

FEATURES

- Eight TC channels for B, E, J, K, N, R, S, T thermocouple types
- Each channel can have a different TC type or can measure millivolts
- Isolated Remote or Internal Cold Junction Sensor
- 3000 Vrms Isolation Input, Power and Network
- 2000 Vrms Channel-to-Channel Isolation
- 250Vrms Signal Overrange Protection
- Highly stable Apix technology A/D Conversion
- 160 db Common Mode Rejection 50/60 HZ
- 90 db Normal Mode Rejection 50/60 HZ
- 50 or 60 Conversions/Sec with all 8 channels converting synchronously
- Wide Range 9-36 VDC or 7-24 VAC Supply
- -40 to 85 °C Operating Temperature Range
- Synchronized Sampling & Hold of all channels throughout the Network

SPECIFICATIONS

Maximum Ratings

| | |
|------------------------------|--------------------|
| Power Supply Voltage | 39VDC or 28VAC |
| TC Input | 250Vrms continuous |
| External Cold Junction Input | ±50V continuous |
| Storage Temperature | -55 to 125 Deg C |
| Input Common Mode | 3KVrms (1 min) |
| Channel to Channel Voltage | 2KVrms (1 min) |
| RS-485 Common Mode | 2.5KVrms (1 min) |

Emissions & Immunity

Complies with the requirements of IEC61000-6-5 and IEC61326-1

In particular :

| | |
|---------------|---|
| IEC61000-3-2 | Class B emissions |
| IEC61000-4-2 | 8KV electrostatic discharge |
| IEC61000-4-4 | 4KV burst, 5/50 ns, 5 Khz |
| IEC61000-4-5 | 4KV surge 1.2/50 us, line to ground, 2KV line to line |
| IEC61000-4-6 | Conducted RF |
| IEC61000-4-12 | Damped oscillatory wave |

Analog Inputs

| | |
|------------------------|-------------------------------|
| Thermocouple types | B, E, J, K, N, R, S, T |
| Voltage Range | ±80 mV |
| Bandwidth | 5 Hz (-3db) |
| Input Resistance | 22 Mohm ±5 % |
| Normal Mode Rejection | 90 db at 50/60 Hz sample rate |
| Open TC detect current | < 120 nA |

External Cold Junction

| | |
|-------------------|--|
| Sensor type | Pt1000 (Platinum 1000 ohms at 0 °C , 3.85 ohm/°C) |
| Range | -40 to 85 °C |
| Tolerance | ±0.3 °C |
| Operating current | 25 microamps max |

Internal Cold Junction

| | |
|-------------|------------------------------|
| Sensor type | Integrated circuit |
| Range | -40 to +85 °C |
| Tolerance | +/- 2 °C after 20 min warmup |

PRODUCT OVERVIEW

This Modbus RTU version TC Input Module features 8 independent Thermocouple channels and an isolated RS-485 interface. Channel #8 can be used to measure a remote cold junction sensor if it is not desired to use the Internal Sensor in the module.

The channels are fully isolated with 3000 Vrms between Input, Power, RS-485 link and 2000 Vrms Channel-to-Channel.

The module combines Signal Conditioning, robust Isolation, TC linearization, cold junction compensation and an individual highly stable 16bit A/D converter per channel. No multiplexers are used. The sampling rate of 50 or 60 Hz can be set by the user to minimize power line interference.

All 8 channels convert synchronously. A global Modbus command will result in synchronized sampling and hold of all Input Channels in the network. These samples are then stored in a second set of registers in each module for eventual readout.

Highly effective multipole digital low pass and notch filters track the set sampling rate.



Common Mode

| | |
|-----------------|---|
| Rejection | 160 db at 50/60 Hz sample rate |
| Leakage Current | 2 µA rms at 1000 Vrms and 50/60 Hz, per channel |

Capacitance

4 pF max per channel

Performance

| | |
|---------------------|--|
| Initial Accuracy | ±16 microvolts |
| Zero Drift | ±1.6 uV/ °C |
| Span Drift | ±3.2 uV/ °C |
| Cold Junction drift | External ± 0.002 °C/°C, Internal ± 0.03 °C/°C |
| Resolution | 16bits (±80mV => ±32000 decimal) |
| Sample Rate | 50 to 60 samples/sec (All 8 channels simultaneously) |

