MAQ®20

Industrial Data Acquisition and Control System

MA1047

MAQ20-JTC MAQ20-KTC
MAQ20-TTC MAQ20-RSTC
Hardware User Manual



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MAQ20-JTC/-KTC/-TTC/-RSTC Hardware User Manual
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Errata Sheets

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1.0 System Features

The MAQ20 Data Acquisition System encompasses more than 35 years of design excellence in the process control industry. It is a family of high performance, DIN rail mounted, programmable, multi-channel, industrially rugged signal conditioning I/O and communications modules.

Instrument Class Performance

- ±0.035% Accuracy
- Industry leading ±0.3°C CJC Accuracy over full operating temperature range
- Ultra-low Zero and Span Tempco
- Over-range on one channel does not affect other channels
- 1500Vrms Channel-to-Bus Isolation
- 240Vrms Continuous Field I/O Protection
- ANSI/IEEE C37.90.1 Transient Protection
- Ventilated Communications and I/O Modules
- Industrial Operating Temperature of -40°C to +85°C
- Wide Range 7-34VDC Power
- CE Compliant
- UL/cUL (Class I, Div 2, Groups A, B, C, D) Compliant, file E232858
- ATEX Compliance pending

Industry Leading Functionality

- The system is a Modbus Server and can be operated remotely with no local PC
- Up to 8GB of logged data can be transferred via FTP during real-time acquisition
- Up to 24 I/O modules, or 384 analog or 480 digital channels, per system, 19” rack width
- Per-channel configurable for range, alarms, and other functions
- Backbone mounts within DIN rail and distributes power and communications
- System firmware automatically registers the installation and removal of I/O modules
- I/O modules can be mounted remotely from the Communications Module
- Equal load sharing power supply modules allow for system expansion
- Hot Swappable I/O modules with Field-side pluggable terminal blocks on most models
- Sophisticated package enables high density mounting in 3U increments
- DIN Rail can be mounted on a continuous flat panel or plate

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Distributed Processing Enables Even More Functionality

- Output modules are programmable for user-defined waveforms
- Discrete I/O modules have seven high level functions:
  - Pulse Counter
  - Frequency Counter
  - Waveform Measurement
  - Time Between Events
  - Frequency Generator
  - PWM Generator
  - One-Shot Pulse Generator

Multiple Software Options

- Free Configuration Software
  - ReDAQ Shape Graphical HMI Design & Runtime Solution
- Intuitive Graphical Control Software
  - ReDAQ Shape Graphical HMI Design & Runtime Solution
  - Phyton API
  - OPC Server
  - Programming examples and LabVIEW Vis

2.0 System Description and Documentation

A MAQ®20 Data Acquisition System must have as a minimum a Communications Module, a Backbone, and one I/O Module. Examples include:

- MAQ20-COMx Communications Module with Ethernet, USB and RS-232 or RS-485 Interface
- MAQ20-DIOx Discrete Input / Output Module
- MAQ20-xTC Type x Thermocouple Input Module
- MAQ20-mVxN, -VxN Voltage Input Module
- MAQ20-IxN Process Current Input Module
- MAQ20-IO, -VO Process Current Output and Process Voltage Output Module
- MAQ20-BKPLx x Channel System Backbone

Refer to https://www.dataforth.com/maq20 for a complete listing of available modules and accessories.

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System power is connected to the Communications Module, which in turn powers the I/O modules. For systems with power supply requirements exceeding what the Communications Module can provide, the MAQ20-PWR3 Power Supply module is used to provide additional power. When a MAQ®20 I/O module is inserted into a system, module registration occurs automatically, data acquisition starts, and data is stored locally in the module. The system is based on a Modbus compatible memory map for easy access to acquired data, configuration settings and alarm limits. Information is stored in consistent locations from module to module for ease of use and system design.

MAQ®20 modules are designed for installation in Class I, Division 2 hazardous locations and have a high level of immunity to environmental noise commonly present in heavy industrial environments.

The MAQ®20 thermocouple input modules have 8 differential input channels. Separate models are offered for interfacing to Type J, Type K, Type T and Types R and S thermocouples. Cold Junction Compensation uses four internal sensors resulting in industry leading measurement accuracy in any system configuration and over the entire system operating temperature range. All channels are individually configurable for range, alarm limits, and averaging to match the most demanding applications. High, Low, High-High and Low-Low alarms provide essential monitoring and warning functions to ensure optimum process flow and fail-safe applications. Hardware low-pass filtering in each channel provides rejection of 50 and 60 Hz line frequencies. Field I/O connections are made through spring cage terminal blocks with 4 positions provided for the termination of wiring shields.

Input-to-Bus isolation is a robust 1500Vrms and each individual channel is protected up to 150Vrms continuous overload in the case of inadvertent wiring errors. Overloaded channels do not adversely affect other channels in the module which preserves data integrity.

For details on installation, configuration, and system operation, refer to the manuals and software available for download from www.dataforth.com. This includes, but is not limited to:

MA1036 MAQ®20 Quick Start Guide

MA1040 MAQ®20 Communications Module Hardware User Manual

MA1041 MAQ®20 milliVolt, Volt, and Current Input Module Hardware User Manual

MA1037 MAQ®20 Configuration Software Tool User Manual

MA1038 MAQ®20 ReDAQ Shape for MAQ®20 User Manual

MAQ20-940 ReDAQ Shape Software for MAQ®20 – Developer Version

MAQ20-941 ReDAQ Shape Software for MAQ®20 – User Version

MAQ20-945 MAQ®20 Configuration Software Tool

MAQ20-952 IPEMotion Software for MAQ®20

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3.0 Unpacking

Each MAQ20 Data Acquisition System component is shipped in electro-static discharge (ESD) protective packaging. Use appropriate ESD protection measures while unpacking. Check visually for physical damage. If physical damage is noted, file a claim with the shipping carrier and contact the factory.

4.0 Module Dimensions and Input Connections

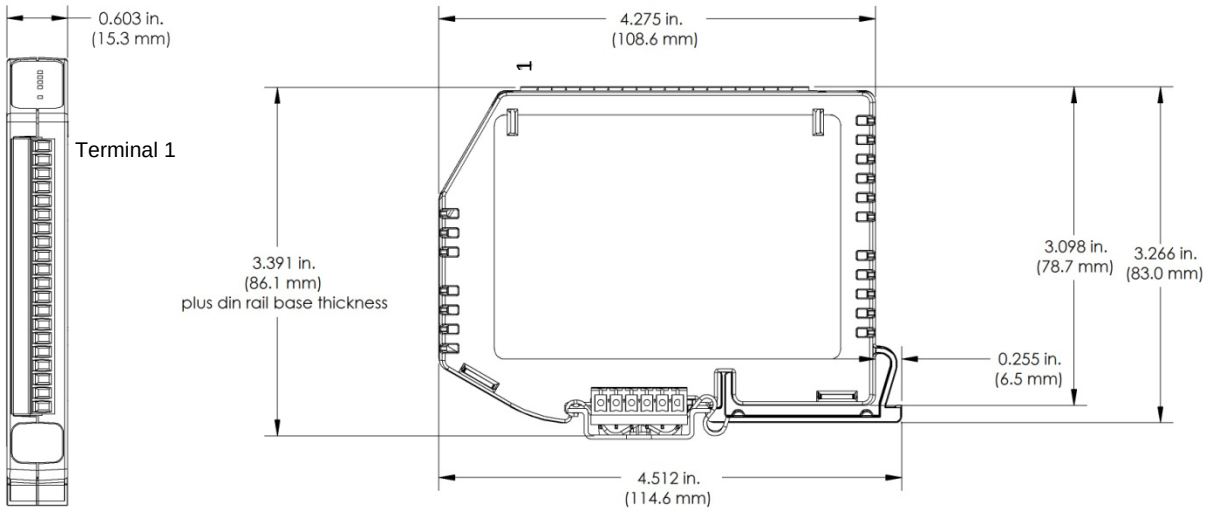


Figure 1: Module Dimensions

Table 1: Input Terminal Block Connections

TERMINAL BLOCK POSITION (TOP TO BOTTOM)	MAQ20-xTC INPUT CONNECTIONS
1	CH0 +IN
2	CH0 -IN
3	SHIELD
4	CH1 +IN
5	CH1 -IN
6	CH2 +IN
7	CH2 -IN
8	SHIELD
9	CH3 +IN
10	CH3 -IN
11	CH4 +IN
12	CH4 -IN
13	SHIELD
14	CH5 +IN
15	CH5 -IN
16	CH6 +IN
17	CH6 -IN
18	SHIELD
19	CH7 +IN
20	CH7 -IN

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The shield terminals are connected to the Field Side common and are isolated from the Bus. If shield drain to system ground is required, this connection must be made external to the module.

5.0 Installation

The MAQ®20 I/O module package has been designed for easy insertion into and removal from a system and can mate with DIN rails mounted flush on continuous panels or plates.

