MAQ®20

Industrial Data Acquisition and Control System

MA1048

MAQ20-FREQ
Hardware User Manual



DATAFORTH®

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MAQ20-FREQ Hardware User Manual
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Table of Contents

1.0 System Features 1
2.0 System Description and Documentation 2
3.0 Unpacking 4
4.0 Module Dimensions and I/O Connections 4
5.0 Installation 7
6.0 Building a System 8
7.0 Maintaining a System 9
8.0 Expanding a System 11
9.0 MAQ20 I/O Module Registration and Reading the Input Signal 12
10.0 Data Minimum and Maximum, Counter Reset 15
11.0 Sensor Excitation or Logic Output 18
12.0 Timebase 19
13.0 RPM 20
14.0 State Change 21
15.0 Alarm Functions (Preliminary. Not currently implemented.) 23
16.0 Setting and Monitoring Alarms (Preliminary. Not Currently Implemented.) 25
17.0 Reset Functions 29
18.0 Module Identification and Status Registers 30
19.0 LED Indicators 30
20.0 Specifications 32
21.0 MAQ20-FREQ Address Map 33

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Errata Sheets

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1.0 System Features

The MAQ20 Data Acquisition System encompasses more than 30 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 ±0.3C 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 4GB of logged data can be transferred via FTP during real-time acquisition
- Up to 24 I/O modules, or 384 channels, per system, per 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 MAQ20 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 MAQ20 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 in module memory for ease of use and system design.

MAQ20 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 MAQ20 Frequency Input module offers 8 input channels for measuring frequencies from 1Hz to 1MHz or counts to 4 billion. Frequency input data can also be presented as RPM when pulses per revolution is specified. All channels have a fixed range, high resolution measurement and are individually configurable for alarms to match the most demanding applications. Four controllable outputs can be used as sensor excitation or as 5V logic compatible outputs. High, Low, High-High and Low-Low alarms provide essential monitoring and warning functions to ensure optimum process flow and fail-safe applications. Field I/O connections are made through a pluggable terminal block for ease of wiring and system construction.

Input-to-Bus isolation is a robust 1500Vrms and each individual channel is protected up to 300Vrms continuous overload in the case of inadvertent wiring errors. Overloaded or over-ranged 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.

4.0 Module Dimensions and I/O Connections

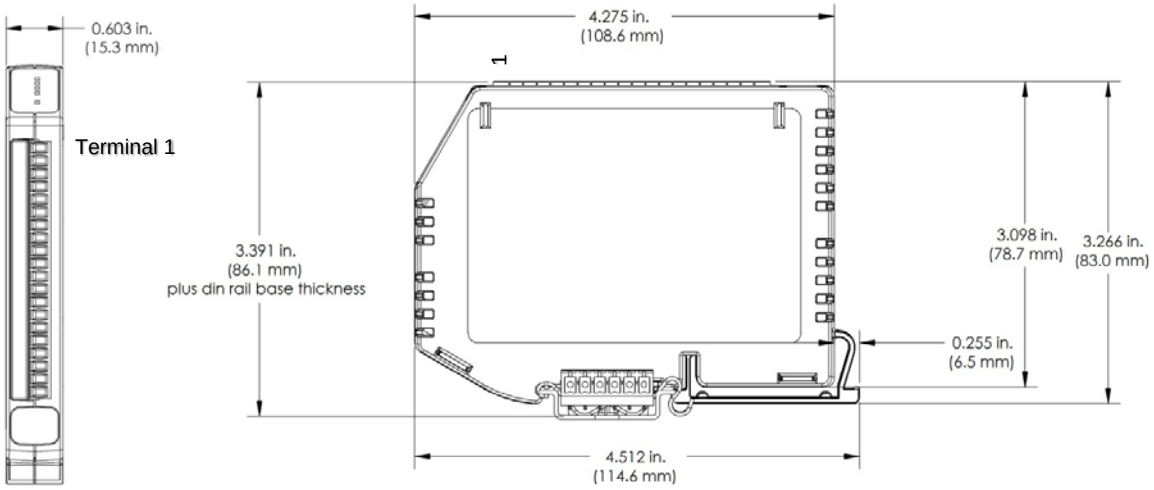


Figure 1: Module Dimensions

Table 1: I/O Terminal Block Connections

TERMINAL BLOCK POSITION (TOP TO BOTTOM)	MAQ20-FREQ I/O CONNECTIONS
1	CH0 +IN
2	CH0 -IN
3	CH1 +IN
4	CH1 -IN
5	EXC0 / OUT0
6	CH2 +IN
7	CH2 -IN
8	CH3 +IN
9	CH3 -IN
10	EXC1 / OUT1
11	CH4 +IN
12	CH4 -IN
13	CH5 +IN
14	CH5 -IN
15	EXC2 / OUT2
16	CH6 +IN
17	CH6 -IN
18	CH7 +IN
19	CH7 -IN
20	EXC3 / OUT3

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The rugged inputs of the MAQ20-FREQ module have a high-level protection against overload and transient events and are also configured for a high level of sensitivity. A 50mV hysteresis band allows measurement of signals as low as 75mVp-p. While this is beneficial when interfacing to low level signals, the high sensitivity can cause false triggering if there is a large amount of noise riding on input signals.

The 8 input channels and 4 excitation sources share a common ground inside the module. For optimal measurement of low level or noisy signals, use twisted-pair or twisted-shielded-pair wires with a dedicated wire pair between the I/O terminal block and the sensor for each channel used. If shielded wire is used, connect the shield to ground either at the sensor end of the cable or at the I/O terminal block –IN terminal. In most applications the best results are obtained with a shield connected at only one end, but in some situations a connection at both ends may yield better results.

