3 | 240mm x 35mm |
|---|---|---|




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




**Note**: The recommended wire to connect to the earth ground is 16 – 14 AWG wire.



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## 1.12 Technical Support

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

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

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

1. Module name and serial number: The serial number can be found printed on the barcode label attached to the cover of the module.
2. Firmware version: See Section 2.14, 3.3.7, and 3.4 for information regarding the command used to identify the firmware version.
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. Specific error messages displayed. If a dialog box with an error message is displayed, please include the full text of the dialog box, including the text in the title bar.
6. If the problem involves other programs or hardware devices, please describe the details of the problem in full.
7. Any comments and suggestions related to the problem are welcome.

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



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# 2. DCON Protocol

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

## Command Format:

| Leading Character | Module Address | Command | [CHKSUM] | CR |
|---|---|---|---|---|

## Response Format:

| Leading Character | Module Address | Data | [CHKSUM] | CR |
|---|---|---|---|---|

**CHKSUM** A 2-character checksum that is present when the checksum setting is enabled. See Section 1.10 and 2.1 for details.

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



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## Checksum Calculation:

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

## Example:

Command string: $012(CR)

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

Response string: !01200600(CR)

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

## Note:

All characters should be in upper case.



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| General Command Sets | | | |
|---|---|---|---|
| **Command** | **Response** | **Description** | **Section** |
| %AANNTTCCFF | !AA | Set Module Configuration | 2.1 |
| #AA | >(Data) | Reads the Analog Inputs of All Channels | 2.2 |
| #AAN | >(Data) | Reads the Analog Input of the Specified Channel | 2.3 |
| $AA0 | !AA | Performs a Span Calibration | 2.4 |
| $AA1 | !AA | Performs a Zero Calibration | 2.5 |
| $AA0Ci | !AA | Performs a Single Channel Span calibration | 2.6 |
| $AA1Ci | !AA | Performs a Single Channel Zero calibration | 2.7 |
| $AA2 | !AANNTTCCFF | Reads the Module Configuration | 2.8 |
| $AA5VV | !AA | Enables/Disables the Channel | 2.9 |
| $AA6 | !AAVV | Reads the Channel Enable/Disable Status | 2.10 |
| $AA7CiRrr | !AA | Sets a single channel range configuration | 2.11 |
| $AA8Ci | !AACiRrr | Reads a single channel range configuration | 2.12 |
| $AAA | >(data) | Reads the Analog Inputs of All Channels in Hex Format | 2.13 |
| $AAF | !AA(Data) | Reads the Firmware Version | 2.14 |
| $AAM | !AA(Data) | Reads the Module Name | 2.15 |
| $AAP | !AASC | Reads the Protocol | 2.16 |
| $AAPN | !AA | Sets the Protocol | 2.17 |
| ~AAEV | !AA | Enables/Disables the Calibration | 2.18 |
| ~AAO(Name) | !AA | Sets the Module Name | 2.19 |

| Host Watchdog Command Sets | | | |
|---|---|---|---|
| **Command** | **Response** | **Description** | **Section** |
| ~** | No Response | Host OK | 2.20 |
| ~AA0 | !AASS | Reads the Host Watchdog Status | 2.21 |
| ~AA1 | !AA | Resets the Host Watchdog Status | 2.22 |
| ~AA2 | !AAETT | Reads the Host Watchdog Timeout Settings | 2.23 |
| ~AA3ETT | !AA | Sets the Host Watchdog Timeout Settings | 2.24 |



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# 2.1 %AANNTTCCFF

## Description:

Sets the configuration of an analog input module.

## Syntax:

**%AANNTTCCFF[CHKSUM](CR)**

% Delimiter character

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

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

TT New type code, see Section 1.10 for details. Not used by the tM-AD2. For the tM-AD2, use the $AA7CiRrr command to set the type of each channel. see Section 2.11 for details.

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

FF Used to set the data format, checksum, and mode settings (Section 1.10). To change the checksum setting, the right slide switch must be set to the INIT position. See Section A.1 for details.



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## Response:

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

! Delimiter character for a valid response

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

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

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



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## Examples:

Command: %0102000600 Response: !02

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

Command: %0202000602 Response: !02

Set the data format of module 02 to be 2 (2's complement hexadecimal). The module returns a valid response.

Command: %0101000A00 Response: ?01

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

Command: %0101000A00 Response: !01

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

## Related Commands:

Section 2.8 $AA2

## Related Topics:

Section 1.10 Configuration Tables, Section A.1 INIT Mode

## Notes:

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



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## 2.2 #AA

### Description:

Reads the data from every analog input channel.

### Syntax:

**#AA[CHKSUM](CR)**

| | |
|---|---|
| # | Delimiter character |
| AA | Address of the module to be read (00 to FF) |

### Response:

Valid Response: **>(Data)[CHKSUM](CR)**

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

| | |
|---|---|
| > | Delimiter character for a valid response |
| ? | Delimiter character for an invalid response |
| (Data) | Data from every analog input channels, see Section 1.10 for the details of data format |

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



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## Examples:

Command: #01 Response:
>+025.12+020.45+012.78+018.97+003.24+015.35+008.07+014.79

Reads module 01 and receives the data in engineering format.

Command: #02 Response:
>4C532628E2D683A20F2ADBA16284BA71

Reads module 02 and receives the data in hexadecimal format.

Command: #03 Response:
>-9999.9-9999.9-9999.9-9999.9-9999.9-9999.9-9999.9-9999.9

Reads module 03 and the data are under range.

## Related Commands:

Section 2.1 %AANNTTCCFF, Section 2.8 $AA2

## Related Topics:

Section 1.10 Configuration Tables



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## 2.3 #AAN

### Description:

Reads the analog input of channel N.

### 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 Response: **>(Data)[CHKSUM](CR)**

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

| | |
|---|---|
| > | Delimiter character for a valid response |
| ? | Delimiter character for an invalid response. An invalid command is returned if the specified channel is incorrect. |
| (Data) | Analog input data of the specified channel, see Section 1.10 for details of the data format. |
| AA | Address of the responding module (00 to FF) |

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



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## Examples:

Command: #032 Response: >+025.13

Reads data from channel 2 of module 03.

Command: #0511 Response: >+025.13

Reads data from channel 17 of module 05 for an I-7017Z in single-ended mode.