RS-485 Interface

| | |
|----------------|---|
| Protocol | Modbus RTU |
| Baud Rate | 2400 to 921.6K standard baud rates, default = 19200 |
| Duplex | Half duplex |
| Parity | None |
| Data bits | 8 |
| Stop bits | 2 |
| Response Delay | 0 to 6553.5 msec in 0.1 msec increments |
| Module Address | 1 to 247 |
| Max nodes | 1 to 31 without repeater |
| Max distance | 4000 ft, 1230 meters (varies with baud rate) |

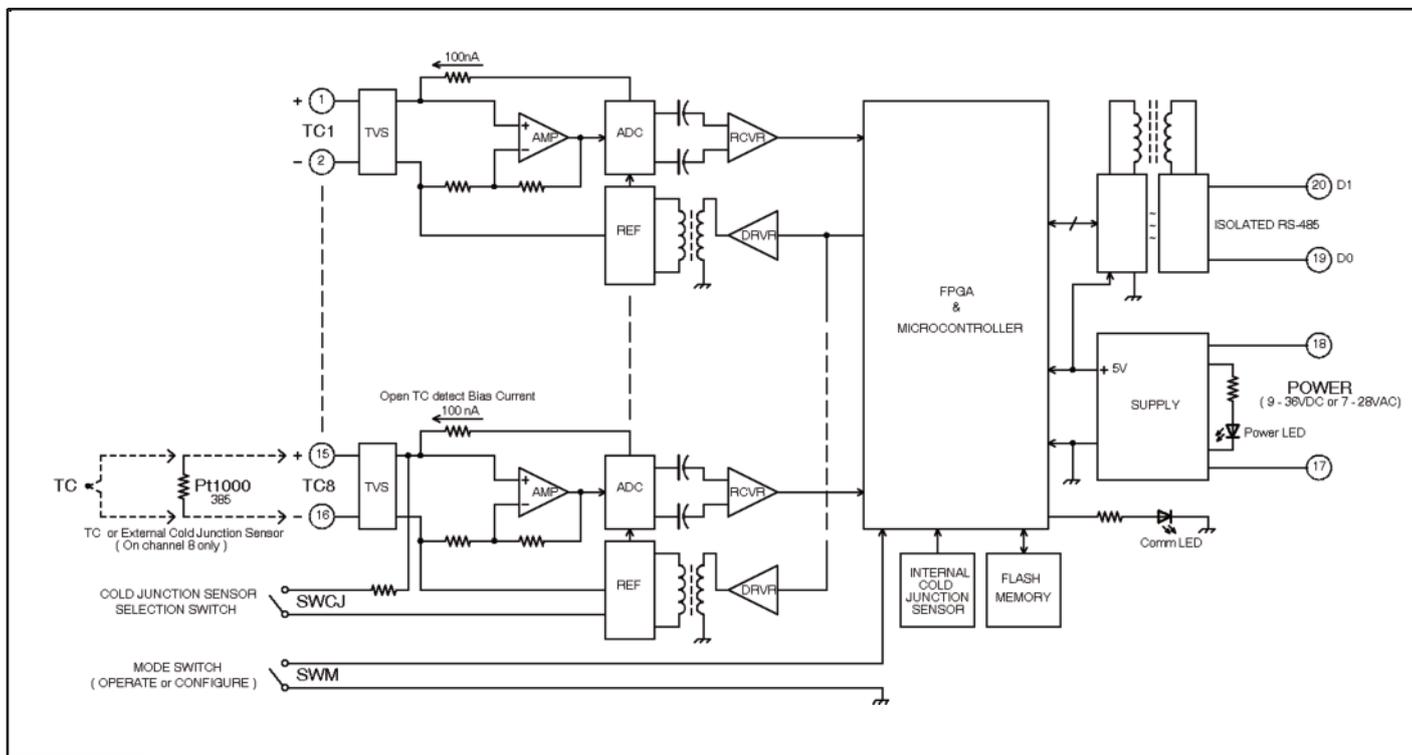
Power Requirements

| | |
|----------------|----------------------------|
| Supply Voltage | 9 to 36 VDC or 7 to 28 VAC |
| Max Power | 1.8 W, Non Polarized |

Environmental & Mechanical

| | |
|-----------------------|--|
| Operating Temperature | -40 to 85 °C |
| Relative Humidity | < 95 % Non Condensing |
| Overall Dimensions | 113.6 x 117.2 x 22.5 (mm) , 4.47 x 4.62 x 0.89 (in) |
| Enclosure material | PA 66 GF 30 |
| PC Board material | FR4 |
| Protection Class | IP20 |
| Conductor Size | AWG26 min, AWG14 max |

Functional Block Diagram



OPERATION

The Functional Block Diagram shows how the external TC inputs are connected to the eight identical isolated processing channels.