I/O Terminal Block Connections

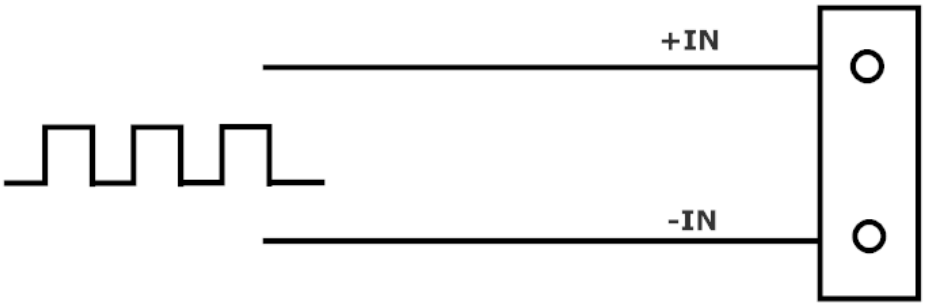
TERMINAL BLOCK POSITION (TOP TO BOTTOM)	MAQ20-FREQ I/O CONNECTIONS
1	CH0 +IN
2	CH0 -IN
3	CH1 +IN
4	CH1 -IN
5	EXC0 / OUT0

The following diagram shows connection of a low-level AC signal for frequency measurement with twisted shielded pair wiring.

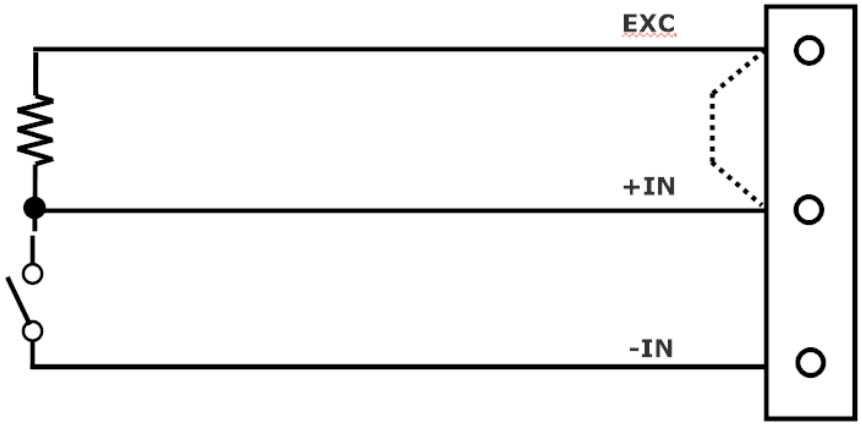


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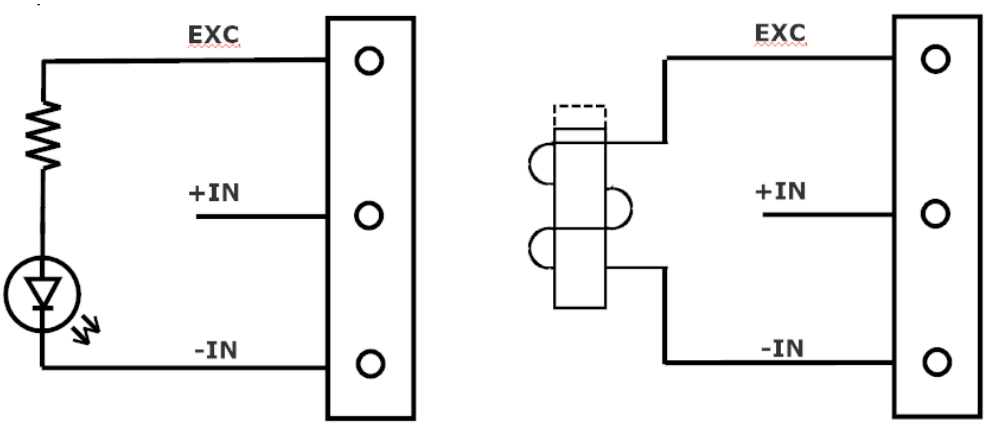
The following diagram shows connection of a pulse train signal or series of non-periodic pulses for count measurement.



The following diagram shows connection to a relay or dry contact sensor using the module excitation. A pullup resistor or direction connection between EXC and +IN can be used.



The following diagram shows how to use the excitation as a logic output to drive an indicator or a solenoid. The excitation is compatible with any device that accepts 5V logic.



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5.0 Installation

The MAQ20 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) as shown in Figure 2 below.

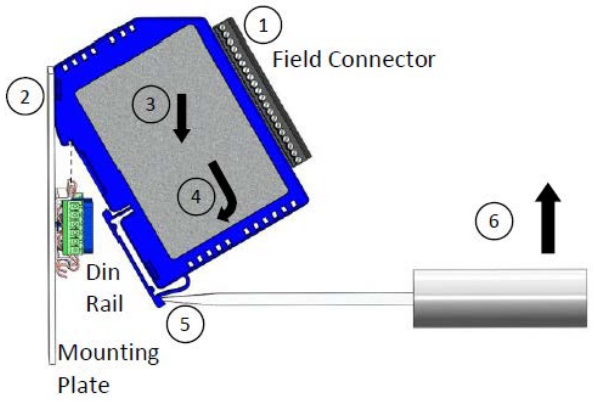


Figure 2: Installation and Removal

Multiple rows of MAQ20 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 in Figure 3 below.