Command: #029 Response: ?02

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

## Related Commands:

Section 2.1 %AANNTTCCFF, Section 2.8 $AA2

## Related Topics:

Section 1.10 Configuration Tables



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## 2.4 $AA0

### Description:
Performs a span calibration.

### Syntax:
**$AA0[CHKSUM](CR)**

| | |
|---|---|
| $ | Delimiter character |
| AA | Address of the module to be calibrated (00 to FF) |
| 0 | Command for the span calibration |

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

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

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



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## Examples:

Command: $010 Response: !01

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

Command: $020 Response: ?02

Performs a span calibration on module 02. An invalid command is returned because the “enable calibration” command was not sent in advance.

## Related Commands:

Section 2.5 $AA1, Section 2.18 ~AAEV

## Related Topics:

Section 1.9 Calibration

## Notes:

1. This command is only applicable to tM-AD5 and tM-AD8.
2. The “enable calibration” command, ~AAEV, must be sent before this command is used, see Section 1.9 for details.



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## 2.5 $AA1

### Description:
Performs a zero calibration.

### Syntax:
**$AA1[CHKSUM](CR)**

| | |
|---|---|
| $ | Delimiter character |
| AA | Address of the module to be set (00 to FF) |
| 1 | Command for the zero calibration |

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

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

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



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## Examples:

Command: $011 Response: !01

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

Command: $021 Response: ?02

Performs a zero calibration on module 02. An invalid command is returned because the "enable calibration" command was not sent in advance.

## Related Commands:

Section 2.4 $AA0, Section 2.18 ~AAEV

## Related Topics:

Section 1.9 Calibration

## Note:

The "enable calibration" command, ~AAEV, must be sent before this command is used, see Section 1.9 for details.



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## 2.6 $AA0Ci

### Description:

Performs a span calibration on the specified channel.

### Syntax:

**$AA0Ci[CHKSUM](CR)**

| | |
|---|---|
| $ | Delimiter character |
| AA | Address of the module to be calibrated (00 to FF) |
| 0 | Command for the span calibration |
| Ci | Specifies the channel to be calibrated |

### Response:

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

| | |
|---|---|
| ! | Delimiter character for a valid response |
| ? | Delimiter character for an invalid response. An invalid command is returned if the specified channel is incorrect. |
| AA | Address of the responding module (00 to FF) |

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



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## Examples:

Command: $010C0 Response: !01

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

Command: $020C5 Response: !02

Performs a span calibration on channel 5 of module 02 and returns a valid response.

Command: $030C1 Response: ?03

Performs a span calibration on channel 1 of module 03. An invalid command is returned because the "enable calibration" command was not sent in advance.

## Related Commands:

Section 2.5 $AA1, Section 2.7 $AA1Ci, Section 2.18 ~AAEV

## Related Topics:

Section 1.9 Calibration

## Notes:

1. This command is only applicable to tM-AD2, tM-AD5C and tM-AD8C.
2. The "enable calibration" command, ~AAEV, must be sent before this command is used, see Section 1.9 for details.



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## 2.7 $AA1Ci

### Description:

Performs a zero calibration on the specified channel.

### Syntax:

**$AA1Ci[CHKSUM](CR)**

| | |
|---|---|
| $ | Delimiter character |
| AA | Address of the module to be calibrated (00 to FF) |
| 1 | Command for the zero calibration |
| Ci | Specifies the channel to be calibrated |

### Response:

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

| | |
|---|---|
| ! | Delimiter character for a valid response |
| ? | Delimiter character for an invalid response. An invalid command is returned if the specified channel is incorrect. |
| AA | Address of the responding module (00 to FF) |

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



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## Examples:

Command: $011C0 Response: !01

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

Command: $021C1 Response: !02

Performs a zero calibration on channel 1 of module 02 and returns a valid response.

Command: $031C1 Response: ?03

Performs a zero calibration on channel 1 of module 03. An invalid command is returned because the "enable calibration" command was not sent in advance.

## Related Commands:

Section 2.6 $AA0Ci, Section 2.18 ~AAEV

## Related Topics:

Section 1.9 Calibration

## Notes:

1. This command is only applicable to tM-AD2.
2. The "enable calibration" command, ~AAEV, must be sent before this command is used, see Section 1.9 for details.



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## 2.8 $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 Response: !AATTCCFF[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) |
| TT | Type code of the module, see Section 1.10 for details. |
| CC | Baud Rate code of the module, see Section 1.10 for details. |
| FF | Data format, checksum settings and mode settings of the module, see Section 1.10 for details. |

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



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## Examples:

Command: $012 Response: !01050600

Reads the configuration of module 01.

Command: $022 Response: !02030602

Reads the configuration of module 02.

## Related Commands:

Section 2.1 %AANNTTCCFF

## Related Topics:

Section 1.10 Configuration Tables, Section A.1 INIT Mode



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## 2.9 $AA5VV

### Description:

Specifies the channel(s) to be enabled.

### Syntax:

**$AA5VV(VV)[CHKSUM](CR)**

| | |
|---|---|
| $ | Delimiter character |
| AA | Address of the module to be set (00 to FF) |
| 5 | Command to set the channel(s) to enabled |
| VV | 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 means that the channel is enabled and 0 means that the channel is disabled. |

### Response:

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

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

| | |
|---|---|
| ! | Delimiter character for a valid response |
| ? | Delimiter character for an invalid response. An invalid command is returned if an attempt is made to enable a channel that is not present. |
| AA | Address of the responding module (00 to FF) |



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

## Examples:

Command: $0153A Response: !01

Enables channels 1, 3, 4, and 5 and disables all other channels of module 01. The module returns a valid response.

Command: $016 Response: !013A

Reads the channel status of module 01 and returns a response of 3A, meaning that channels 1, 3, 4, and 5 are enabled and all other channels are disabled.

## Related Commands:

Section 2.10 $AA6

## Note:

1. It is recommended that only the channels that will be used are enabled.



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## 2.10 $AA6

### Description:

Reads the enabled/disabled status of each channel.

### Syntax:

**$AA6[CHKSUM](CR)**

| | |
|---|---|
| $ | Delimiter character |
| AA | Address of the module to be read (00 to FF) |
| 6 | Command to read the channel status |

### Response:

Valid Response: **!AAVV(VV)[CHKSUM](CR)**

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

| | |
|---|---|
| ! | Delimiter character for a valid response |
| ? | Delimiter character for an invalid response |
| AA | Address of the responding module (00 to FF) |
| VV | 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 means that the channel is enabled and 0 means that the channel is disabled. |

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



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## Examples:

Command: $0153A Response: !01

Enables channels 1, 3, 4, and 5 and disables all other channels of module 01. The module returns a valid response.