To install a module:

1. Orient the module with the field connector facing out.
2. Align the angled surface on the top rear corner with panel or plate the DIN rail is mounted to.
3. Slide the module down to capture the DIN rail with the hook on the module.
4. Rotate the module and snap in place

To remove a module, reverse the steps in the installation process. If space is available, the clip at the bottom of the module can be squeezed by hand to release. For tight installations, insert a flat blade screwdriver into the recess in the clip (5), place the shaft of the screwdriver against the curved part of the clip and gently pry the clip to release (6).

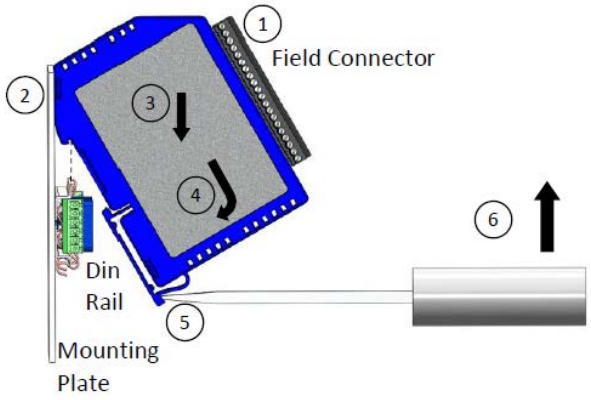


Figure 2: Installation and Removal

Multiple rows of MAQ®20 modules can be mounted at a 3U vertical spacing interval. Backbones can be combined to add I/O modules to a system. A system is only allowed to have one MAQ20-COMx module. Some possible configurations in a 19" rack are shown.

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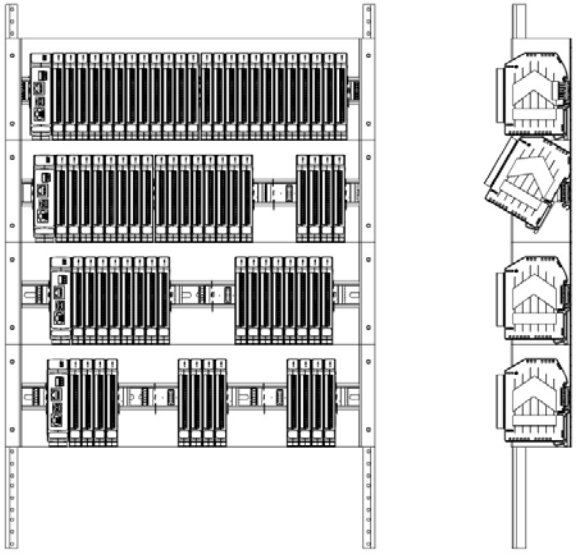


Figure 3: Possible System Configurations

6.0 Building a System

An automated I/O module registration process reduces system setup to three basic steps:

STANDARD SETUP PROCESS

1.) Install a MAQ20-BKPLx backbone in a DIN rail then insert a MAQ20-COMx module in the left-most position and apply power.

2.) Install any MAQ®20 I/O Module in any vacant local or remote backbone position. Observe that the green Power LED is on and communications activity is seen on the TX and RX LEDs. Allow 1 second for registration. This module has now been assigned Registration Number 1.

3.) Label and connect field wiring to the I/O Module. If desired, record module physical position in the system.

4.) Repeat Step 2 for all remaining MAQ®20 I/O modules in the system. Subsequent modules installed are assigned Registration Number 2, 3, etc. The Registration Number sequence matches the physical sequence of module installation.

ALTERNATE SETUP PROCESS

1.) Do not apply power. Install a MAQ20-BKPLx backbone in a DIN rail then insert a MAQ20-COMx module in the left-most position and install all required MAQ®20 I/O modules in any vacant local or remote backbone position. Label and connect field wiring to the I/O Module and if desired record physical position in the system.

2.) Apply system power and observe that each module has the green Power LED on and communications activity is seen on the TX and RX LEDs. Allow 5 seconds for full system registration. All modules have now been assigned Registration Numbers, but in a random sequence not associated with the physical position on the backbone.

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NOTES:

Once the registration process is complete, Registration Numbers are permanent as long as I/O modules are not removed from or added to a system. When system power is cycled or the system is reset, I/O module Registration Numbers will always remain the same.

I/O modules in a system are identified in general by their model number (MAQ20-VDN, MAQ20-JTC, etc.) and uniquely by their Serial Number printed on the side label (i.e. 1234567-89). When I/O modules are installed in the system, only a general identifier is visible on the front of the module (V, I, TCPL, etc.). Wire tags or additional labeling applied to the module terminal block may be used for visible unique identification in an installed system.

MAQ20-940 - ReDAQ Shape Software for MAQ®20 automatically assigns tag names to each input and output channel. These can be changed by the customer to associate channels with input wiring or parameters measured and controlled.

The system does not identify I/O modules by physical position on a backbone, only by registration sequence. MAQ20-940 - ReDAQ Shape Software for MAQ®20 and MAQ20-945 - MAQ®20 Configuration Software Tool provided by Dataforth show a graphical representation of a system based on registration sequence and not by physical position. Tools within each software package allow the user to reassign Registration Numbers thereby making graphical representations match physical location for a single, local backbone. For further details, see Section 9.0.

Module Detect: A write to the Module Detect Register at I/O module address 98 plus the module offset based on Registration Number will blink the STAT LED on the top angled surface of the module at a 5Hz rate for 5 seconds so the module location in a system can be visually identified.

7.0 Maintaining a System

The MAQ20-COMx Communications Module periodically scans the system and will detect if a MAQ®20 I/O module has been removed from the system or has lost communications. When this happens the module Registration Number will be released and available for reassignment.

Standard system maintenance involves a simple three step process:

STANDARD MAINTENANCE PROCESS

1.) Turn system power on and observe communications activity on the I/O modules.

2.) **CASE 1:** I/O module is suspected faulty and is to be replaced with the same model number: Remove a single MAQ®20 I/O module from any local or remote backbone position. Replace the module with another of the same model number. This module can be installed in any vacant local or remote backbone position. Observe that the green Power LED is on and communications activity is seen on the TX and RX LEDs. Allow 1 second for registration. This module now has the same Registration Number as the one removed.

CASE 2: I/O module is to be replaced with another having a different model number: Remove a single MAQ®20 I/O module from any local or remote backbone position. Replace

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the module with another having a different model number. This module can be installed in any vacant local or remote backbone position. Observe that the green Power LED is on and that there is communications activity on the TX and RX LEDs. Allow 1 second for registration. This module now has the same Registration Number as the one removed.

Label and connect input/output wiring to the I/O module and if desired record physical position in the system.

3.) Repeat Step 2 for any remaining MAQ®20 I/O modules in the system requiring maintenance.

ALTERNATE MAINTENANCE PROCESS

1.) With the system power off, remove any I/O modules which are to be replaced. Replace the modules with others of the same or different model numbers. Modules can be installed in any vacant local or remote backbone position.

2.) Label and connect input/output wiring to the I/O module and if desired record physical position in the system.

3.) Apply system power and observe that each module has the green Power LED on and communications activity is seen on the TX and RX LEDs. Allow 5 seconds for full system registration. Replaced modules have now been assigned the Registration Numbers of those removed, but in a random sequence not associated with the physical position on the backbone. Modules which were not replaced retain their assigned Registration Numbers.

NOTES:

Once the registration process is complete, Registration Numbers are permanent as long as I/O modules are not removed from or added to a system. When system power is cycled or the system is reset, I/O module Registration Numbers will always remain the same. Tools within MAQ20-940 - ReDAQ Shape Software for MAQ®20 and MAQ20-945 - MAQ®20 Configuration Software Tool allow the user to reassign Registration Numbers. For further details, see Section 9.0.

Module Detect: A write to the Module Detect Register at I/O module address 98 plus the module offset based on Registration Number will blink the STAT LED on the top angled surface of the module at a 5Hz rate for 5 seconds so the module location in a system can be visually identified.

8.0 Expanding a System

The MAQ20-COMx Communications Module periodically scans the system and will detect if a MAQ®20 I/O module has been added. When this happens the next available sequential Registration Number is assigned to the module.

Standard system expansion involves a simple three step process:

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STANDARD EXPANSION PROCESS

1.) Turn system power on and observe communications activity on the I/O modules.

2.) Add a single MAQ®20 I/O module in any local or remote backbone position. Observe that the green Power LED is on, and communications activity is seen on the TX and RX LEDs. Allow 1 second for registration. This module has now been assigned the next available sequential Registration Number.

Label and connect input/output wiring to the I/O module and if desired record physical position in the system.

3.) Repeat Step 2 for all remaining MAQ®20 I/O modules to be added to the system. Subsequent modules installed are assigned the next sequential Registration Number.