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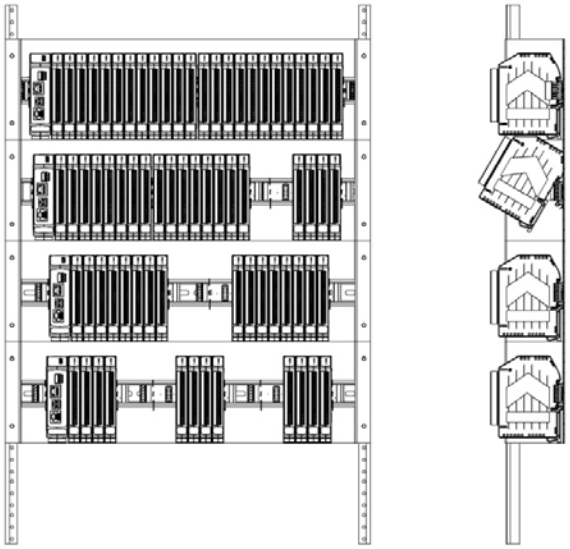


Figure 3: Possible System Configurations

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 MAQ20 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.

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

3.) Repeat Step 2 for all remaining MAQ20 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 MAQ20 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 MAQ20 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 MAQ20 provided by Dataforth shows a graphical representation of a system based on registration sequence and not by physical position. Tools within this 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 MAQ20 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 MAQ20 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 MAQ20 I/O module from any local or remote backbone position. Replace 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

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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 MAQ20 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.

Label and connect input/output 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. 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 MAQ20 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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8.0 Expanding a System

The MAQ20-COMx Communications Module periodically scans the system and will detect if a MAQ20 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:

STANDARD EXPANSION PROCESS

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

2.) Add a single MAQ20 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 MAQ20 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 MAQ20 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 MAQ20 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 MAQ20 I/O Module Registration and Reading the Input Signal

The MAQ20 Data Acquisition System uses an automated registration process which periodically scans the system and will detect when MAQ20 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 MAQ20 provided by Dataforth shows a graphical representation of a system based on registration sequence and not by physical position. Tools within the 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.

MAQ20-940 - ReDAQ Shape Software for MAQ20 has 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 has been used instead of the Standard Registration Processes. Registration is described in Sections 6.0, 7.0 and 8.0.

ReDAQ Shape provides a graphical representation of a system which displays 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 graphic shows a 24-position backbone regardless of the backbone or combination of backbones used in a system.

The graphical representation of the system is presented on the Acquire panel as shown in Figure 4.

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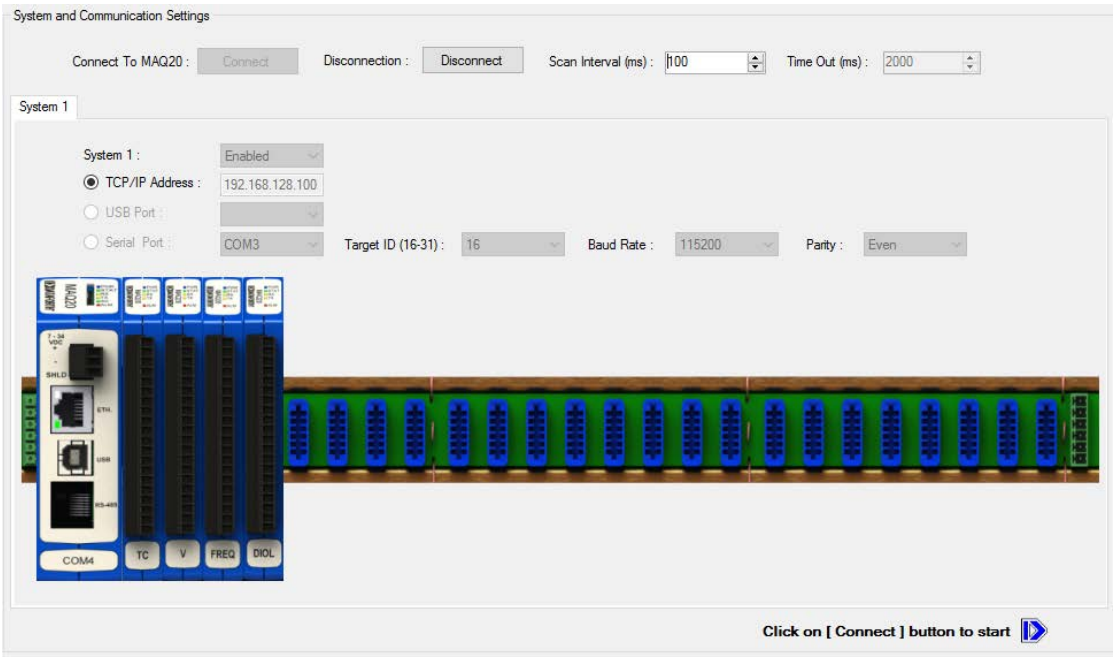
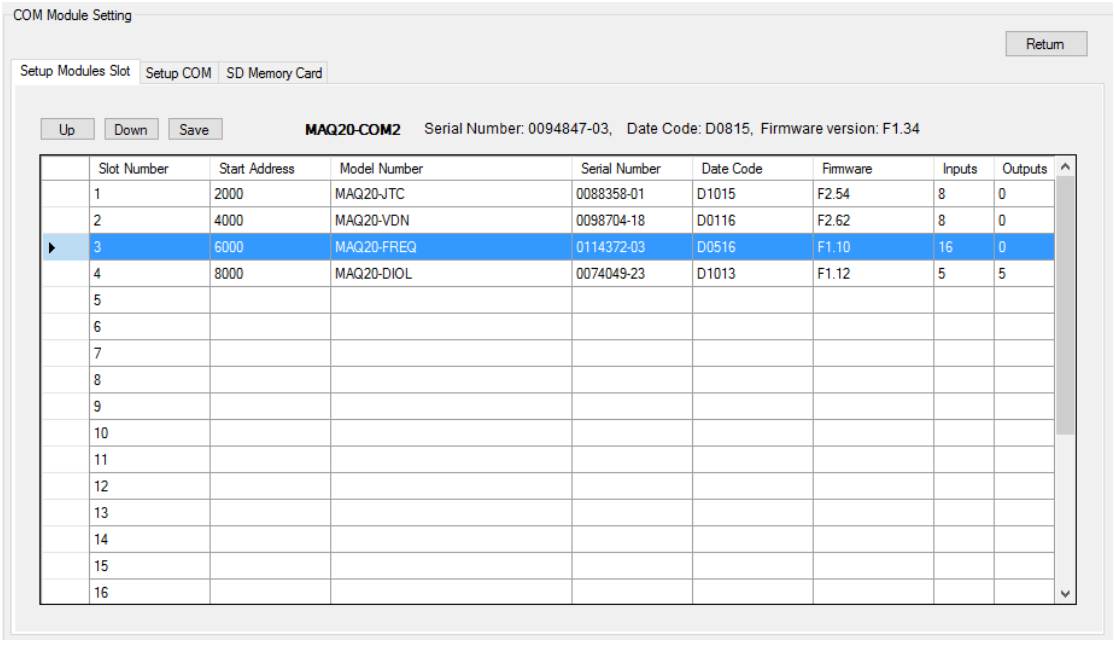