Command: $016 Response: !013A

Reads the channel status of module 01 and returns a response of 3A, meaning that channels 1, 3, 4, and 5 are enabled and all other channels are disabled.

## Related Commands:

Section 2.9 $AA5VV



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## 2.11 $AA7CiRrr

### Description:

Sets the type code of a channel.

### Syntax:

**$AA7CiRrr[CHKSUM](CR)**

| | |
|---|---|
| $ | Delimiter character |
| AA | Address of the module to be set (00 to FF) |
| 7 | Command to set the channel range code |
| Ci | i specifies the input channel to be set (0-1 for tM-AD2). |
| Rrr | rr represents the type code of the channel to be set. Refer to the Analog Input Type Setting table in Section 1.10 for details. |

### Response:

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

| | |
|---|---|
| ! | Delimiter character for a valid response |
| ? | Delimiter character for an invalid response or invalid type code |



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

## Examples:

Command: $017C0R0A Response: !01

Sets the type code for channel 0 of module 01 to be 0A (-1 ~ +1V) and the module returns a valid response.

Command: $037C1R30 Response: ?03

Sets the type code for channel 1 of module 03 to be 30. The module returns an invalid response because the type code is invalid.

## Related Commands:

Section 2.12 $AA8Ci

## Related Topics:

Section 1.10 Configuration Tables



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## 2.12 $AA8Ci

### Description:

Reads the type code information of a channel.

### Syntax:

**$AA8Ci[CHKSUM](CR)**

| | |
|---|---|
| $ | Delimiter character |
| AA | Address of the module to be read (00 to FF) |
| 8 | Command to read the type code of a channel |
| Ci | Specifies which channel to access for the type code information (i=0-1 for tM-AD2). |

### Response:

Valid Response: !AACiRrr[CHKSUM](CR)

Invalid Response: ?AA[CHKSUM](CR)

| | |
|---|---|
| ! | Delimiter character for a valid response |
| ? | Delimiter character for an invalid response or invalid channel |
| AA | Address of the responding module (00 to FF) |
| Ci | Specifies which input channel to access to retrieve the type code information. |
| Rrr | Represents the type code of the specified input channel. Refer to the Analog Input Type Setting table in Section 1.10 for details. |



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

## Examples:

Command: $018C0 Response: !01C0R0A

Reads the channel 0 input range of module 01 and returns 0A (-1 ~ +1V).

## Related Commands:

Section 2.11 $AA7CiRrr

## Related Topics:

Section 1.10 Configuration Tables



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## 2.13 $AAA

### Description:

Reads the data from every analog input channel in hex format.

### Syntax:

**$AAA[CHKSUM](CR)**

| | |
|---|---|
| $ | Delimiter character |
| AA | Address of the module to be read (00 to FF) |
| A | Command to read every analog input |

### Response:

Valid Response: **>(Data)[CHKSUM](CR)**

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

| | |
|---|---|
| > | Delimiter character for a valid response |
| ? | Delimiter character for an invalid response |
| (Data) | Data from every analog input channels in hex format. |

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



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## Examples:

Command: $01A

Response: >0000012301257FFF1802744F98238124

Reads module 01 and receives the data in hex format.

## Related Commands:

Section 2.2 #AA



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## 2.14 $AAF

### Description:

Reads the firmware version of a module.

### Syntax:

**$AAF[CHKSUM](CR)**

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

### Response:

Valid Response: **!AA(Data)[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) |
| (Data) | A string indicating the firmware version of the module |

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

### Examples:

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

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



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## 2.15 $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 Response: !AA(Name)[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) |
| (Name) | A string showing the name 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.



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## Examples:

Command: $01M Response: !017018

Reads the module name of module 01 and returns the name "7018".

## Related Commands:

Section 2.19 ~AAO(Name)



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## 2.16 $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<br>0: only DCON protocol is supported<br>1: both the DCON and Modbus RTU protocols are supported<br>3: all of the DCON and Modbus RTU/ASCII protocols are supported |
| C | Current protocol saved in EEPROM that will be used at the next power on reset<br>0: the protocol set in EEPROM is DCON<br>1: the protocol set in EEPROM is Modbus RTU<br>3: the protocol set in the EEPROM is Modbus ASCII |



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

## Examples:

Command: $01P Response: !0110

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

## Related Commands:

Section 2.17 $AAPN



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## 2.17 $AAPN

### Description:

Sets the communication protocol.

### Syntax:

$AAPN[CHKSUM](CR)

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

### Response:

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

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

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



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## Examples:

Command: $01P1 Response: ?01

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

Command: $01P1 Response: !01

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

## Related Commands:

Section 2.16 $AAP

## Related Topics:

Section A.1 INIT Mode



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## 2.18 ~AAEV

### Description:

Enable/Disable module calibration.

### Syntax:

**~AAEV[CHKSUM](CR)**

| | |
|---|---|
| ~ | Delimiter character |
| AA | Address of the module to be set (00 to FF) |
| E | Command to enable/disable calibration |
| V | 1: enable calibration<br>0: disable calibration |

### Response:

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

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

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

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



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## Examples:

Command: $010 Response: ?01

Sends the command to perform a span calibration on module 01. It returns an invalid response because the "enable calibration" command was not sent in advance.

Command: ~01E1 Response: !01

Enables calibration on module 01 and returns a valid response.

Command: $010 Response: !01

Sends the command to perform a span calibration on module 01 and returns a valid response.

## Related Commands:

Section 2.4 $AA0, Section 2.5 $AA1, Section 2.6 $AA0Ci, Section 2.7 $AA1Ci

## Related Topics:

Section 1.9 Calibration



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## 2.19 ~AAO(Name)

### Description:

Sets the name of a module.

### Syntax:

**~AAO(Name)[CHKSUM](CR)**

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

### Response:

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

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

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

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



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## Examples:

Command: ~01O7019A Response: !01

Sets the name of module 01 to be “7019A” and returns a valid response.

Command: $01M Response: !017019A

Reads the name of module 01 and returns “7019A”.

## Related Commands:

Section 2.15 $AAM



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## 2.20 ~**

### Description:
Informs all modules that the host is OK.

### Syntax:
**~**[CHKSUM](CR)**
~ Delimiter character
** Host OK command

### Response:
No response.

### Examples:
Command: ~** No response
Sends a “Host OK” command to all modules.

### Related Commands:
Section 2.21 ~AA0, Section 2.22 ~AA1, Section 2.23 ~AA2, Section 2.24 ~AA3EVV

### Related Topics:
Section A.2 Dual Watchdog Operation

### Note:
After sending this command, there must be a 2ms delay before the next command can be sent.



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## 2.21 ~AA0

### Description:

Reads the host watchdog status of a module.