Each channel has a Transient Voltage Suppressor Network across the input terminals, followed by signal conditioning, AD conversion and isolation. The channel input resistance is 22Mohm. A low value current bias is used to sense an open thermocouple.

Eight different thermocouple types are supported. Each channel may have a different thermocouple of the following types:

| TC Type | Temp. Range (°C) |
|---------|------------------|
| B | 254 to 1818 |
| E | -171 to 995 |
| J | -205 to 1190 |
| K | -153 to 1360 |
| N | -130 to 1285 |
| R | 0 to 1760 |
| S | 0 to 1750 |
| T | -193 to 394 |

Any channel may be set to measure millivolts directly, instead of temperature, with a resolution of 2.5 microvolts.

The temperature values are presented with a resolution of $1/16$ °C, so for example:

$$16000 = 1000 \text{ °C} \quad (\text{Divide value by 16 to get temperature reading})$$

The maximum possible value is 32767 which corresponds to 2048 °C.

If a thermocouple fails (opens), the input voltage will exceed 80mV, due to the bias current and this will result in a maximum value of 32767 for this channel.

A watchdog timer will restart the module if any unusual event disrupts normal operation.

A internal or external cold junction sensor can be chosen during configuration . Channel #8 can be used to measure an external cold junction sensor or a thermocouple, as shown in the block diagram.

If channel 8 is set for the External cold junction sensor then the module will compensate for the temperatures of channels 1 to 7. Otherwise, when the internal sensor is used (default) all 8 channels will be compensated.

A transformer and associated driver (DRVR) supply power for each channel. Output values from the ADCs are isolated by high voltage capacitors and differential receivers (RCVR) and are passed on to the FPGA & 32 Bit Processor for digital filtering, calibration, linearization and transmission to the Modbus network.

External power at the POWER terminals is indicated by the "Power" LED.

An isolated RS-485 interface drives the network cable. The "Comm" LED turns ON when the module is transmitting.

INSTALLATION

Enclosure

All ISODIN modules offer IP20 level protection to withstand typical industrial environments. The thermoplastic package is non-flammable per UL94 V-0 with high impact resistance.

They feature surge protection on each input and have low radiated emissions and high immunity tolerance

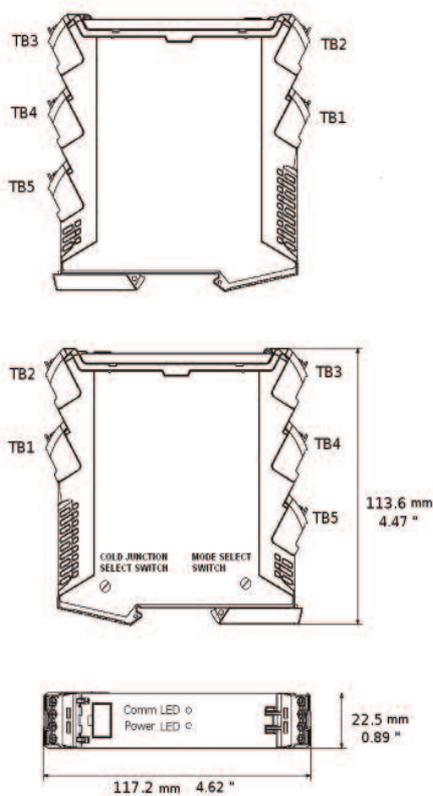
The Outline drawing details the mechanical dimensions, plug-in terminal block identification and LED locations.

Mounting

This module must be mounted vertically on a 35mm "T" type DIN rail as per EN50022.

Module attachment is done by locating the top groove of the adapter over the upper lip of the rail then pushing the unit downwards until it snaps into place.

Removal is accomplished by inserting a screwdriver into the groove of the bottom side latch and using it as a lever to open the latch until the module disconnects from the rail.