Figure 4: MAQ20-940 ReDAQ Shape for MAQ20 Main Configuration Screen

To view the registration sequence, double-click on the MAQ20-COMx graphic to obtain the system panel shown in Figure 5.



	Slot Number	Start Address	Model Number	Serial Number	Date Code	Firmware	Inputs	Outputs
	1	2000	MAQ20-JTC	0088358-01	D1015	F2.54	8	0
	2	4000	MAQ20-VDN	0098704-18	D0116	F2.62	8	0
▶	3	6000	MAQ20-FREQ	0114372-03	D0516	F1.10	16	0
	4	8000	MAQ20-DIOL	0074049-23	D1013	F1.12	5	5
	5							
	6							
	7							
	8							
	9							
	10							
	11							
	12							
	13							
	14							
	15							
	16							

Figure 5: 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 store the new configuration. The new registration sequence is permanent as long as I/O modules are not removed from or added to a system.

The Address Map for the MAQ20-FREQ Frequency Input Module is found at the end of this manual. An excerpt from the Address Map is shown below. Channel Data for frequency and RPM is stored starting at address 1000 and Channel Data for counter is stored starting at address 1100.

NOTE:

When a module is registered in a system, addresses are offset by 2000 * R, where R is the Registration Number.

Address Range 1000 - 1699: Module Data						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1000	R	16	Channel Data, Frequency or RPM	Frequency Data for 8 Channels. 32-bit data. LSB at 10xx, MSB at 10xx+1.	0 to 1 million	INT32
1100	R	16	Channel Data, Counter	Counter Data for 8 Channels. 32-bit data. LSB at 11xx, MSB at 11xx+1.	4,294,967,295	INT32

Example: A MAQ20-FREQ module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 3, as in Figure 5. Read Frequency Data for Channel 0 and Counter Data for Channel 5.

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

The input frequency data and counter data is 32-bit and is stored in two 16-bit registers. LSB data is stored at the lower address and MSB data is stored at the higher address.

Read from register address 6000 + 1000 = 7000 the Channel 0 Frequency Data LSB
Read from register address 6000 + 1001 = 7001 the Channel 0 Frequency Data MSB

Read from register address 6000 + 1110 = 7110 the Channel 5 Counter Data LSB
Read from register address 6000 + 1111 = 7111 the Channel 5 Counter Data MSB

If the data read from Channel 0 LSB is 14464 counts and the data read from Channel 0 MSB is 1 count, the input signal is:

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Ch 0 LSB convert to binary	00111000 10000000
Ch 0 MSB convert to binary	00000000 00000001
Ch 0 32-bit representation	MSB + LSB = 00000000 00000001 00111000 10000000
Ch 0 Decimal equivalent	80000

80000 counts = 80000 Hz

If the data read from Channel 5 LSB is 8347 counts and the data read from Channel 0 MSB is 333 counts, the input signal is:

Ch 5 LSB convert to binary	00100000 10011011
Ch 5 MSB convert to binary	00000001 01001101
Ch 5 32-bit representation	MSB + LSB = 00000001 01001101 00100000 10011011
Ch 5 Decimal equivalent	21831835

21,831,835 counts = 21,831,835 events

10.0 Data Minimum and Maximum, Counter Reset

Minimum and maximum frequency and RPM values are continuously monitored and stored. Maximum counter values are stored and are preserved until cleared with a Standard Reset or Reset-to-Default command. Counters for each of the 8 channels can be cleared individually or all at once.

The Address Map for the MAQ20-FREQ Frequency Input Module is found at the end of this manual. An excerpt from the Address Map is shown below. Channel Data for frequency and RPM is stored starting at address 1000 and Channel Data for counter is stored starting at address 1100.

NOTE:

When a module is registered in a system, addresses are offset by 2000 * R, where R is the Registration Number.

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Address Range 1000 - 1699: Module Data						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1000	R	16	Channel Data, Frequency or RPM	Frequency Data for 8 Channels. 32-bit data. LSB at 10xx, MSB at 10xx+1.	0 to 1 million	INT32
1030	R/W	16	Channel Data Minimum, Frequency or RPM	Minimum value for each of 8 channels. 32-bit data LSB at 10xx, MSB at 10xx+1.	0 to 1 million	INT32
1050	R/W	16	Channel Data Maximum, Frequency or RPM	Maximum value for each of 8 channels. 32-bit data LSB at 10xx, MSB at 10xx+1.	0 to 1 million	INT32
1100	R	16	Channel Data, Counter	Counter Data for 8 Channels. 32-bit data. LSB at 11xx, MSB at 11xx+1.	4,294,967,295	INT32
1150	R/W	16	Channel Data Maximum, Counter	Maximum value for each of 8 channels. 32-bit data LSB at 10xx, MSB at 10xx+1.	4,294,967,295	INT32
1171	R/W	1	Counter Reset	Resets the count value for all channels or a single channel	0 -7 = Reset an individual channel 8 = Reset all channels	INT16

Example: A MAQ20-FREQ module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 3, as in Figure 5. Read Minimum and Maximum Frequency Data for Channel 0 and Maximum Counter Data for Channel 5. Reset the Channel 5 counter. Reset the Minimum and Maximum data registers.