### Syntax:

**~AA0[CHKSUM](CR)**

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

### Response:

Valid Response: **!AASS[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) |
| SS | Two hexadecimal digits that represent the host watchdog status, where:<br>Bit 7: 0 indicates that the host watchdog is disabled and 1 indicates the host watchdog is enabled,<br>Bit 2: 1 indicates that a host watchdog time out has occurred and 0 indicates that no host watchdog time out has occurred.<br>The host watchdog status is stored in EEPROM and can only be reset using the ~AA1 command. |



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

## Examples:

Command: ~010 Response: !0100

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

Command: ~020 Response: !0204

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

## Related Commands:

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

## Related Topics:

Section A.2 Dual Watchdog Operation



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## 2.22 ~AA1

### Description:

Resets the host watchdog time out status of a module.

### Syntax:

**~AA1[CHKSUM](CR)**

| | |
|---|---|
| ~ | Delimiter character |
| AA | Address of the module to be set (00 to FF) |
| 1 | Command to reset the host watchdog time out status |

### Response:

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

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

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

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



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## Examples:

Command: ~010 Response: !0104

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

Command: ~011 Response: !01

Resets the host watchdog time out 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 time out has occurred.

## Related Commands:

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

## Related Topics:

Section A.2 Dual Watchdog Operation



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## 2.23 ~AA2

### Description:

Reads the host watchdog time out 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 time out value |

### Response:

Valid Response: **!AAEVV[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) |
| E | 1: the host watchdog is enabled<br>0: the host watchdog is disabled |
| VV | Two hexadecimal digits to represent the time out value in tenths of a second, for example, 01 means 0.1 seconds and FF means 25.5 seconds. |

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



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## Examples:

Command: ~012 Response: !011FF

Reads the host watchdog time out value of module 01 and returns FF, meaning that the host watchdog is enabled and the host watchdog time out value is 25.5 seconds.

## Related Commands:

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

## Related Topics:

Section A.2 Dual Watchdog Operation



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## 2.24 ~AA3EVV

### Description:

Enables/disables the host watchdog and set the host watchdog time out value of a module.

### Syntax:

**~AA3EVV[CHKSUM](CR)**

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

### Response:

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

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

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

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



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## Examples:

Command: ~013164 Response: !01

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

Command: ~012 Response: !01164

Reads the host watchdog time out value of module 01. The module returns 164, meaning that the host watchdog is enabled and the host watchdog time out value is 10.0 seconds.

## Related Commands:

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

## Related Topics:

Section A.2 Dual Watchdog Operation



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## 2.25 ~AARD

### Description:

Reads the response delay time value of a module.

### Syntax:

~AARD[CHKSUM](CR)

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

### Response:

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

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

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



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## Examples:

Command: ~01RD Response: !0102

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

## Related Commands:

Section 2.26 ~AARDVV



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## 2.26 ~AARDVV

### Description:

Sets the response delay time value of a module.

### Syntax:

~AARDVV[CHKSUM](CR)

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

### Response:

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

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

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



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## Examples:

Command: ~01RD06 Response: !01

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

Command: ~01RD Response: !0106

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

## Related Commands:

Section 2.25 ~AARD



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# 3. Modbus Protocol

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

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

| Function Code | Description | Section |
|---|---|---|
| 02 (0x02) | Read input status | 3.1 |
| 04 (0x04) | Read input channels | 3.2 |
| 70 (0x46) | Read/write module settings | 3.3 |

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

**Error Response**

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

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



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# 3.1 02 (0x02) Read Input Status

This function code is used to read the open wire status of a module in the current input type.

## Request

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x02 |
| 02 ~ 03 | Starting channel | 2 Bytes | 0x80 to 0x87 (0x81 for tM-AD2, and 0x84 for tM-AD5C), where 0x80 corresponds to channel 0, 0x81 corresponds to channel 1, etc |
| 04 ~ 05 | Number of input channels | 2 Bytes | N, 1 to 8 (2 for tM-AD2 and 5 for tM-AD5C); (Starting channel + N) should be less than or equal to 0x88 (0x82 for tM-AD2 and 0x85 for tM-AD5C) |

**Note:** This function is only available on tM-AD2, tM-AD5C and tM-AD8C.

## 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 enabled and is either over-range, under-range or wire opening. If the bit is 0 it denotes that the channel is disabled or normal. |

## 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<br>03: (starting channel + number of input channels) out of range, incorrect number of bytes received |



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## 3.2 04 (0x04) Read Input Channels

This function code is used to read from contiguous analog input channels.

### Request

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x04 |
| 02 ~ 03 | Starting channel | 2 Bytes | 0 to 7 (1 for tM-AD2 and 4 for tM-AD5 and tM-AD5C) for reading analog inputs |
| 04 ~ 05 | Number of input channels (N) | 2 Bytes | 1 to 8 (2 for tM-AD2 and 5 for tM-AD5 and tM-AD5C); (Starting channel + N) <= 8 (2 for tM-AD2 and 5 for tM-AD5 and tM-AD5C) for reading analog inputs. |

### 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 | |

### 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<br>03: (starting channel + number of input channels) out of range, incorrect number of bytes received |



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## 3.3 70 (0x46) Read/Write Module Settings

This function code is used to read the settings of the module or change the settings of the module. The following sub-function codes are supported.

| Sub-function Code | Description | Section |
|---|---|---|
| 00 (0x00) | Read the module name | 3.3.1 |
| 04 (0x04) | Set the module address | 3.3.2 |
| 05 (0x05) | Read the communication settings | 3.3.3 |
| 06 (0x06) | Set the communication settings | 3.3.4 |
| 07 (0x07) | Read the type code | 3.3.5 |
| 08 (0x08) | Set the type code | 3.3.6 |
| 32 (0x20) | Read the firmware version | 3.3.7 |
| 37 (0x25) | Read the channel enable/disable status | 3.3.8 |
| 38 (0x26) | Set the channel enable/disable | 3.3.9 |
| 41 (0x29) | Read the miscellaneous settings | 3.3.10 |
| 42 (0x2A) | Write the miscellaneous settings | 3.3.11 |

If the module does not support the sub-function code specified in the message, then it responds as follows.

**Error Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0xC6 |
| 02 | Exception code | 1 Byte | 02: invalid sub-function code |



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## 3.3.1 Sub-function 00 (0x00) Read module name

This sub-function code is used to read the name of a module.