ALTERNATE EXPANSION PROCESS

1.) With system power off, install all additional MAQ®20 I/O modules in any vacant local or remote backbone positions. Label and connect field wiring to the I/O module and if desired record physical position in the system. Do not apply power.

2.) Apply system power and observe that each module has the green Power LED on, and communications activity is seen on the TX and RX LEDs. Allow 5 seconds for full system registration. Added modules have now been assigned the next available sequential Registration Numbers, but in a random sequence not associated with the physical position on the backbone. Modules previously installed and registered in the system retain their assigned Registration Numbers.

NOTES:

Once the registration process is complete Registration Numbers are permanent as long as I/O modules are not removed from or added to a system. When system power is cycled or the system is reset, I/O module Registration Numbers will always remain the same. Tools within MAQ20-940 - ReDAQ Shape Software for MAQ®20 and MAQ20-945 - MAQ®20 Configuration Software Tool allow the user to reassign Registration Numbers. For further details, see Section 9.0.

Module Detect: A write to the Module Detect Register at I/O module address 98 plus the module offset based on Registration Number will blink the STAT LED on the top angled surface of the module at a 5Hz rate for 5 seconds so the module location in a system can be visually identified.

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9.0 MAQ®20 I/O Module Registration

The MAQ®20 Data Acquisition System uses an automated registration process which periodically scans the system and will detect when MAQ®20 I/O modules are added and removed. Modules are assigned a sequential Registration Number based on the order in which they are detected. This order can be forced to occur in a given sequence by adding modules one at a time or it can be allowed to happen randomly. For further details, see Sections 6.0, 7.0 and 8.0.

The system does not identify I/O modules by physical position on a backbone, only by registration sequence. MAQ20-940 - ReDAQ Shape Software for MAQ®20 and MAQ20-945 - MAQ®20 Configuration Software Tool provided by Dataforth show a graphical representation of a system based on registration sequence and not by physical position. Tools within each software package allow the user to reassign Registration Numbers thereby making graphical representations match physical location for a single, local backbone.

Module Detect: A write to the Module Detect Register at I/O module address 98 plus the module offset based on Registration Number will blink the STAT LED on the top angled surface of the module at a 5Hz rate for 5 seconds so the module location in a system can be visually identified.

Each module is assigned an address space of 2000 addresses based on the Registration Number and starting at address 2000. I/O module with Registration Number 1 is assigned address space 2000 – 3999, I/O module with Registration Number 2 is assigned address space 4000 – 5999 and so on. The starting address for the module is very important because this is the offset address that must be added to the addresses listed in the I/O module address map to know where data for that module is located within the system level address map. The MAQ20-COMx Communication Module is always assigned a Registration Number of 0.

The Address Map for the MAQ20-xTC Types J, K, T, R and S Thermocouple Input Modules is found at the end of this manual. An excerpt from the Address Map is shown below. Channel Data is stored starting at address 1000.

NOTE:

When a module is registered in a system, addresses are offset by 2000 * R, where R is the Registration Number. Refer to Section 9.0 for further details on Registration Number.

Address Range 1000 - 1699: Module Data						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1000	R/W	8	Channel Data	Data for all 8 Channels	See Table 4	INT16

Example: A MAQ20-KTC module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 6. Read Current Data from Channels 0-7.

The MAQ20-KTC module with s/n 1234567-89 has an address offset of 2000 * 6 = 12000

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Read from register addresses 12000 + 1000 to 1007 = 12000 to 12007 the Current Data from Channels 0-7.

The MAQ20-940 - ReDAQ Shape Software for MAQ®20 and MAQ20-945 - MAQ®20 Configuration Software Tool both have a utility which allows the user to reassign Registration Numbers to I/O Modules in a system. This can be used to rearrange the way I/O modules are displayed in the software if the Alternate Registration Processes have been used instead of the Standard Registration Processes. These are both described in Sections 6.0, 7.0 and 8.0.

Graphical representations of a system in the ReDAQ Shape and Configuration Software Tool display I/O modules sequentially in the order they were registered. The display does not represent physical position and will not show vacant positions between I/O modules. The ReDAQ Shape graphic shows a 24-position backbone regardless of the backbone or combination of backbones used in a system.

When using the Configuration Software Tool, the registration sequence is presented on the main screen as shown in Figure 4.

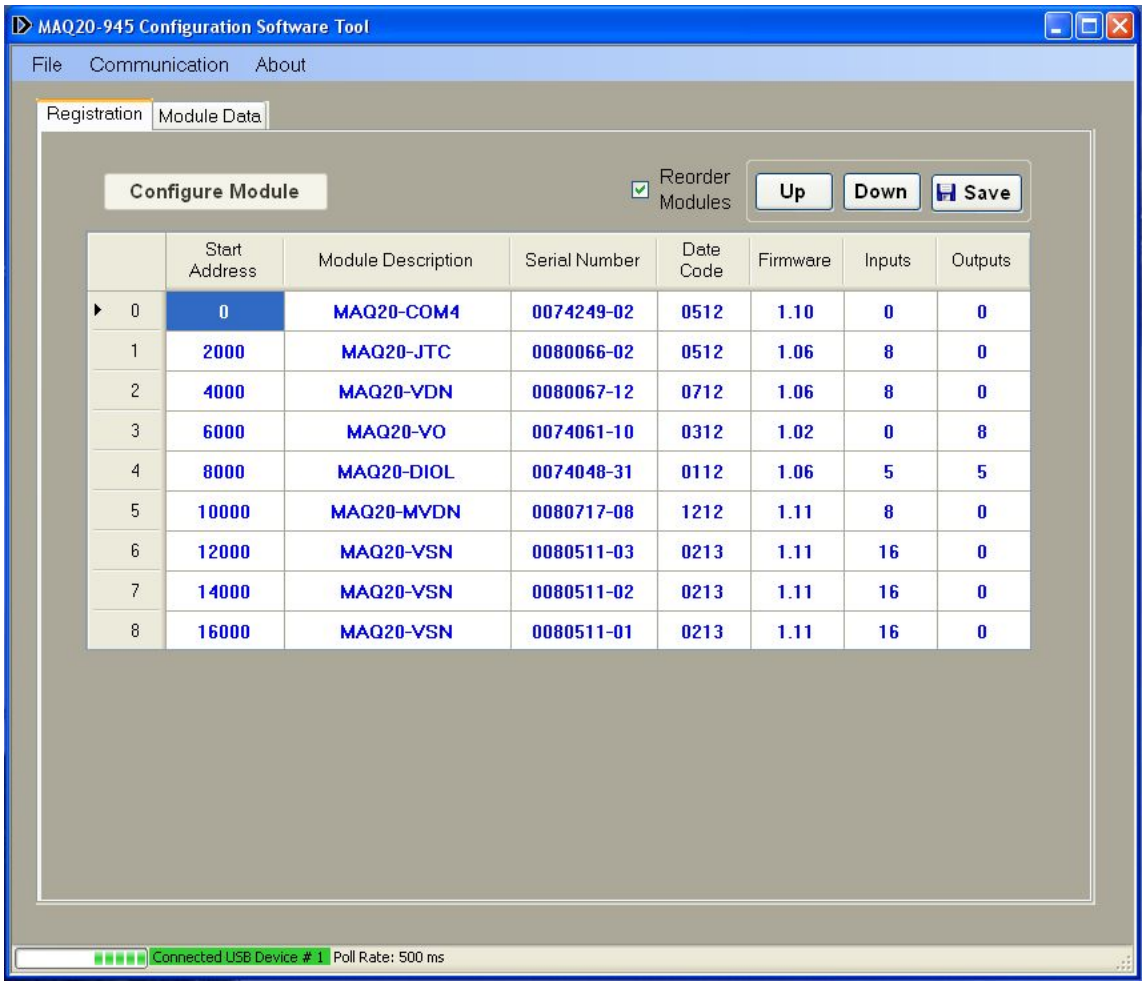


Figure 4: Module Registration using MAQ20-945 Configuration Software Tool

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Registration Numbers are listed in the left column. To change the Registration Number of an I/O module, click the box with the Registration Number in the left column, select the 'Reorder Modules' box, then use the Up and Down buttons to move the module within the sequence. The system automatically reassigns the I/O modules above and below the one moved. Repeat for other modules if desired. The MAQ20-COMx module always has Registration Number 0 and cannot be moved. Press 'Save' to save the configuration. The new registration sequence is permanent as long as I/O modules are not removed from or added to a system.

ReDAQ Shape Software for MAQ®20 presents a graphical representation of the system on the Acquire panel as shown in Figure 5.