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

The input frequency data and counter data is 32-bit and is stored in two 16-bit registers. LSB data is stored at the lower address and MSB data is stored at the higher address.

Read from register address 6000 + 1030 = 7030 the Channel 0 Minimum Frequency Data LSB
Read from register address 6000 + 1031 = 7031 the Channel 0 Minimum Frequency Data MSB

If the data read from Channel 0 LSB is 500 counts and the data read from Channel 0 MSB is 0 counts, the input signal is:

Ch 0 LSB convert to binary	00000001 11110100
Ch 0 MSB convert to binary	00000000 00000000
Ch 0 32-bit representation	MSB + LSB = 00000000 00000000 00000001 11110100
Ch 0 Decimal equivalent	500

500 counts = 500Hz

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Read from register address 6000 + 1050 = 7050 the Channel 0 Maximum Frequency Data LSB
Read from register address 6000 + 1051 = 7051 the Channel 0 Maximum Frequency Data MSB

If the data read from Channel 0 LSB is 14464 counts and the data read from Channel 0 MSB is 1 count, the input signal is:

Ch 0 LSB convert to binary	00111000 10000000
Ch 0 MSB convert to binary	00000000 00000001
Ch 0 32-bit representation	MSB + LSB = 00000000 00000001 00111000 10000000
Ch 0 Decimal equivalent	80000

80000 counts = 80000 Hz

Read from register address 6000 + 1160 = 7160 the Channel 5 Maximum Counter Data LSB
Read from register address 6000 + 1161 = 7161 the Channel 5 Maximum Counter Data MSB

If the data read from Channel 5 LSB is 8347 counts and the data read from Channel 0 MSB is 333 counts, the input signal is:

Ch 5 LSB convert to binary	00100000 10011011
Ch 5 MSB convert to binary	00000001 01001101
Ch 5 32-bit representation	MSB + LSB = 00000001 01001101 00100000 10011011
Ch 5 Decimal equivalent	21831835

21,831,835 counts = 21,831,835 events

To reset the Channel 5 counter, use the reset register at address 1170.

Write to address 6000 + 1171 = 7171 a value of 5 to reset only the Channel 5 counter or a value of 8 to reset the counters for all 8 channels.

To reset the minimum and maximum frequency and counter registers, use the Standard Reset.

Write a 0 to address 6000 + 99 = 6099 to perform a Standard Reset.

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11.0 Sensor Excitation or Logic Output

Four +5V outputs are offered to provide excitation for sensors or for 5V logic compatible outputs. Each excitation can source up to 8mA. The excitation outputs are referenced to the –IN terminal. The –IN terminals for all channels are tied together inside the module so any –IN terminal can be used as an excitation output return.

I/O Terminal Block Connections

TERMINAL BLOCK POSITION (TOP TO BOTTOM)	MAQ20-FREQ I/O CONNECTIONS
1	CH0 +IN
2	CH0 -IN
3	CH1 +IN
4	CH1 -IN
5	EXC0 / OUT0

The Address Map for the MAQ20-FREQ Frequency Input Module is found at the end of this manual. An excerpt from the Address Map is shown below. Module Configuration is stored starting at address 100.

NOTE:

When a module is registered in a system, addresses are offset by 2000 * R, where R is the Registration Number.

Address Range 100 - 699: Module Configuration						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
110	R/W	4	Default Excitation Output Configuration	EXC0/OUT0 - EXC3/OUT3 Excitation Output Default State. 0 = 0V, 1 = 5V. Default = 0V for all channels.	0 or 1	INT16
119	W	1	Save to EEPROM	1 = Default Output	1	INT16
150	R/W	4	Excitation Output	EXC0/OUT0 - EXC3/OUT3 Excitation Output. 0 = 0V, 1 = 5V.	0 or 1	INT16

The excitations are set by writing either a 0 or a 1 to registers 150-153.

Each excitation has a default state that can be selected by the user. This state is stored in EEPROM and will be set upon module power cycle or when a Standard Reset is issued. To change Default Excitation Output, write either a 0 or 1 to registers 110-113 and then write a 1 to register 119.

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Example: A MAQ20-FREQ module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 3, as in Figure 5. Set EXC0 to +5V and set the default output of EXC3 to +5V.

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

Write a 1 to register address 6000 + 150 = 6150 to set EXC0 to +5V
Write a 1 to register address 6000 + 113 = 6113 to set EXC3 default output to +5V
Write a 1 to register address 6000 + 119 = 6119 to store the excitation default output to EEPROM

12.0 Timebase

A single input range is used to measure frequencies between 1Hz and 1MHz, RPM, counts, or state change. Internal to the module, measurements are made by counting transitions using a given timebase. User selectable timebases are 1s, 100ms, and 10ms.

The selected timebase must be greater than or equal to the inverse of the maximum frequency to be measured. For optimal measurements, the following timebases are recommended.

Signal Frequency	Timebase = 1s	Timebase = 100ms	Timebase = 10ms
1Hz – 99.9Hz or State Change	X		
100Hz – 999Hz	X	X	
1kHz – 1MHz	X	X	X

Selection of timebase affects the response time of the measurement.