**Request**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x00 |

**Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x00 |
| 03 ~ 06 | Module name | 4 Bytes | 0x07 0x00 0x20 0x01 for tM-AD2<br>0x07 0x00 0x50 0x01 for tM-AD5<br>0x07 0x00 0x50 0x02 for tM-AD5C<br>0x07 0x00 0x80 0x01 for tM-AD8<br>0x07 0x00 0x80 0x02 for tM-AD8C |

**Error Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0xC6 |
| 02 | Exception code | 1 Byte | 03: incorrect number of bytes received |



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## 3.3.2 Sub-function 04 (0x04) Set module address

This sub-function code is used to set the address of a module.

**Request**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x04 |
| 03 | New address | 1 Byte | 1 to 247 |
| 04 ~ 06 | Reserved | 3 Bytes | 0x00 0x00 0x00 |

**Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x04 |
| 03 | Set address result | 1 Byte | 0: OK,<br>others: error |
| 04 ~ 06 | Reserved | 3 Bytes | 0x00 0x00 0x00 |

**Error Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0xC6 |
| 02 | Exception code | 1 Byte | 03: new address out of range, reserved bytes should be filled with zero, incorrect number of bytes received |



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## 3.3.3 Sub-function 05 (0x05) Read communication settings

This sub-function code is used to read the communication protocol settings of a module.

**Request**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x05 |
| 03 | Reserved | 1 Byte | 0x00 |

**Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x05 |
| 03 | Protocol supported | 1 Byte | 0x00: Modbus RTU<br>0x03: Modbus RTU & ASCII |
| 04 | Baud Rate | 1 Byte | Baud Rate code, see Section 1.10 for details. |
| 05 | Reserved | 1 Bytes | 0x00 |
| 06 | Data format | 1 Byte | 0x00: no parity, 1 stop bit<br>0x01: no parity, 2 stop bits<br>0x02: even parity, 1 stop bit<br>0x03: odd parity, 1 stop bit |
| 07 | Reserved | 1 Bytes | 0x00 |
| 08 | Mode | 1 Byte | 0x00: DCON protocol<br>0x01: Modubs RTU protocol<br>0x03: Modbus ASCII protocol |
| 09 ~ 10 | Reserved | 2 Bytes | 0x00 0x00 |

**Note**: This information is the data saved in the EEPROM and will be used for the next power-on reset. It is not the currently used settings.

**Error Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0xC6 |
| 02 | Exception code | 1 Byte | 03: reserved byte should be filled with zero, incorrect number of bytes received |



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## 3.3.4 Sub-function 06 (0x06) Set communication settings

This sub-function code is used to set the communication protocol of a module.

**Request**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x06 |
| 03 | Reserved | 1 Byte | 0x00 |
| 04 | Baud Rate | 1 Byte | Baud Rate code, see Section 1.10 for details. |
| 05 | Reserved | 1 Byte | 0x00 |
| 06 | Data format | 1 Byte | 0x00: no parity, 1 stop bit<br>0x01: no parity, 2 stop bits<br>0x02: even parity, 1 stop bit<br>0x03: odd parity, 1 stop bit |
| 07 | Reserved | 1 Byte | 0x00 |
| 08 | Mode | 1 Byte | 0x00: DCON protocol<br>0x01: Modubs RTU protocol<br>0x03: Modubs ASCII protocol |
| 09 ~ 10 | Reserved | 2 Bytes | 0x00 0x00 |



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## Response

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x06 |
| 03 | Reserved | 1 Byte | 0x00 |
| 04 | Baud Rate | 1 Byte | 0x00: OK, others: error |
| 05 | Reserved | 1 Byte | 0x00 0x00 0x00 |
| 06 | Data format | 1 Byte | 0x00: OK,<br>others: error |
| 07 | Reserved | 1 Byte | 0x00 |
| 08 | Mode | 1 Byte | 0x00: OK, others: error |
| 09 ~ 10 | Reserved | 2 Bytes | 0x00 0x00 |

**Note**: The new Baud Rate and protocol will be effective after the next power-on reset.

## Error Response

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0xC6 |
| 02 | Exception code | 1 Byte | 03: Baud Rate or mode out of range, reserved bytes should be filled with zero, incorrect number of bytes received |



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## 3.3.5 Sub-function 07 (0x07) Read type code

This sub-function code is used to read the type code information of a module.

**Request**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x07 |
| 03 | Reserved | 1 Bytes | 0x00 |
| 04 | Reserved | 1 Byte | 0x00, channel for tM-AD2 |

**Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x07 |
| 03 | Type code | 1 Byte | Type code, see Section 1.10 for details. |

**Error Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0xC6 |
| 02 | Exception code | 1 Byte | 03: reserved bytes should be filled with zero |



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## 3.3.6 Sub-function 08 (0x08) Set type code

This sub-function code is used to set the type code of a module.

**Request**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x08 |
| 03 | Reserved | 1 Byte | 0x00 |
| 04 | Reserved | 1 Byte | 0x00, channel for tM-AD2 |
| 05 | Type code | 1 Byte | Type code, see Section 1.10 for details. |

**Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x08 |
| 03 | Type code | 1 Byte | 0x00: OK<br>others: error |

**Error Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0xC6 |
| 02 | Exception code | 1 Byte | 03: type code out of range, reserved bytes should be filled with zero, incorrect number of bytes received |



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## 3.3.7 Sub-function 32 (0x20) Read firmware version

This sub-function code is used to read the firmware version information of a module.

**Request**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x20 |

**Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x20 |
| 03 | Major version | 1 Byte | 0x00 ~ 0xFF |
| 04 | Minor version | 1 Byte | 0x00 ~ 0xFF |
| 05 | Build version | 1 Byte | 0x00 ~ 0xFF |

**Error Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0xC6 |
| 02 | Exception code | 1 Byte | 03: incorrect number of bytes received |



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## 3.3.8 Sub-function 37 (0x25) Read channel enabled/disabled status

This sub-function code is used to read the enabled/disabled status of each channel in a module.

**Request**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x25 |

**Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x25 |
| 03 | Enabled/disabled status | 1 Byte | 0x00 ~ 0xFF, enabled/disabled status of each channel, where bit 0 corresponds to channel 0, bit 1 corresponds to channel 1, etc. When the bit is 1 it denotes that the channel is enabled and 0 denotes that the channel is disabled.<br>0x00 ~ 0x03 for tM-AD2<br>0x00 ~ 0x01F for tM-AD5 and tM-AD5C |

**Error Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0xC6 |
| 02 | Exception code | 1 Byte | 03: incorrect number of bytes received |



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## 3.3.9 Sub-function 38 (0x26) Set channel enable/disable

This sub-function code is used to specify the channels to be enabled in a module.