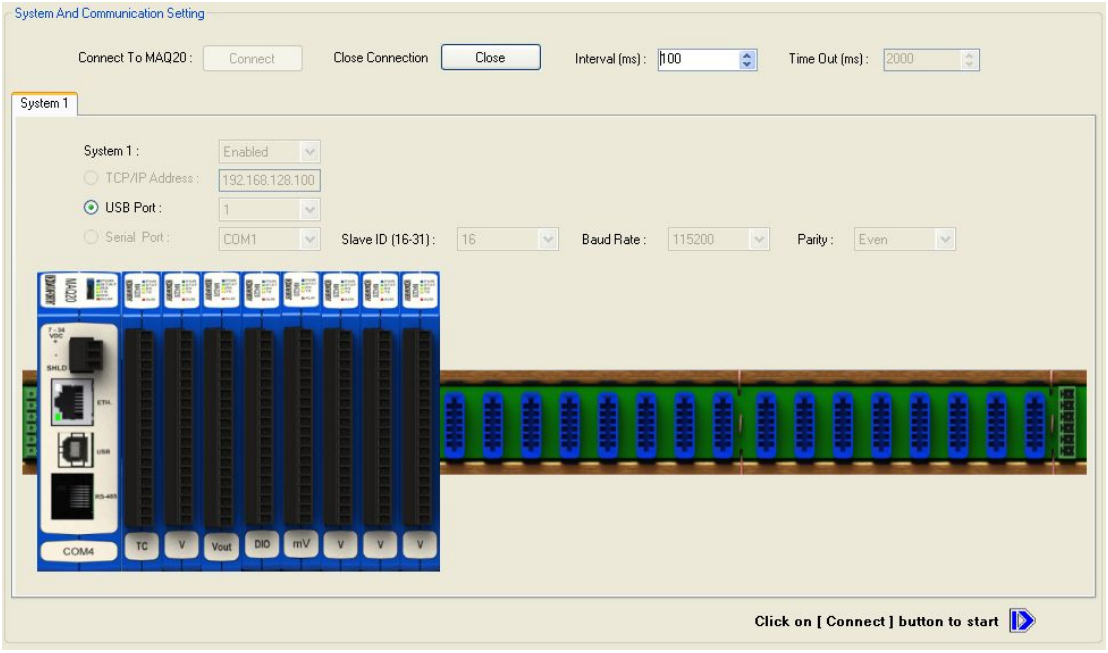
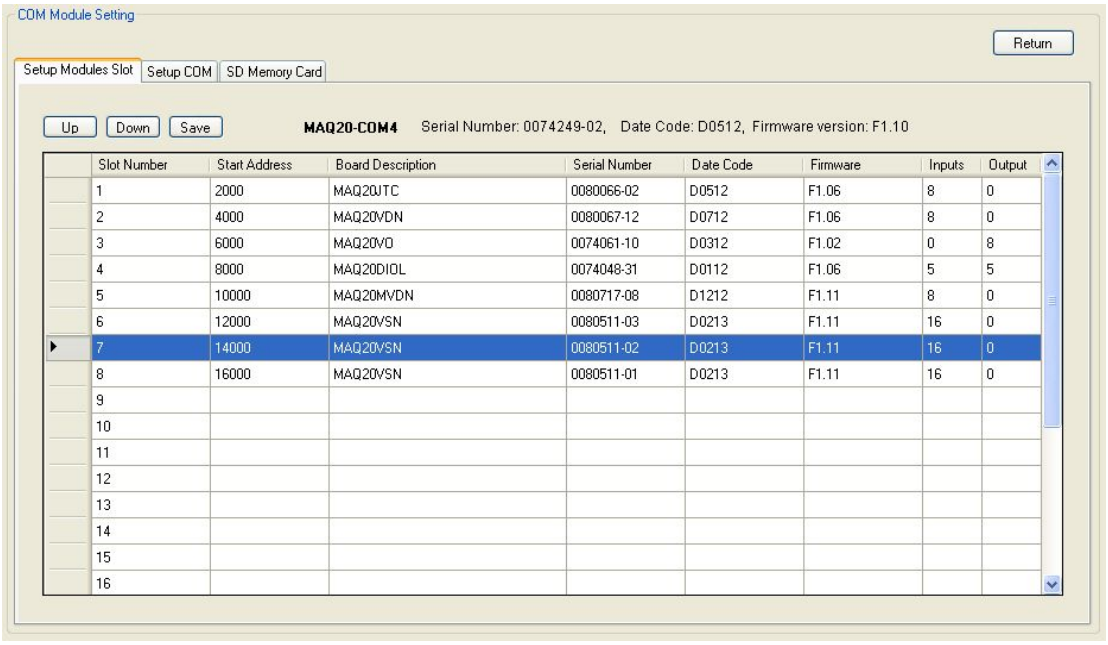


Figure 5: MAQ20-940 ReDAQ Shape for MAQ®20 Main Configuration Screen

To view the registration sequence, double-click on the MAQ20-COMx graphic as shown in Figure 6.

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Slot Number	Start Address	Board Description	Serial Number	Date Code	Firmware	Inputs	Output
1	2000	MAQ20JTC	0080066-02	D0512	F1.06	8	0
2	4000	MAQ20VDN	0080067-12	D0712	F1.06	8	0
3	6000	MAQ20VO	0074061-10	D0312	F1.02	0	8
4	8000	MAQ20DIOL	0074048-31	D0112	F1.06	5	5
5	10000	MAQ20MVDN	0080717-08	D1212	F1.11	8	0
6	12000	MAQ20VSN	0080511-03	D0213	F1.11	16	0
7	14000	MAQ20VSN	0080511-02	D0213	F1.11	16	0
8	16000	MAQ20VSN	0080511-01	D0213	F1.11	16	0
9							
10							
11							
12							
13							
14							
15							
16							

Figure 6: Module Registration using MAQ20-940 ReDAQ Shape for MAQ20

Registration Numbers are listed in the left column. To change the Registration Number of an I/O module, click the box in the left column next to the Registration Number, then use the Up and Down buttons to move the module within the sequence. The system automatically reassigns the I/O modules above and below the one moved. Repeat for other modules if desired. The MAQ20-COMx module always has Registration Number 0 and cannot be moved. Press 'Save' to save the new configuration. The new registration sequence is permanent as long as I/O modules are not removed from or added to a system.

10.0 Range Selection and Channel Enable

The MAQ20-JTC, -KTC, -TTC and –RSTC modules have two to four user selectable input ranges depending on model. Input ranges are selectable on a per-channel basis. Over-range and Under-range up to 2% beyond the standard input values will be measured. Sensor linearization is performed in the module and published accuracy is guaranteed over the standard input ranges. The Range Table following the Address Map at the end of this manual shows the input ranges for each module and the input temperature to counts mapping. An excerpt from Range Table for the MAQ20-KTC module is shown below for reference.

	Range	Standard Input Temperature	Equivalent Counts	Over/Under Range	Equivalent Counts	Deg C per Count
KTC	0	-100°C to +1350°C (Default)	-303 to 4095	-102°C to +1377°C	-309 to 4177	0.3296
	1	-100°C to +651°C	-607 to 3950	-102°C to +664°C	-619 to 4029	0.1648
	2	-100°C to +332°C	-1214 to 4029	-102°C to +339°C	-1238 to 4110	0.0824

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The Address Map for the MAQ20-xTC Type x Thermocouple Input Modules is found at the end of this manual. An excerpt from the Address Map is shown below. Input Range is stored starting at address 100, Channel Enable is stored starting at address 140, and Channel Data is stored starting at address 1000.

NOTE:

When a module is registered in a system, addresses are offset by 2000 * R, where R is the Registration Number. Refer to Section 9.0 for further details on Registration Number.

Address Range 100 - 699: Module Configuration						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
100	R/W	8	Input Range	Range for each of 8 channels	See Table 4	INT16
140	R/W	8	Channel Enable	0 = Disable 1 = Enable (default)	0 or 1	INT16

Address Range 1000 - 1699: Module Data						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1000	R/W	8	Channel Data	Data for each of 8 Channels	See Table 4	INT16

To change the input range, write the appropriate range code to address 100 + 2000 * R.

Channels in a module can be selectively enabled for scanning. By default, all channels are enabled. Non-used channels may be disabled to increase sampling rate of enabled channels. To disable a channel, write a 0 to the appropriate register starting at address 140 + 2000 * R. To enable a channel, write a 1 to this register.

Once a range selection is made it can be saved to EEPROM. Standard Reset does not affect the setting in volatile memory. Reset-to-Default will clear the setting in volatile memory and reset the ranges to the default values. Settings stored to EEPROM are not affected by Standard Reset or Reset-to-Default. Module power cycle will restore range settings from EEPROM.

Example: A MAQ20-KTC module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 2. Set channels 0 and 1 to measure -100 to 651°C, channels 4 and 5 to measure -100 to 332°C, and disable channels 2, 3, 6 and 7. Obtain the current readings in counts and convert these to Engineering units.

The MAQ20-KTC module with s/n 1234567-89 has an address offset of 2000 * 2 = 4000

The default module configuration is all channels enabled and all channels with range -100 to +1350°C. The table shows that Range 1 is -100 to 651°C in and Range 2 is -100 to 332°C in. Range information is also stored in registers at addresses 1700 – 1780 for user read back if desired.