Timebase	Response Time
1s	1.6s
100ms	170ms
10ms	100ms

The Address Map for the MAQ20-FREQ Frequency Input Module is found at the end of this manual. An excerpt from the Address Map is shown below. Module Configuration is stored starting at address 100.

NOTE:

When a module is registered in a system, addresses are offset by 2000 * R, where R is the Registration Number.

Address Range 100 - 699: Module Configuration						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
160	R/W	1	Time Base	0 = 1s, 1 = 100ms, 2 = 10ms. Default = 1s	0, 1, 2	INT16

The timebase is selected by writing a 0, 1, or 2 to register 160. The default timebase is 1 second.

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Example: **A MAQ20-FREQ module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 3, as in Figure 5. The frequency to be measured is 15kHz. Set the timebase to 10ms.**

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

Write a 2 to register address 6000 + 160 = 6160 to set the timebase to 10ms

13.0 RPM

Frequency measurements can be expressed as Revolutions Per Minute by specifying the number of pulses per revolution received from a pickup sensor mounted on a rotating piece of equipment. The number of pulses can be between 1 and 65,535 with a default value of 1. Input channel data stored in registers 1000-1015 will be frequency if Pulses Per Revolution is 1 or if the rotating equipment has only one pulse per revolution or will be RPM if Pulses Per Revolution is more than one.

The Address Map for the MAQ20-FREQ Frequency Input Module is found at the end of this manual. An excerpt from the Address Map is shown below. Module Configuration is stored starting at address 100 and input 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.

Address Range 100 - 699: Module Configuration						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
170	R/W	8	Pulses Per Revolution	For RPM measurement. Number of pulses per revolution. Configure per channel.	1 to 65,535 Default = 1	INT16

Address Range 1000 - 1699: Module Data						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1000	R	16	Channel Data, Frequency or RPM	Frequency Data for 8 Channels. 32-bit data. LSB at 10xx, MSB at 10xx+1.	0 to 1 million	INT32

Pulses Per Revolution is specified by writing a value to register 170. The default value is 1.

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Example: ***A MAQ20-FREQ module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 3, as in Figure 5. A rotating shaft has an optical pickup sensor and 10 reflectors equally spaced around the shaft circumference. Set the Pulses Per Revolution to 10. The sensor is connected to Channel 6.***

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

Write a value of 10 to register address 6000 + 170 = 6170 to set the Pulses Per Revolution to 10.

Input frequency or RPM data is 32-bit and is stored in two 16-bit registers. LSB data is stored at the lower address and MSB data is stored at the higher address.

Read from register address 6000 + 1010 = 7010 the Channel 6 RPM Data LSB
Read from register address 6000 + 1011 = 7011 the Channel 6 RPM Data MSB

If the data read from Channel 0 LSB is 500 counts and the data read from Channel 0 MSB is 0 counts, the input signal is:

Ch 0 LSB convert to binary	00000001 11110100
Ch 0 MSB convert to binary	00000000 00000000
Ch 0 32-bit representation	MSB + LSB = 00000000 00000000 00000001 11110100
Ch 0 Decimal equivalent	500

500 counts = 500 RPM

14.0 State Change

The lowest frequency that can be measured is 1Hz, but the Counter can also be used to detect state change. The edge to trigger on to detect state change can be set to Rising (Positive) Edge or Falling (Negative) Edge. Upon the specified state change, the counter will increment. In addition, the current state of each channel, High or Low, can be read from the module.

The Address Map for the MAQ20-FREQ Frequency Input Module is found at the end of this manual. An excerpt from the Address Map is shown below. Module Configuration is stored starting at address 100 and input channel counter data is stored starting at address 1100.

NOTE:

When a module is registered in a system, addresses are offset by 2000 * R, where R is the Registration Number.

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Address Range 100 - 699: Module Configuration						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
180	R/W	8	Internal Trigger for State Change	Sets the edge to trigger on for state change. 0 = Rising or Postive Edge (default), 1 = Falling or Negative Edge	0 or 1	INT16

Address Range 1000 - 1699: Module Data						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1100	R	16	Channel Data, Counter	Counter Data for 8 Channels. 32-bit data. LSB at 11xx, MSB at 11xx+1.	4,294,967,295	INT32
1170	R	1	State Detect	Channel State. Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = Low, 1 = High.	0 to 255	INT16
1172	R	1	Counter Overflow Status	Status of Counter Overflow. Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Overflow, 1 = Overflow.	0 to 255	INT16

The internal trigger edge is specified by writing a 0 for Rising or Positive Edge or a 1 for Falling or Negative Edge to register 180. The default value is 0.

Example: A MAQ20-FREQ module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 3, as in Figure 5. An actuator that detects a door opening outputs a 1 for door open and a 0 for door closed. Configure the module to detect when the door goes from open to closed. The sensor is connected to Channel 4.

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

Write a 1 to register address 6000 + 180 = 6180 to set trigger edge to Falling or Negative
Input frequency or RPM data is 32-bit and is stored in two 16-bit registers. LSB data is stored at the lower address and MSB data is stored at the higher address.

Read from register address 6000 + 1106 = 7106 the Channel 4 Counter Data LSB
Read from register address 6000 + 1107 = 7107 the Channel 4 Counter Data MSB

An increment in the counter signifies that the door has gone from open to closed.

Read from register address 6000 + 1116 = 7116 the state of all 8 channels

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Convert the decimal value to binary to view the state of each channel.

If the data read is 238, the input channel states are:

State Detect convert to binary 1110 1110
Channels 0 and 4 are closed

Read from register address 6000 + 1117 = 7117 the overflow status of all 8 channels
Convert the decimal value to binary to view the state of each channel.

If the data read 1, the status of each counter is:

Counter Overflow status convert to binary 0000 0001
Channel 0 counter has exceeded the maximum count value and has rolled over. All other channels have not overflowed.