**Request**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x26 |
| 03 | Enable/disable setting | 1 Byte | 0x00 ~ 0xFF, enable/disable setting of each channel, where bit 0 corresponds to channel 0, bit 1 corresponds to channel 1, etc. When the bit is 1 it denotes that the channel is enabled and 0 denotes that the channel is disabled.<br>0x00 ~ 0x03 for tM-AD2<br>0x00 ~ 0x01F for tM-AD5 and tM-AD5C |

**Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x26 |
| 03 | Enable/disable setting | 1 Byte | 0: OK<br>others: error. |

**Error Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0xC6 |
| 02 | Exception code | 1 Byte | 03: enable/disable setting out of range, incorrect number of bytes received |



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## 3.3.10 Sub-function 41 (0x29) Read miscellaneous settings

This sub-function code is used to read the miscellaneous settings of a module.

**Request**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x29 |

**Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x29 |
| 03 | Miscellaneous settings | 1 Byte | Bit 7~6: reserved<br>Bit 5: mode setting<br>0: normal mode<br>1: fast mode<br>Bit 4~0: reserved |

**Note**: The reserved fields are filled with zeros.

**Error Response**

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0xC6 |
| 02 | Exception code | 1 Byte | 03: incorrect number of bytes received |



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## 3.3.11 Sub-function 42 (0x2A) Write miscellaneous settings

This sub-function code is used to set the miscellaneous settings of a module.

### Request

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x2A |
| 03 | Miscellaneous settings | 1 Byte | Bit 7~6: reserved<br>Bit 5: mode setting<br>0: normal mode<br>1: fast mode<br>Bit 4~0: reserved |

**Note:** The reserved fields are filled with zeros.

### Response

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0x46 |
| 02 | Sub function code | 1 Byte | 0x2A |
| 03 | Miscellaneous settings | 1 Byte | 0: OK<br>others: error |

### Error Response

| | | | |
|---|---|---|---|
| 00 | Address | 1 Byte | 1 to 247 |
| 01 | Function code | 1 Byte | 0xC6 |
| 02 | Exception code | 1 Byte | 03: reserved bits should be filled with zero, incorrect number of bytes received |



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## 3.4 Address Mappings

### 3.4.1 tM-AD2 Address Mappings

<table>
<tr><th>Address</th><th>Description</th><th>Attribute</th></tr>
<tr><td>30001 ~ 30002<br>40001 ~ 40002</td><td>Analog input value of channel 0 to 1</td><td>R</td></tr>
<tr><td>40257 ~ 40258</td><td>Analog input type code of channel 0 to 1</td><td>R/W</td></tr>
<tr><td>40481</td><td>Firmware version (low word)</td><td>R</td></tr>
<tr><td>40482</td><td>Firmware version (high word)</td><td>R</td></tr>
<tr><td>40483</td><td>Module name (low word) , 0x2001</td><td>R</td></tr>
<tr><td>40484</td><td>Module name (high word) , 0x0700</td><td>R</td></tr>
<tr><td>40485</td><td>Module address, valid range: 1 ~ 247</td><td>R/W</td></tr>
<tr><td>40486</td><td>Bits 5:0<br>Baud rate, 0x03 ~ 0x0A
<table>
<tr><td>Code</td><td>0x03</td><td>0x04</td><td>0x05</td><td>0x06</td></tr>
<tr><td>Baud</td><td>1200</td><td>2400</td><td>4800</td><td>9600</td></tr>
<tr><td>Code</td><td>0x07</td><td>0x08</td><td>0x09</td><td>0x0A</td></tr>
<tr><td>Baud</td><td>19200</td><td>38400</td><td>57600</td><td>115200</td></tr>
</table>
Bits 7:6<br>00: no parity, 1 stop bit<br>01: no parity, 2 stop bits<br>10: even parity, 1 stop bit<br>11: odd parity, 1 stop bit</td><td>R/W</td></tr>
<tr><td>40488</td><td>Modbus response delay time in ms, valid range: 0 ~ 30</td><td>R/W</td></tr>
<tr><td>40489</td><td>Host watchdog timeout value, 0 ~ 255, in 0.1s</td><td>R/W</td></tr>
<tr><td>40490</td><td>Channel enable/disable, 00h ~ 03h</td><td>R/W</td></tr>
<tr><td>40492</td><td>Host watchdog timeout count, write 0 to clear</td><td>R/W</td></tr>
<tr><td>40494</td><td>4mA under range threshold in 0.1mA, 0 ~ 40</td><td>R/W</td></tr>
</table>



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| Address | Description | Attribute |
|---|---|---|
| 10129 ~ 10130<br>00129 ~ 00130 | Over/under range status of channel 0 to 1 for 4 ~ 20mA or 0 ~ 20mA ranges | R |
| 00257 | Protocol, 0: DCON, 1: Modbus RTU | R/W |
| 00258 | Protocol, 0: determined by 00257, 1: Modbus ASCII | 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 |
| 00271 | 1: enable, 0: disable fast mode | R/W |
| 00273 | Reset status, 1: first read after powered on, 0: not the first read after powered on | R |



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## 3.4.2 tM-AD5 Address Mappings

<table>
<tr><th>Address</th><th>Description</th><th>Attribute</th></tr>
<tr><td>30001 ~ 30005<br>40001 ~ 40005</td><td>Analog input value of channel 0 to 4</td><td>R</td></tr>
<tr><td>40481</td><td>Firmware version (low word)</td><td>R</td></tr>
<tr><td>40482</td><td>Firmware version (high word)</td><td>R</td></tr>
<tr><td>40483</td><td>Module name (low word) , 0x5001</td><td>R</td></tr>
<tr><td>40484</td><td>Module name (high word) , 0x0700</td><td>R</td></tr>
<tr><td>40485</td><td>Module address, valid range: 1 ~ 247</td><td>R/W</td></tr>
<tr><td>40486</td><td>Bits 5:0<br>Baud rate, 0x03 ~ 0x0A
<table>
<tr><td>Code</td><td>0x03</td><td>0x04</td><td>0x05</td><td>0x06</td></tr>
<tr><td>Baud</td><td>1200</td><td>2400</td><td>4800</td><td>9600</td></tr>
<tr><td>Code</td><td>0x07</td><td>0x08</td><td>0x09</td><td>0x0A</td></tr>
<tr><td>Baud</td><td>19200</td><td>38400</td><td>57600</td><td>115200</td></tr>
</table>
Bits 7:6<br>00: no parity, 1 stop bit<br>01: no parity, 2 stop bits<br>10: even parity, 1 stop bit<br>11: odd parity, 1 stop bit</td><td>R/W</td></tr>
<tr><td>40487</td><td>Type code</td><td>R/W</td></tr>
<tr><td>40488</td><td>Modbus response delay time in ms, valid range: 0 ~ 30</td><td>R/W</td></tr>
<tr><td>40489</td><td>Host watchdog timeout value, 0 ~ 255, in 0.1s</td><td>R/W</td></tr>
<tr><td>40490</td><td>Channel enable/disable, 00h ~ 1Fh</td><td>R/W</td></tr>
<tr><td>40492</td><td>Host watchdog timeout count, write 0 to clear</td><td>R/W</td></tr>
</table>