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1.) Write to register address 4000 + 100 = 4100 a data value of 1 to set Ch 0 input range -100 to 651°C

2.) Write to register address 4000 + 101 = 4101 a data value of 1 to set Ch 1 input range -100 to 651°C

3.) Write to register address 4000 + 104 = 4104 a data value of 2 to set Ch 4 input range -100 to 332°C

4.) Write to register address 4000 + 105 = 4105 a data value of 2 to set Ch 5 input range -100 to 332°C

5.) Write to register address 4000 + 142 = 4142 a data value of 0 to disable Channel 2

6.) Write to register address 4000 + 143 = 4143 a data value of 0 to disable Channel 3

7.) Write to register address 4000 + 146 = 4146 a data value of 0 to disable Channel 6

8.) Write to register address 4000 + 147 = 4147 a data value of 0 to disable Channel 7

9.) Read from register address 4000 + 1000 = 5000 the data from Channel 0

10.) Read from register address 4000 + 1001 = 5001 the data from Channel 1

11.) Read from register address 4000 + 1004 = 5004 the data from Channel 4

12.) Read from register address 4000 + 1005 = 5005 the data from Channel 5

If the data read from Channel 0 is 3120 counts and the data read from Channel 4 is -133 counts, the input signals are:

$$\text{Ch 0: } \frac{3120 \text{ counts} * (651°\text{C} - (-100°\text{C}))}{(3950 \text{ counts} - (-607\text{counts}))} = +514.2°\text{C}$$

$$\text{Ch 4: } \frac{-133 \text{ counts} * (332°\text{C} - (-100°\text{C}))}{(4029 \text{ counts} - (-1214 \text{ counts}))} = -10.96°\text{C}$$

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11.0 Alarm Functions

The powerful alarm functions in the MAQ®20 Data Acquisition System provide essential monitoring and warnings to ensure optimum process flow and fail-safe applications. Alarms have the following parameters which can be configured:

Alarm Enable

Enables the Alarm on a given channel provided that the Alarm Configuration Register has a valid configuration. Set the bit corresponding to the given channel to a 1 to enable the alarm. If the Alarm Configuration register for the given channel does not have a valid value, the write will be ignored and the Alarm Enable bit will remain 0. Write a 0 to the bit corresponding to the given channel to disable the alarm and clear any alarms that have tripped.

Alarm Configuration

Selects Tracking or Latching alarms for a given channel and selects which limits trip the alarm - High, Low, High-High or Low-Low. There is a register for each channel. The value written to this register is the sum of the codes for the Alarm Type and Alarm Limits. Refer to Section 12.0 for the specific codes. If an invalid value is written to this register, the value will be ignored and the last valid value that the register contained will be kept. If a 0 is written to the register, the Alarm Enable register for the channel will be set to 0 and alarms that the channel has tripped will be cleared.

Tracking alarms follow the value of the input signal and reset automatically when the signal comes back into the valid range specified by the limit and deadband. Latching alarms trip when the signal exceeds the alarm condition and remains set until reset by the user.

High Limit

Sets the value for the High limit in counts. Alarm status is stored in a register.

Low Limit

Sets the value for the Low limit in counts. Alarm status is stored in a register.

High Low Deadband

Used for the High and/or Low limits to prevent false tripping or alarm chatter for noisy signals. Deadband is the region less than the High limit or greater than the Low limit, measured in counts, which the signal must traverse through before the alarm is reset after being tripped.

High-High Limit

Sets the value for the High-High limit in counts. Alarm status is stored in a register.

Low-Low Limit

Sets the value for the Low-Low limit in counts. Alarm status is stored in a register.

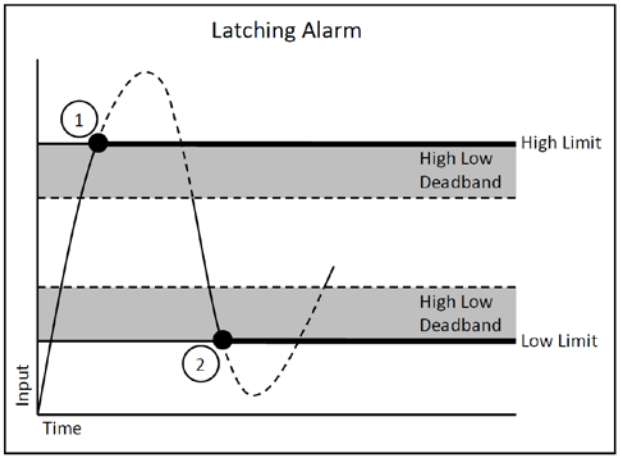
High-High Low-Low Deadband

Used for the High-High and/or Low-Low limits to prevent false tripping or alarm chatter for noisy signals. Deadband is the region less than the High-High limit or greater than the Low-Low limit, measured in counts, which the signal must traverse through before the alarm is reset after being tripped.

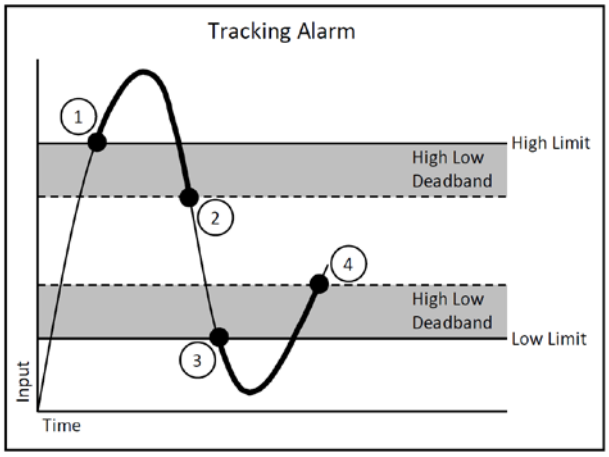
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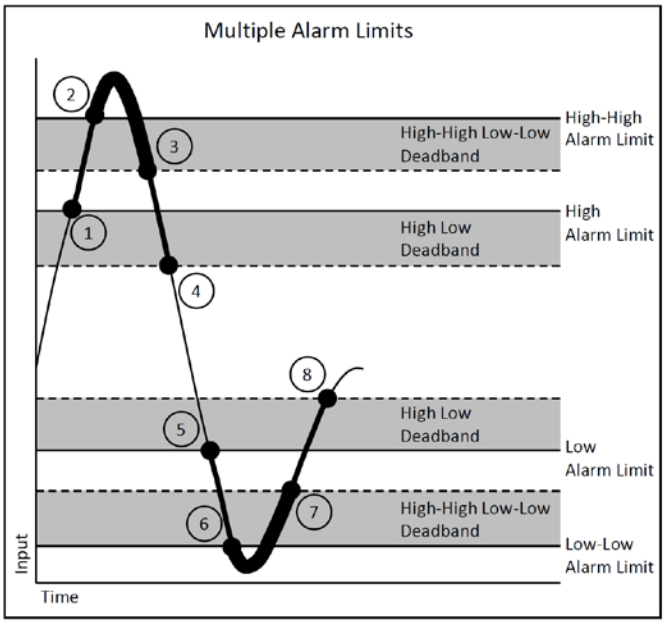
See Figure 7 below for graphical representations of alarm parameters and functionality.



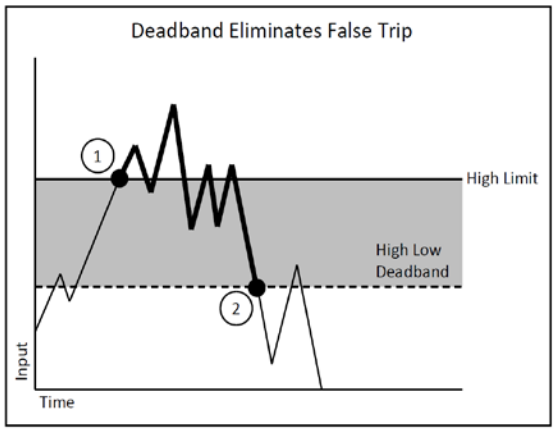
1. High Alarm Tripped
2. Low Alarm Tripped



1. High Alarm Tripped
2. High Alarm Reset
3. Low Alarm Tripped
4. Low Alarm Reset



1. High Alarm Trip
2. High-High Alarm Trip
3. High-High Alarm Reset
4. High Alarm Reset
5. Low Alarm trip
6. Low-Low Alarm Trip
7. Low-Low Alarm Reset
8. Low Alarm Reset



1. High Alarm Trip
2. High Alarm Reset

Figure 7: Alarm Parameters and Functionality

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12.0 Setting and Monitoring Alarms

The Address Map for the MAQ20-xTC Type x Thermocouple Input Modules is found at the end of this manual. An excerpt from the Address Map is shown below. Alarm parameters are stored in registers at addresses 700 – 999.