15.0 Alarm Functions (Preliminary. Not currently implemented.)

Alarms in the MAQ20-FREQ module can be set for frequency, RPM, or counter measurements. Alarms have the following parameters which can be configured to meet application requirements.

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 14.0 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 remain set until reset by the user.

High Limit

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

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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.

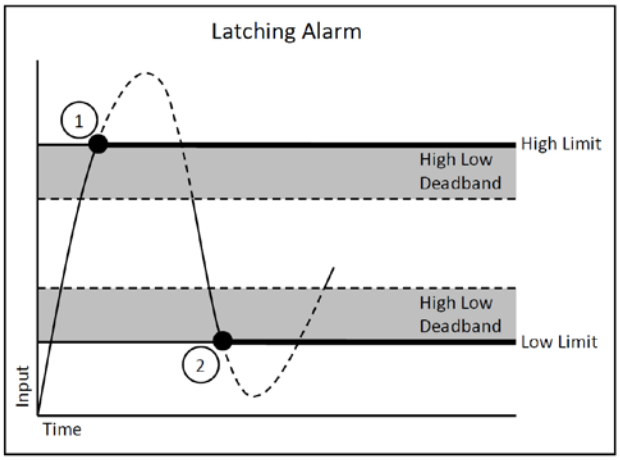
Low-Low Limit

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

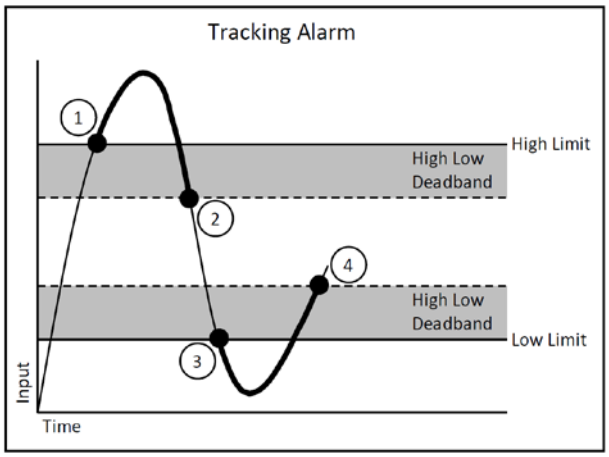
High-High Low-Low Deadband

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.

See Figure 6 below for graphical representations of alarm parameters and functionality keeping in mind that the parameters being monitored for alarms are event count, time between events, and event pair count.



1. High Alarm Tripped
2. Low Alarm Tripped



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

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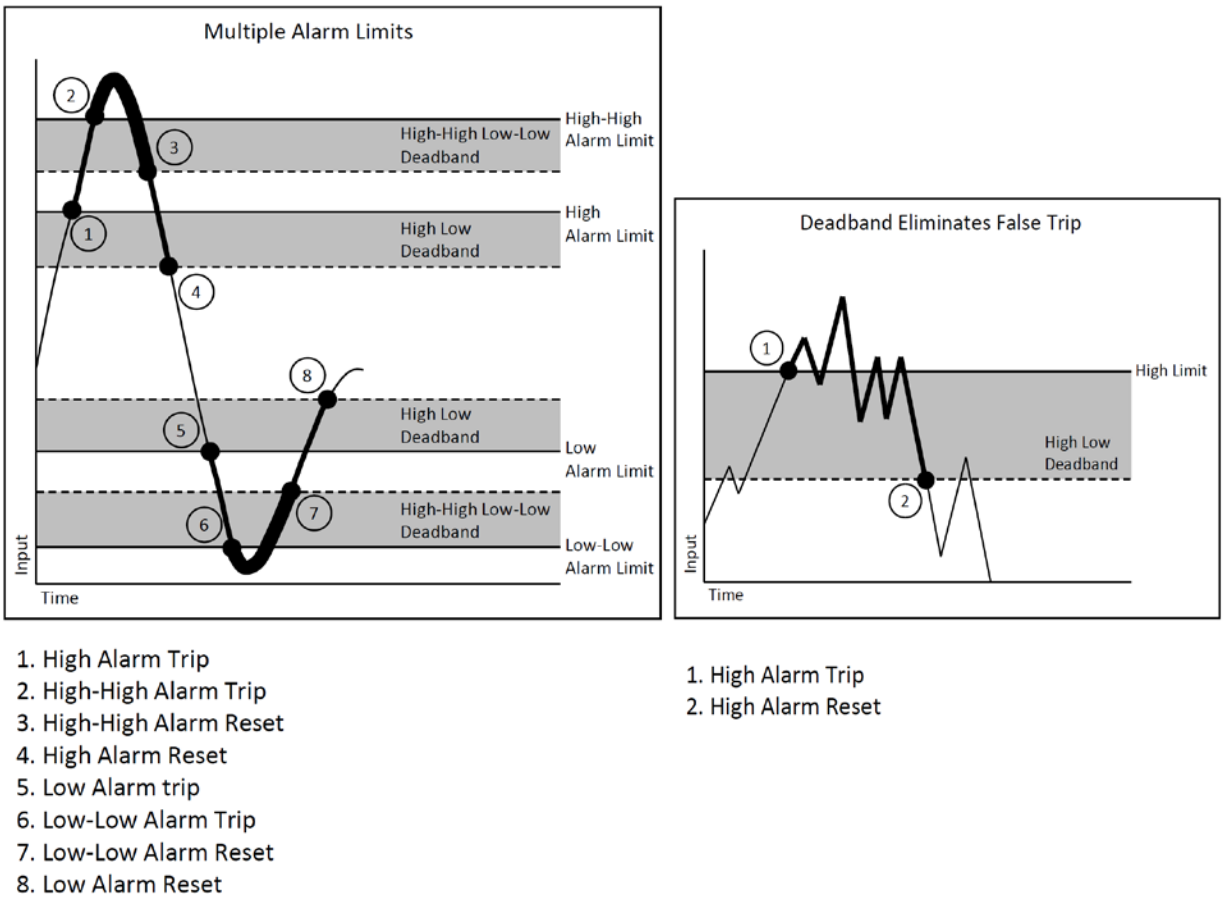


Figure 6: Alarm Parameters and Functionality

16.0 Setting and Monitoring Alarms (Preliminary. Not Currently Implemented.)

When an alarm condition occurs, the appropriate register is written to show alarm status. This register can then be monitored by the host software for alarm detection.