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| Address | Description | Attribute |
|---|---|---|
| 00257 | Protocol, 0: DCON, 1: Modbus RTU | R/W |
| 00258 | Protocol, 0: determined by 00257, 1: Modbus ASCII | 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 |
| 00271 | 1: enable, 0: disable fast mode | R/W |
| 00273 | Reset status, 1: first read after powered on, 0: not the first read after powered on | R |



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## 3.4.3 tM-AD5C Address Mappings

<table>
<tr><th>Address</th><th>Description</th><th>Attribute</th></tr>
<tr><td>10129 ~ 10133<br>00129 ~ 00133</td><td>Over/under range status of channel 0 to 4 for 4 ~ 20mA or 0 ~ 20mA ranges</td><td>R</td></tr>
<tr><td>30001 ~ 30005<br>40001 ~ 40005</td><td>Analog input value of channel 0 to 4</td><td>R</td></tr>
<tr><td>40481</td><td>Firmware version (low word)</td><td>R</td></tr>
<tr><td>40482</td><td>Firmware version (high word)</td><td>R</td></tr>
<tr><td>40483</td><td>Module name (low word) , 0x5002</td><td>R</td></tr>
<tr><td>40484</td><td>Module name (high word) , 0x0700</td><td>R</td></tr>
<tr><td>40485</td><td>Module address, valid range: 1 ~ 247</td><td>R/W</td></tr>
<tr><td>40486</td><td>Bits 5:0<br>Baud rate, 0x03 ~ 0x0A
<table>
<tr><td>Code</td><td>0x03</td><td>0x04</td><td>0x05</td><td>0x06</td></tr>
<tr><td>Baud</td><td>1200</td><td>2400</td><td>4800</td><td>9600</td></tr>
<tr><td>Code</td><td>0x07</td><td>0x08</td><td>0x09</td><td>0x0A</td></tr>
<tr><td>Baud</td><td>19200</td><td>38400</td><td>57600</td><td>115200</td></tr>
</table>
Bits 7:6<br>00: no parity, 1 stop bit<br>01: no parity, 2 stop bits<br>10: even parity, 1 stop bit<br>11: odd parity, 1 stop bit</td><td>R/W</td></tr>
<tr><td>40487</td><td>Type code</td><td>R/W</td></tr>
<tr><td>40488</td><td>Modbus response delay time in ms, valid range: 0 ~ 30</td><td>R/W</td></tr>
<tr><td>40489</td><td>Host watchdog timeout value, 0 ~ 255, in 0.1s</td><td>R/W</td></tr>
<tr><td>40490</td><td>Channel enable/disable, 00h ~ 1Fh</td><td>R/W</td></tr>
<tr><td>40492</td><td>Host watchdog timeout count, write 0 to clear</td><td>R/W</td></tr>
</table>



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| Address | Description | Attribute |
|---|---|---|
| 00257 | Protocol, 0: DCON, 1: Modbus RTU | R/W |
| 00258 | Protocol, 0: determined by 00257, 1: Modbus ASCII | 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 |
| 00271 | 1: enable, 0: disable fast mode | R/W |
| 00273 | Reset status, 1: first read after powered on, 0: not the first read after powered on | R |



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## 3.4.4 tM-AD8 Address Mappings

<table>
<tr><th>Address</th><th>Description</th><th>Attribute</th></tr>
<tr><td>30001 ~ 30008<br>40001 ~ 40008</td><td>Analog input value of channel 0 to 7</td><td>R</td></tr>
<tr><td>40481</td><td>Firmware version (low word)</td><td>R</td></tr>
<tr><td>40482</td><td>Firmware version (high word)</td><td>R</td></tr>
<tr><td>40483</td><td>Module name (low word), 0x8001</td><td>R</td></tr>
<tr><td>40484</td><td>Module name (high word), 0x0700</td><td>R</td></tr>
<tr><td>40485</td><td>Module address, valid range: 1 ~ 247</td><td>R/W</td></tr>
<tr><td>40486</td><td>Bits 5:0<br>Baud rate, 0x03 ~ 0x0A
<table>
<tr><td>Code</td><td>0x03</td><td>0x04</td><td>0x05</td><td>0x06</td></tr>
<tr><td>Baud</td><td>1200</td><td>2400</td><td>4800</td><td>9600</td></tr>
<tr><td>Code</td><td>0x07</td><td>0x08</td><td>0x09</td><td>0x0A</td></tr>
<tr><td>Baud</td><td>19200</td><td>38400</td><td>57600</td><td>115200</td></tr>
</table>
Bits 7:6<br>00: no parity, 1 stop bit<br>01: no parity, 2 stop bits<br>10: even parity, 1 stop bit<br>11: odd parity, 1 stop bit</td><td>R/W</td></tr>
<tr><td>40487</td><td>Type code</td><td>R/W</td></tr>
<tr><td>40488</td><td>Modbus response delay time in ms, valid range: 0 ~ 30</td><td>R/W</td></tr>
<tr><td>40489</td><td>Host watchdog timeout value, 0 ~ 255, in 0.1s</td><td>R/W</td></tr>
<tr><td>40490</td><td>Channel enable/disable, 00h ~ FFh</td><td>R/W</td></tr>
<tr><td>40492</td><td>Host watchdog timeout count, write 0 to clear</td><td>R/W</td></tr>
</table>



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| Address | Description | Attribute |
|---|---|---|
| 00257 | Protocol, 0: DCON, 1: Modbus RTU | R/W |
| 00258 | Protocol, 0: determined by 00257, 1: Modbus ASCII | 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 |
| 00271 | 1: enable, 0: disable fast mode | R/W |
| 00273 | Reset status, 1: first read after powered on, 0: not the first read after powered on | R |



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## 3.4.5 tM-AD8C Address Mappings