NOTE: When a module is registered in a system, addresses are offset by 2000 * R, where R is the Registration Number. Refer to Section 9.0 for further details on Registration Number.

Address Range 700 - 999: Alarm Configuration						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
700	R/W	1	Alarm Status, Low-Low	To clear a Latched alarm, write a 0 to the corresponding channel bit.	0 to 65,535	INT16
701	R/W	1	Alarm Status, Low	To clear a Latched alarm, write a 0 to the corresponding channel bit.	0 to 65,535	INT16
702	R/W	1	Alarm Status, High	To clear a Latched alarm, write a 0 to the corresponding channel bit.	0 to 65,535	INT16
703	R/W	1	Alarm Status, High-High	To clear a Latched alarm, write a 0 to the corresponding channel bit.	0 to 65,535	INT16
704	R/W	1	Alarm Enable	1 = Enabled 0 = Disabled	See below	INT16
710	R/W	8	Alarm Config	Alarm Configuration	See below	INT16
730	R/W	8	High Limit	High Alarm Limit	See Table 4	INT16
750	R/W	8	Low Limit	Low Alarm Limit	See Table 4	INT16
770	R/W	8	High Low Deadband	Deadband for High Low Alarm	See Table 4	INT16
790	R/W	8	High-High Limit	High-High Alarm Limit	See Table 4	INT16
810	R/W	8	Low-Low Limit	Low-Low Alarm Limit	See Table 4	INT16
830	R/W	8	High-High Low-Low Deadband	Deadband for High-High Low-Low Alarm	See Table 4	INT16

Alarms are configured by writing a code to the register at address 710 + 2000 * R and then enabled and disabled by writing a 1 or 0 to the register at address 704 + 2000 * R. Alarm Status is stored in registers at address range 700 – 703, offset by 2000 * R. The code written to address 710 + 2000 * R is the sum of a number representing the type of alarm and a number representing the alarm limits to be monitored.

Alarm Configuration Value = Alarm Type Code + Alarm Limit Code

Alarm Type	**Code**
Tracking	1000
Latching	2000

Alarm Limit	**Code**
Low Limit	100
High Limit	200
High Low Limit	300
Low-Low Limit	400
High-High Limit	500
High-High Low-Low Limit	600

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If the Alarm Configuration Value = 0, the Alarm is Off (Disabled). The Alarm for a given channel cannot be turned On (Enabled) until a valid, non-zero value is written to the Alarm Configuration register.

Example: A MAQ20-KTC module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 3. Set up the module to have a Tracking Alarm on Channel 1 with a High limit of 3000 counts, a Low limit of 500 counts and a Deadband of 100 counts.

The MAQ20-KTC module with s/n 1234567-89 has an address offset of 2000 * 3 = 6000

1.) Write to register address 6000 + 711 = 6711 a value of 1000 + 300 = 1300 to set a Tracking Alarm with High Low limits

2.) Write to register address 6000 + 731 = 6731 a data value of 3000 to set the High limit

3.) Write to register address 6000 + 751 = 6751 a data value of 500 to set the Low limit

4.) Write to register address 6000 + 771 = 6711 a data value of 100 to set the Deadband for the High and Low limits

5.) Write to register address 6000 + 704 = 6704 the equivalent of bit code 0000 0010 = 3 to enable the alarm on Channel 1

When an alarm condition is reached as specified by the above parameters, the Alarm Status registers are written in response to the events and the red LED on the module is lit.

1.) Read register address 6000 + 701 = 6701 to view the status of the Low Alarm.

If bit code 0000 0010 = 3 is read, a Low Alarm has occurred on Channel 1.

2.) Read register address 6000 + 702 = 6702 to view the status of the High Alarm

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13.0 Signal Averaging

Signal averaging can be set on a per-channel basis by configuring the Average Weight. Average Weight is calculated as 2^x where x = 0 to 15 and the default value is x = 0. The running average is then calculated as follows:

$$\text{Average} = \text{Average} + \frac{\text{Sampled Value} - \text{Average}}{\text{Average Weight}}$$

The Address Map for the MAQ20-xTC Type x Thermocouple Input Modules is found at the end of this manual. An excerpt from the Address Map is shown below. Signal averaging parameters are stored in registers at addresses 120 – 127.

NOTE:

When a module is registered in a system, addresses are offset by 2000 * R, where R is the Registration Number. Refer to Section 9.0 for further details on Registration Number.

Address Range 100 - 699: Module Configuration						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
120	R/W	8	AVG Weight	Weight for AVG Calculation	0 to 15	INT16

Address Range 1000 - 1699: Module Data						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1000	R/W	8	Channel Data	Data for all 8 Channels	See Table 4	INT16
1016	R/W	1	Alarm Status	Status of Low-Low Alarm	0 to 65,535	INT16
1017	R/W	1	Alarm Status	Status of Low Alarm	0 to 65,535	INT16
1018	R/W	1	Alarm Status	Status of High Alarm	0 to 65,535	INT16
1019	R/W	1	Alarm Status	Status of High-High Alarm	0 to 65,535	INT16
1020	R	4	Temp Sensor 0-3	Resolution = 0.0625°C / Count	-640 to 1360	INT16
1030	R/W	8	Data Minimum	Minimum for each of 8 Channels	See Table 4	INT16
1050	R/W	8	Data Maximum	Maximum for each of 8 Channels	See Table 4	INT16
1070	R/W	8	Data Average	Average for each of 8 Channels	See Table 4	INT16
1090	R	8	Channel 0 Data	Last 8 readings for Channel 0	See Table 4	INT16
1100	R	8	Channel 1 Data	Last 8 readings for Channel 1	See Table 4	INT16
1110	R	8	Channel 2 Data	Last 8 readings for Channel 2	See Table 4	INT16
1120	R	8	Channel 3 Data	Last 8 readings for Channel 3	See Table 4	INT16
1130	R	8	Channel 4 Data	Last 8 readings for Channel 4	See Table 4	INT16
1140	R	8	Channel 5 Data	Last 8 readings for Channel 5	See Table 4	INT16
1150	R	8	Channel 6 Data	Last 8 readings for Channel 6	See Table 4	INT16
1160	R	8	Channel 7 Data	Last 8 readings for Channel 7	See Table 4	INT16

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Example: A MAQ20-KTC module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 4. Set the Average Weight of Channel 4 to 8, then read the following parameters for Channel 4: Current Data, Min Data, Max Data, Average Data and the last 8 readings.

The MAQ20-KTC module with s/n 1234567-89 has an address offset of 2000 * 4 = 8000

1.) Write to register address 8000 + 124 = 8124 a data value of 8 to set the Average Weight
2.) Read from register address 8000 + 1034 = 9034 the min data from Channel 4
3.) Read from register address 8000 + 1054 = 9054 the max data from Channel 4
4.) Read from register address 8000 + 1074 = 9074 the average data from Channel 4 with weight 8
5.) Read from register address 8000 + 1130 to 1137 = 9130 - 9137 the last 8 readings from Channel 4

14.0 Reset Functions

Two types of firmware reset are supported in the MAQ®20 I/O modules:

Standard Reset is used to put the module in a user-defined state. The parameters listed below will be set to the last state saved to EEPROM. Parameters stored in EEPROM are not affected.

Reset-to-Default reverts the module to the settings used at the factory during manufacture. It performs the standard reset actions plus resets most non-volatile parameters to default settings. Parameters stored in EEPROM are not affected.

Table 2 shows what parameters are affected for each reset.

Table 2: Parameters Affected by Standard Reset and Reset-to-Default

RESET TYPE	PARAMETERS
Standard Reset	Disables all Alarms Resets Min, Max and Average registers to 0 Clears all Status and Diagnostic registers
Reset-to-Default	All parameters listed under Standard Reset, plus: Clears all Alarm Limits and Deadbands

Reset Registers

Writing a valid data value to the Reset Register will force the module to perform a specified reset. Write 0 to perform Standard Reset and write 255 to perform Reset-to-Default.

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NOTE:

The MAQ®20 I/O modules send a response to the reset register write before carrying out the reset. This means the module will be unresponsive to commands for approximately 3 seconds.

Power-On-Reset (POR) and Brownout

MAQ®20 I/O modules utilize a brown-out detect circuit and watchdog timer to ensure reliable and predictable operation under all conditions. Upon power cycle, brown-out detect or any extreme circumstance under which the watchdog timer expires, a Standard Reset is performed, and parameters stored in EEPROM are loaded to the appropriate registers.

15.0 Module Identification and Status Registers

Module identification including model number, serial number, date code and firmware revision are stored in registers at addresses 0 – 44.