NOTE:

When using the Internal Cold Junction Sensor, please leave a 1/4 inch minimum space between adjacent modules.

CONNECTIONS

There are 5 plug-in terminal blocks, TB1—TB4 for TC and external cold junction sensor input wiring and one 4 pin terminal, TB5 for power and RS-485 connections. These terminal blocks and voltage input signal polarities are clearly indicated on the module side label. TB1-TB5 have a convenient lever mechanism for easy ejection.

All terminals will accept from AWG26 up to AWD14 wire and are rated 10A/400V at ambient temperature and II/2 pollution severity.

TC inputs should preferably use twisted pair cables, with or without shields, to minimize external magnetic field pickup, thus preserving the excellent 16bit resolution and signal to noise ratio.

The power input can be from 9 to 36VDC or 7 to 24VAC and connects to the POWER terminals. An internal diode protects against accidental reverse polarity connection. A Green LED, labeled “Power” on the front panel is fed directly by the power input.

APIX Industrial Automation

8 ISOLATED THERMOCOUPLE INPUTS
Model : DAQ8-TC4-2RTU Rev 2.6

10041376
www.apixcorp.com

Range: ±80 mV
Max Signal Input: 250 Vrms
Accuracy: ±0.01% if Span
Power: 9-36 VDC / 7-28 VAC
 Non Polarized 1.8W

Temp Range: -40 to 85 C
Network: Modbus RTU
Isolation : 3 KVrms In-Out
 2 KVrms Ch-to-Ch

Complies with the requirements of IEC61000-6-5 and IEC61326-1
 In particular:
 IEC61000-3-2 IEC61000-4-2
 IEC61000-4-4 IEC61000-4-5
 IEC61000-4-6 IEC61000-4-12

| POWER | | RS-485 | |
|----------|----|--------|----|
| 17 | 18 | 19 | 20 |
| 9-36 VDC | | D0 | D1 |
| 7-28 VAC | | | |

COLD JUNCTION
 INTERNAL
 EXTERNAL

MODE SELECTION
 OPERATE
 CONFIGURE

A twisted pair cable should be used for the RS-485 signal and daisy chained from module to module, without branching. Terminals labeled D0 and D1, as per the Modbus specification, carry the differential half duplex RS-485 signal. A cable shield is not normally required but if available should be connected to chassis (DIN rail) ground. Since this RS-485 link is isolated, there is no current flow along the shield drain wire.

RS-485 line polarization is required for proper operation of this module. This is usually provided by the Modbus Master node via pullup and pulldown resistors. The Master node should also provide a 120 or 150 ohm line termination resistor across the D0 & D1 pins. If the cable is very long and reflections are a problem, then a second termination resistor, at the far end of the cable, may be required.

CONFIGURATION

An external MODE Rotary Switch must be set to the “CONFIGURE” position (fully clockwise) in order to permit changes to all internal parameters. The procedure is as follows:

- 1) Power must be OFF
- 2) Turn MODE switch fully clockwise
- 3) Power ON
- 4) Change any parameters as necessary
- 5) Power OFF
- 6) Turn MODE switch fully counterclockwise (OPERATE position , default)
- 7) Power ON to operate normally

NOTE that the MODE switch state will be recognized only when power is applied.

In the CONFIGURE position , default communication parameters are set as follows:

Module address = 1
 Baud rate = 19200
 Sample rate = 50

All user accessible parameters are stored in Flash memory and can be read and written to as “Holding Registers”, via the Modbus RTU protocol (function codes 3 and 6), in the following locations:

| Register Address | Name | Value Range |
|------------------|------------------------|--|
| 0 | Module ID | 4 (DAQ8-TC4-2RTU Module) |
| 1 | Module Address | 1 to 247 |
| 2 | Sample Rate | 50 or 60 |
| 3 | Baud Rate | 24 to 9216 (Actual rate divided by 100) |
| 4 | Parity | 0=none |
| 5 | Response Delay | 0 to 65535 (equals 0 to 6553.5 msec) |
| 6 | Ext. Cold Junc. Offset | -32768 to 32767 |
| 7 | Ext. Cold Junc. Gain | -32768 to 32767 |
| 8 | Offset channel 1 | -32768 to 32767 |
| 9 | Offset channel 2 | -32768 to 32767 |
| 10 | Offset channel 3 | -32768 to 32767 |
| 11 | Offset channel 4 | -32768 to 32767 |
| 12 | Offset channel 5 | -32768 to 32767 |
| 13 | Offset channel 6 | -32768 to 32767 |
| 14 | Offset channel 7 | -32768 to 32767 |
| 15 | Offset channel 8 | -32768 to 32767 |
| 16 | Gain channel 1 | 0 to 65535 |
| 17 | Gain channel 2 | 0 to 65535 |
| 18 | Gain channel 3 | 0 to 65535 |
| 19 | Gain channel 4 | 0 to 65535 |
| 20 | Gain channel 5 | 0 to 65535 |
| 21 | Gain channel 6 | 0 to 65535 |
| 22 | Gain channel 7 | 0 to 65535 |
| 23 | Gain channel 8 | 0 to 65535 |
| 24 | Channel 1 type | 0 to 8 |
| 25 | Channel 2 type | 0 to 8 |
| 26 | Channel 3 type | 0 to 8 |
| 27 | Channel 4 type | 0 to 8 |
| 28 | Channel 5 type | 0 to 8 |
| 29 | Channel 6 type | 0 to 8 |
| 30 | Channel 7 type | 0 to 8 |
| 31 | Channel 8 type | 0 to 9 (9 = External Cold Junction Sensor) |
| 32 | Ch 1 Int. CJ offset | -250 to 250 |
| 33 | Ch 2 Int. CJ offset | -250 to 250 |
| 34 | Ch 3 Int. CJ offset | -250 to 250 |
| 35 | Ch 4 Int. CJ offset | -250 to 250 |
| 36 | Ch 5 Int. CJ offset | -250 to 250 |
| 37 | Ch 6 Int. CJ offset | -250 to 250 |
| 38 | Ch 7 Int. CJ offset | -250 to 250 |
| 39 | Ch 8 Int. CJ offset | -250 to 250 |

The Channel type numbers in the above list represent the following inputs:

Channel type

| | |
|---|---|
| 0 | millivolts |
| 1 | B thermocouple |
| 2 | E “ |
| 3 | J “ |
| 4 | K “ |
| 5 | N “ |
| 6 | R “ |
| 7 | S “ |
| 8 | T “ |
| 9 | Pt1000 (ExternalCold Junction Sensor) |

Due to the nature of Flash memory, it can be read very quickly but when writing to a single location it actually writes a complete block of 65536 locations. This can take several seconds to complete.

Please note that the offset and gain values are set very precisely at the factory and should not need to be modified.

MODBUS FUNCTIONS

All data values and Flash memory parameters are accessed via the Modbus RTU protocol as per the “Modbus Application Protocol Specification V1.1b”. Available at www.Modbus-IDA.org

For reading data values of the 8 input channels, use function code 04 (read input registers). You must specify the starting address 0 to 7 (for channel 1 to 8) and the number of registers to read (1 to 8). Example.....

04 Function code - (Read input registers)
0000 Starting address – (begin at channel 1)
0008 Number of registers – (all 8 channels)

In a similar manner, to read the Flash memory parameters, use function code 03 (read holding registers). Example...

03 Function code
0002 Read address 2 = Sample rate
0001 One register

To write parameters into the Flash memory, use function code 06 (write single register). Example...

06 Function code
0002 Write address 2 = Sample rate
003C Sample rate value = 3C hex = 60 Hz decimal

SYNC COMMAND

A Modbus global broadcast command has been implemented to take a synchronized sample of all Input Channels in the network. When this command is received by the module, it immediately starts a new sample (discarding any ongoing AD conversions) on all 8 channels simultaneously. This broadcast command is 2 bytes ...

00 Broadcast address
01 Take sample

These samples are then stored in a second set of 8 registers for eventual readout. This second set of registers begins at address 8 and ends at address 15 and can be accessed as “ Input registers” in the normal manner, for example...

04 Function code - (Read input registers)
0008 Starting address – (begin at channel 1 of second register set)
0008 Number of registers – (all 8 channels)

ERROR CODES

If any error occurs in these message transactions, the appropriate exception code will be returned to the Master node. The supported codes are as follows:

| Code | Meaning |
|------|--|
| 01 | Illegal function, not supported by this module |
| 02 | Illegal data address, not valid for this module |
| 03 | Illegal data value, indicates a fault in the structure of the message. |