<table>
<tr><th>Address</th><th>Description</th><th>Attribute</th></tr>
<tr><td>10129 ~ 10136<br>00129 ~ 00136</td><td>Over/under range status of channel 0 to 7 for 4 ~ 20mA or 0 ~ 20mA ranges</td><td>R</td></tr>
<tr><td>30001 ~ 30008<br>40001 ~ 40008</td><td>Analog input value of channel 0 to 7</td><td>R</td></tr>
<tr><td>40481</td><td>Firmware version (low word)</td><td>R</td></tr>
<tr><td>40482</td><td>Firmware version (high word)</td><td>R</td></tr>
<tr><td>40483</td><td>Module name (low word) , 0x8002</td><td>R</td></tr>
<tr><td>40484</td><td>Module name (high word) , 0x0700</td><td>R</td></tr>
<tr><td>40485</td><td>Module address, valid range: 1 ~ 247</td><td>R/W</td></tr>
<tr><td>40486</td><td>Bits 5:0<br>Baud rate, 0x03 ~ 0x0A
<table>
<tr><td>Code</td><td>0x03</td><td>0x04</td><td>0x05</td><td>0x06</td></tr>
<tr><td>Baud</td><td>1200</td><td>2400</td><td>4800</td><td>9600</td></tr>
<tr><td>Code</td><td>0x07</td><td>0x08</td><td>0x09</td><td>0x0A</td></tr>
<tr><td>Baud</td><td>19200</td><td>38400</td><td>57600</td><td>115200</td></tr>
</table>
Bits 7:6<br>00: no parity, 1 stop bit<br>01: no parity, 2 stop bits<br>10: even parity, 1 stop bit<br>11: odd parity, 1 stop bit</td><td>R/W</td></tr>
<tr><td>40487</td><td>Type code</td><td>R/W</td></tr>
<tr><td>40488</td><td>Modbus response delay time in ms, valid range: 0 ~ 30</td><td>R/W</td></tr>
<tr><td>40489</td><td>Host watchdog timeout value, 0 ~ 255, in 0.1s</td><td>R/W</td></tr>
<tr><td>40490</td><td>Channel enable/disable, 00h ~ FFh</td><td>R/W</td></tr>
<tr><td>40492</td><td>Host watchdog timeout count, write 0 to clear</td><td>R/W</td></tr>
</table>



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| Address | Description | Attribute |
|---|---|---|
| 00257 | Protocol, 0: DCON, 1: Modbus RTU | R/W |
| 00258 | Protocol, 0: determined by 00257, 1: Modbus ASCII | 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 |
| 00271 | 1: enable, 0: disable fast mode | R/W |
| 00273 | Reset status, 1: first read after powered on, 0: not the first read after powered on | R |



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## 3.5 Engineering Data Format Table

The under range value is –32768 and the over range value is +32767. For the hex data format, please refer to Section 1.10.

### 3.5.1 tM-AD2 Engineering Data Format Table

| Type Code | Input Type | Min. | Max. |
|---|---|---|---|
| 05 | 0 V ~ +2.5 V | 0 | 25000 |
| 06 | 0 mA ~ +20 mA | 0 | 20000 |
| 07 | +4 mA ~ +20 mA | 4000 | 20000 |
| 08 | 0 V ~ +10 V | 0 | 10000 |
| 09 | 0 V ~ +5 V | 0 | 5000 |
| 0A | 0 V ~ +1 V | 0 | 10000 |
| 0B | 0 mV ~ +500 mV | 0 | 5000 |
| 0D | 0 mA ~ +20 mA | 0 | 20000 |
| 1A | 0 mA ~ +20 mA | 0 | 20000 |

### 3.5.2 tM-AD5 Engineering Data Format Table

| Type Code | Input Type | Min. | Max. |
|---|---|---|---|
| 05 | -2.5 V ~ +2.5 V | -25000 | 25000 |
| 08 | -10 V ~ +10 V | -10000 | 10000 |
| 09 | -5 V ~ +5 V | -5000 | 5000 |
| 0A | -1 V ~ +1 V | -10000 | 10000 |

### 3.5.3 tM-AD5C Engineering Data Format Table

| Type Code | Input Type | Min. | Max. |
|---|---|---|---|
| 06 | -20 mA ~ +20 mA | -20000 | 20000 |
| 07 | +4 mA ~ +20 mA | 4000 | 20000 |
| 0D | -20 mA ~ +20 mA | -20000 | 20000 |
| 1A | 0 ~ +20 mA | 0 | 20000 |



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## 3.5.4 tM-AD8 Engineering Data Format Table

| Type Code | Input Type | Min. | Max. |
|---|---|---|---|
| 05 | 0 V ~ +2.5 V | 0 | 25000 |
| 08 | 0 V ~ +10 V | 0 | 10000 |
| 09 | 0 V ~ +5 V | 0 | 5000 |
| 0A | 0 V ~ +1 V | 0 | 10000 |
| 0B | 0 mV ~ +500 mV | 0 | 5000 |

## 3.5.5 tM-AD8C Engineering Data Format Table

| Type Code | Input Type | Min. | Max. |
|---|---|---|---|
| 06 | 0 mA ~ +20 mA | 0 | 20000 |
| 07 | +4 mA ~ +20 mA | 4000 | 20000 |
| 0D | 0 mA ~ +20 mA | 0 | 20000 |
| 1A | 0 ~ +20 mA | 0 | 20000 |



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# 4. Troubleshooting

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



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## 4.1 Communicating with the module

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

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



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## 4.2 Reading Data

If the data read from the input channel is not correct, first check the following:

- Make sure the type code and data format settings are correct. For the tM-AD5, tM-AD5C, tM-AD8 and tM-aD8C, the type code is set by using the %AANNTTCCFF command, see Section 2.1 for details. For the tM-AD2, the type code is set by using the $AA7CiRrr command, see Section 2.11 for details. The data format is set by using the %AANNTTCCFF command. For the Modbus RTU protocol, the type code is set by using sub-function 08h of the function 46h.
- If the voltage read by the module is incorrect, then it may be because the calibration parameters stored in the non-volatile memory are corrupted. You can calibrate the module by yourself. Be sure to read Section 1.9 in detail before doing any calibration.



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# A. Appendix

## A.1 INIT Mode

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

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

The configuration information stored in the EEPROM is not changed and they 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 2.17 for details.



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






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## A.2 Dual Watchdog Operation

### Dual Watchdog = Module Watchdog + Host Watchdog

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

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

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

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



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## A.3 Frame Ground

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

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



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