I/O modules in a system are identified in general by their model number (MAQ20-VDN, MAQ20-JTC, etc.) and uniquely by their Serial Number printed on the side label (1234567-89). When I/O modules are installed in the system, only a general identifier is visible on the front of the module (V, I, TCPL, etc.). Wire tags or additional labeling applied to the module terminal block may be used for visible unique identification in an installed system. Additionally, the system has the utility to provide a visible indication of module response for identification. Any write to address 98 plus the offset based on the Registration Number will blink the STATUS LED on the top angled surface of the module at a 5Hz rate for 5 seconds.

For troubleshooting purposes, reset status, communications errors, and invalid data written to a module is monitored and made available to the user. Registers at addresses 1900 – 1910 hold this information.

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16.0 LED Indicators

A set of 5 LEDs on the top panel of the MAQ®20 I/O modules indicate module power, operation, communication, and alarm status.



Figure 8: MAQ®20 Faceplate

LED Function and Troubleshooting Tips:

PWR

Normal operation: BLUE, solid lit

LED Off: Abnormal power situation

- Verify that a MAQ20-COMx is present in the system.
- Verify that the MAQ20-COMx module has 7-34VDC power connected and turned on
- Determine if the module is communicating by observing the TX and RX LEDs

STAT

Normal operation: GREEN, 1 Hz blinking

Module Detect: A write to the Module Detect Register will force this LED to blink at 5Hz rate for 5 seconds so the module location in a system can be visually identified. Referring to the Address Map, this register is at address 98 off of the module base address.

LED Constant On or Constant Off: Abnormal operation

- Remove and reinstall module to force a reset.
- Remove and reinstall module into another backbone position.
- Determine if the module is communicating by observing the TX and RX LEDs

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RX, TX

Normal Operation – YELLOW, rapid blinking during communication with MAQ20-COMx module

LED Constant Off: Abnormal operation or no communications to MAQ20-COMx module

- Verify communications by sending a request for data. Note that the fast communications rate used on the system backbone will result in the LED appearing dim due to short blinking cycle.
- Verify that the PWR and STAT LED indicate normal operation.
- Verify that there is only one MAQ20-COMx module installed in the system.

ALM

Normal operation: Off

Alarm Condition Detected: RED, solid lit.

- One or more alarms have been tripped.
- Read Alarm Registers based on Alarm Configuration to determine system status

The following troubleshooting tips can be used to further diagnose and fix system problems:

- Remove and reinstall MAQ®20 I/O module and/or MAQ20-COMx module to verify proper insertion into Backbone.
- Remove and reinstall MAQ®20 I/O module into another backbone position.
- If a Backbone extension cable is used, ensure that the connections are made correctly.

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17.0 Specifications

MAQ®20 THERMOCOUPLE INPUT MODULE Typical at Ta = +25°C and +24V system power

Model Number	**Description**
MAQ20-JTC	8-channel, Type JTC, Differential Input -100°C to +760°C (Default) -100°C to +393°C, -100°C to +199°C
MAQ20-KTC	8-channel, Type KTC, Differential Input -100°C to +1350°C (Default) -100°C to +651°C, -100°C to +332°C
MAQ20-TTC	8-channel, Type TTC, Differential Input -100°C to +400°C (Default), -100°C to +220°C
MAQ20-RSTC	8-channel, Type RTC and Type STC, Differential Input Type R -100°C to +1750°C (Default), -100°C to +990°C Type S: -100°C to +1750°C, -100°C to +970°C
Per Channel Setup	Individually configurable for range, alarms, averaging
Input Protection	
Continuous	150Vrms max
Transient	ANSI/IEEE C37.90.1
CMV	
Channel-to-Bus	1500Vrms, 1 min
Channel-to-Channel	±3V
Transient	ANSI/IEEE C37.90.1
CMR	100dB @ 50/60 Hz
NMR	26dB @ 50/60 Hz
Accuracy(1)	±0.06% span
Conformity	±0.035% span
Cold Junction Compensation	±0.25°C @ +25°C, ±1.0°C @ -40°C to +85°C
Resolution	0.020% span
Stability	
Zero	±15ppm/°C
Span	±35ppm/°C
Bandwidth	3Hz
Scan Rate	20 Ch/s
Alarms	High / High-High / Low / Low-Low
Open Input Response	Downscale, < 5s, Flag Set
Power Supply Current	30mA
Dimensions (h)(w)(d)	4.51” x 0.60” x 3.26” (114.6mm x 15.3mm x 82.8mm)
Environmental	
Operating Temperature	-40°C to +85°C
Storage Temperature	-40°C to +85°C
Relative Humidity	0 to 95%, non-condensing
Emissions, EN61000-6-4	ISM Group 1
Radiated, Conducted	Class A
Immunity EN61000-6-2	ISM Group 1
RF	Performance A +/- 0.5% Span Error
ESD, EFT	Performance B
Certifications	Heavy Industrial CE
	UL/cUL (Class I, Div 2, Groups A, B, C, D) file E232858
	ATEX Pending

(1) Includes conformity, hysteresis, and repeatability. Does not include CJC accuracy.

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18.0 MAQ20-JTC, -KTC, -TTC and -RSTC Address Map and Range Table

Tables in this section outline the MAQ20-xTC address space. Data in these registers contains all permanent and user settable information for module configuration, status, operation of all functions, data read/write, and data storage. Table columns list the following information:

Start Address: Start address for the specified quantity of addresses. The start address is offset by 2000 * R where R is the module Registration Number.

Read/Write: Indicates whether data at the address is Read, Write or both.

Number of Registers: The number of 16-bit registers reserved for the specified contents.

Contents: Parameter stored at the specified address.

Description: Details, examples, limits, and default values for the parameter stored at the specified address.

Data Range: Valid data read from or written to an address range. Data not in this range which is written to an address may return a Modus Exception 3, Illegal Data, or may be ignored.

Data Type: The type of data stored at the specified address.

ASCII 0123456789ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz, -, " "
INT16 16-bit integer value, 0 to 65535, unless otherwise indicated. Stored at a single address.
INT32 32-bit integer value, 0 to 4294967295, unless otherwise indicated. Stored at two 16-bit addresses. MSB is stored at address N, LSB is stored at address N+1.

NOTE:

When a module is registered in a system, addresses are offset by 2000 * R, where R is the Registration Number. Refer to Section 9.0 for further details on Registration Number.

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Table 3: MAQ20-JTC, -KTC, -TTC, -RSTC Address Map

Address Range 0 - 99: Module Information						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
0	R	15	Device Description	MAQ20-xTC	Characters, Numbers, "-" and Space	ASCII
19	R	11	Serial Number	S1234567-89	Characters, Numbers, "-" and Space	ASCII
30	R	5	Date Code	D1510	Characters, Numbers	ASCII
35	R	5	Firmware Rev	F1.00	Characters, Numbers and "."	ASCII
40	R	1	Input Channels	8 Input Channels	8	ASCII
41	R	1	Output Channels	0 Output Channels	0	ASCII
98	W	1	Module Detect	Any write will blink Status LED at 5Hz for 5 seconds	0 to 65,535	INT16
99	W	1	Reset Register	0 = Standard Reset, 255 = Reset to Default	0, 255	INT16

Address Range 100 - 699: Module Configuration						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
100	R/W	8	Input Range	Range for each of 8 channels	See Table 4	INT16
119	W	1	Save to EEPROM	0 = Gain, Avg Weight, Scan List	0	INT16
120	R/W	8	AVG Weight	Weight for AVG Calculation	0 to 15	INT16
140	R/W	8	Channel Enable	0 = Disable 1 = Enable (default)	0 or 1	INT16

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Address Range 700 - 999: Alarm Configuration						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
700	R/W	1	Alarm Status, Low-Low	To clear a Latched alarm, write a 0 to the corresponding channel bit.	0 to 65,535	INT16
701	R/W	1	Alarm Status, Low	To clear a Latched alarm, write a 0 to the corresponding channel bit.	0 to 65,535	INT16
702	R/W	1	Alarm Status, High	To clear a Latched alarm, write a 0 to the corresponding channel bit.	0 to 65,535	INT16
703	R/W	1	Alarm Status, High-High	To clear a Latched alarm, write a 0 to the corresponding channel bit.	0 to 65,535	INT16
704	R/W	1	Alarm Enable	1 = Enabled 0 = Disabled	See Section 12.0	INT16
710	R/W	8	Alarm Configuration	Alarm Configuration	See Section 12.0	INT16
730	R/W	8	High Limit	High Alarm Limit	See Table 4	INT16
750	R/W	8	Low Limit	Low Alarm Limit	See Table 4	INT16
770	R/W	8	High Low Deadband	Deadband for High Low Alarm	See Table 4	INT16
790	R/W	8	High-High Limit	High-High Alarm Limit	See Table 4	INT16
810	R/W	8	Low-Low Limit	Low-Low Alarm Limit	See Table 4	INT16
830	R/W	8	High-High Low-Low Deadband	Deadband for High-High Low-Low Alarm	See Table 4	INT16

Address Range 1000 - 1699: Module Data						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1000	R/W	8	Channel Data	Data for each of 8 Channels	See Table 4	INT16
1016	R/W	1	Alarm Status	Status of Low-Low Alarm	0 to 65,535	INT16
1017	R/W	1	Alarm Status	Status of Low Alarm	0 to 65,535	INT16
1018	R/W	1	Alarm Status	Status of High Alarm	0 to 65,535	INT16
1019	R/W	1	Alarm Status	Status of High-High Alarm	0 to 65,535	INT16
1020	R	4	Temp Sensor 0-3	Resolution = 0.0625°C / Count	-640 to 1360	INT16
1030	R/W	8	Data Minimum	Minimum for each of 8 Channels	See Table 4	INT16
1050	R/W	8	Data Maximum	Maximum for each of 8 Channels	See Table 4	INT16
1070	R/W	8	Data Average	Average for each of 8 Channels	See Table 4	INT16
1090	R/W	8	Channel 0 Data	Last 8 readings for Channel 0	See Table 4	INT16
1100	R/W	8	Channel 1 Data	Last 8 readings for Channel 1	See Table 4	INT16
1110	R/W	8	Channel 2 Data	Last 8 readings for Channel 2	See Table 4	INT16
1120	R/W	8	Channel 3 Data	Last 8 readings for Channel 3	See Table 4	INT16
1130	R/W	8	Channel 4 Data	Last 8 readings for Channel 4	See Table 4	INT16
1140	R/W	8	Channel 5 Data	Last 8 readings for Channel 5	See Table 4	INT16
1150	R/W	8	Channel 6 Data	Last 8 readings for Channel 6	See Table 4	INT16
1160	R/W	8	Channel 7 Data	Last 8 readings for Channel 7	See Table 4	INT16

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Address Range 1700 - 1899: Input Ranges						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1700	**R**	**1**	**Range Count**	**Number of ranges supported**	**1 to 4**	**INT16**
1710	**R**	**1**	**Range 0**	**Engineering -fs.**	**-32,768 to 32,767**	**INT16**
1711	R	1	Range 0	Future Use	-32,768 to 32,767	INT16
1712	R	1	Range 0	Engineering +fs	-32,768 to 32,767	INT16
1713	R	1	Range 0	Future Use	-32,768 to 32,767	INT16
1714	R	1	Range 0	+fs & -fs multiplier Factor 10^X	-32,768 to 32,767	INT16
1715	R	1	Range 0	Engineering Units ("C", "V", etc.)	A to Z	ASCII
1716	R	1	Range 0	Engineering Units ("C", "V", etc.)	A to Z	ASCII
1717	R	1	Range 0	Future Use	-32,768 to 32,767	INT16
1718	R	1	Range 0	Count Value of -fs.	-32,768 to 32,767	INT16
1719	R	1	Range 0	Future Use	-32,768 to 32,767	INT16
1720	R	1	Range 0	Count Value of +fs.	-32,768 to 32,767	INT16
1730	**R**	**1**	**Range 1**	**Engineering -fs.**	**-32,768 to 32,767**	**INT16**
1731	R	1	Range 1	Future Use	-32,768 to 32,767	INT16
1732	R	1	Range 1	Engineering +fs	-32,768 to 32,767	INT16
1733	R	1	Range 1	Future Use	-32,768 to 32,767	INT16
1734	R	1	Range 1	+fs & -fs multiplier Factor 10^X	-32,768 to 32,767	INT16
1735	R	1	Range 1	Engineering Units ("C", "V", etc.)	A to Z	ASCII
1736	R	1	Range 1	Engineering Units ("C", "V", etc.)	A to Z	ASCII
1737	R	1	Range 1	Future Use	-32,768 to 32,767	INT16
1738	R	1	Range 1	Count Value of -fs.	-32,768 to 32,767	INT16
1739	R	1	Range 1	Future Use	-32,768 to 32,767	INT16
1740	R	1	Range 1	Count Value of +fs.	-32,768 to 32,767	INT16
1750	**R**	**1**	**Range 2**	**Engineering -fs.**	**-32,768 to 32,767**	**INT16**
1751	R	1	Range 2	Future Use	-32,768 to 32,767	INT16
1752	R	1	Range 2	Engineering +fs	-32,768 to 32,767	INT16
1753	R	1	Range 2	Future Use	-32,768 to 32,767	INT16
1754	R	1	Range 2	+fs & -fs multiplier Factor 10^X	-32,768 to 32,767	INT16
1755	R	1	Range 2	Engineering Units ("C", "V", etc.)	A to Z	ASCII
1756	R	1	Range 2	Engineering Units ("C", "V", etc.)	A to Z	ASCII
1757	R	1	Range 2	Future Use	-32,768 to 32,767	INT16
1758	R	1	Range 2	Count Value of -fs.	-32,768 to 32,767	INT16
1759	R	1	Range 2	Future Use	-32,768 to 32,767	INT16
1760	R	1	Range 2	Count Value of +fs.	-32,768 to 32,767	INT16
1770	**R**	**1**	**Range 3**	**Engineering -fs.**	**-32,768 to 32,767**	**INT16**
1771	R	1	Range 3	Future Use	-32,768 to 32,767	INT16
1772	R	1	Range 3	Engineering +fs	-32,768 to 32,767	INT16
1773	R	1	Range 3	Future Use	-32,768 to 32,767	INT16
1774	R	1	Range 3	+fs & -fs multiplier Factor 10^X	-32,768 to 32,767	INT16
1775	R	1	Range 3	Engineering Units ("C", "V", etc.)	A to Z	ASCII
1776	R	1	Range 3	Engineering Units ("C", "V", etc.)	A to Z	ASCII
1777	R	1	Range 3	Future Use	-32,768 to 32,767	INT16
1778	R	1	Range 3	Count Value of -fs.	-32,768 to 32,767	INT16
1779	R	1	Range 3	Future Use	-32,768 to 32,767	INT16
1780	R	1	Range 3	Count Value of +fs.	-32,768 to 32,767	INT16

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Address Range 1900 - 1999: Status Registers						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1900	R/W	1	Watchdog Flag	1 = Watchdog Reset, 0 = Normal	0 or 1	INT16
1901	R/W	1	BrownOut Flag	1 = BrownOut Reset, 0 = Normal	0 or 1	INT16
1902	R/W	1	I2C Error	I2C TX Error Counter	0 to 65,535	INT16
1903	R/W	1	I2C Error	I2C RX Error Counter	0 to 65,535	INT16
1906	R/W	1	Numeric Error	Increments when a value received is outside of the allowed range	0 to 65,535	INT16
1908	R/W	1	UART RX Error	UART RX Error Counter. Command Too Short	0 to 65,535	INT16
1909	R/W	1	UART RX Error	UART RX Error Counter. Command Too Long	0 to 65,535	INT16
1910	R/W	1	UART RX Error	UART RX Error Counter. Command received in invalid state	0 to 65,535	INT16

Table 4: MAQ20-JTC, -KTC, -TTC and -RSTC Range Table

	Range	**Standard Input Temperature**	**Equivalent Counts**	**Over/Under Range**	**Equivalent Counts**	**Deg C per Count**
JTC	0	-100°C to +760°C (Default)	-539 to 4095	-102°C to +775°C	-550 to 4177	0.1855
	1	-100°C to +393°C	-1078 to 4236	-102°C to +401°C	-1100 to 4321	0.0928
	2	-100°C to +199°C	-2156 to 4290	-102°C to +203°C	-2199 to 4376	0.0464
KTC	0	-100°C to +1350°C (Default)	-303 to 4095	-102°C to +1377°C	-309 to 4177	0.3296
	1	-100°C to +651°C	-607 to 3950	-102°C to +664°C	-619 to 4029	0.1648
	2	-100°C to +332°C	-1214 to 4029	-102°C to +339°C	-1238 to 4110	0.0824
TTC	0	-100°C to +400°C (Default)	-1024 to 4095	-102°C to +408°C	-1045 to 4177	0.0977
	1	-100°C to +220°C	-2048 to 4505	-102°C to +224°C	-2089 to 4595	0.0488
RSTC	0	Type R 0°C to +1750°C (Default)	0 to 4095	-35°C to +1785°C	-82 to 4177	0.4272
	1	Type R 0°C to +990°C	0 to 4634	-20°C to +1010°C	-93 to 4727	0.2136
	2	Type S 0°C to +1750°C	0 to 4095	-35°C to +1785°C	-82 to 4177	0.4272
	3	Type S 0°C to +970°C	0 to 4541	-19°C to +989°C	-91 to 4632	0.2136

Table 5: MAQ20-JTC, -KTC, -TTC, -RSTC Special Count Readings

Reading	**Condition**
6000	Positive Differential Input Exceeded
-6000	Open Input, Negative Differential Input Exceeded
7000	Positive Common Mode Exceeded
-7000	Negative Common Mode Exceeded

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