The Address Map for the MAQ20-FREQ Frequency Input Module is found at the end of this manual. An excerpt from the Address Map is shown below. Alarm parameters and status are stored in registers at addresses 700 – 999. Alarm status registers are repeated starting at address 1016 for frequency and RPM data or address 1116 for counter data. This repeat allows continuous block reads of channel data and alarm status.

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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Address Range 700 - 999: Alarm Configuration						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
700	R/W	1	Low-Low Alarm, Frequency or RPM	Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Alarm, 1 = Alarm Condition Met. To clear a Latched alarm, write a 0 to the corresponding channel bit.	0 to 255	INT16
701	R/W	1	Low Alarm, Frequency or RPM	0 = No Alarm, 1 = Alarm Condition Met.	0 to 255	INT16
702	R/W	1	High Alarm, Frequency or RPM	0 = No Alarm, 1 = Alarm Condition Met.	0 to 255	INT16
703	R/W	1	High-High Alarm, Frequency or RPM	0 = No Alarm, 1 = Alarm Condition Met.	0 to 255	INT16
704	R/W	1	Alarm Enable, Frequency or RPM	Bitwise 8-bit representation. 1 = Enabled 0 = Disabled	See Section 15.0	INT16
709	W	1	Save Alarm Parmeters for Frequency or RPM to EEPROM	Writing 1 saves the Alarm Configuration, High Limit, Low Limit, High-Low Deadband, High-High Limit, Low-Low Limit and HHLL Deadband to local non-volatile memory.	1	INT16
710	R/W	8	Alarm Configuration, Frequency or RPM	Alarm Configuration for Frequency	See Section 15.0	INT16
730	R/W	16	High Limit, Frequency or RPM	High Alarm Limit. 32-bit data. LSB at 7xx, MSB at 7xx+1.	0 to 1 million	INT32
750	R/W	16	Low Limit, Frequency or RPM	Low Alarm Limit. 32-bit data. LSB at 7xx, MSB at 7xx+1.	0 to 1 million	INT32
770	R/W	8	High Low Deadband, Frequency or RPM	Deadband for High Low Alarm. 32-bit data. LSB at 7xx, MSB at 7xx+1.	0 to 65,535	INT16
790	R/W	16	High-High Limit, Frequency or RPM	High-High Alarm Limit. 32-bit data. LSB at xxx, MSB at xxx+1.	0 to 1 million	INT32
810	R/W	16	Low-Low Limit, Frequency or RPM	Low-Low Alarm Limit. 32-bit data. LSB at 8xx, MSB at 8xx+1.	0 to 1 million	INT32
830	R/W	8	High-High Low-Low Deadband, Frequency or RPM	Deadband for High-High Low-Low Alarm. 32-bit data. LSB at 8xx, MSB at 8xx+1.	0 to 65,535	INT16

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Alarms are configured by writing codes to the 8 registers at addresses 710 – 707, offset by 2000 * R. Alarms are 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
All Limits	600

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-FREQ 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 2 with a High limit of 80000 counts (80kHz), a Low limit of 20000 counts (20kHz) and a Deadband of 500 counts (500Hz).

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

Write to register address 6000 + 712 = 6712 a value of 1000 + 300 = 1300 to set a Tracking Alarm with High and Low limits

Convert 80000 counts to binary format and separate into 16-bit segments
80000 decimal = 00000000 00000001 00111000 10000000 binary

Convert each 16-bit segment back to decimal
00111000 10000000 binary = 14464 decimal
00000000 00000001 binary = 1 decimal

Write to register address 6000 + 734 = 6734 a data value of 14464 to set the High limit LSB
Write to register address 6000 + 735 = 6735 a data value of 1 to set the High limit MSB

Since the low alarm limit is under 65535, the MSB of the 32-bit representation will be 0 and the decimal equivalent can be directly written to the LSB register.

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Write to register address 6000 + 754 = 6754 a data value of 20000 to set the Low limit LSB
Write to register address 6000 + 755 = 6755 a data value of 0 to set the Low limit MSB

Write to register address 6000 + 772 = 6772 a data value of 500 to set the Deadband for the High and Low limits
Write to register address 6000 + 704 = 6704 the equivalent of bit code 0000 0100 = 4 to enable the configured alarms for Channel 2

Write to register address 6000 + 709 = 6709 a data value of 1 to store the alarm configuration to local memory. When this is done it will have permanence and be restored upon power cycle.

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.

Read register address 6000 + 701 = 6701 to view the status of the Low Alarm.
If bit code 0000 0100 = 4 is read, a Low Alarm has occurred on Channel 2

Low Alarm status can also be obtained by reading register address 6000 + 1017 = 7017, which is located above the registers for the channel data.

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

High Alarm status can also be obtained by reading register address 6000 + 1018 = 7018, which is located above the registers for the channel data.

Alarm configuration and monitoring for counter inputs is the same as for frequency and RPM. Refer to the full Address Map for the register addresses for counter alarms.

PRELIMINARY

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17.0 Reset Functions

Two types of firmware reset are supported in the MAQ20 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, Clears Alarm Status Sets Excitations to user defined states Sets Pulses Per Revolution to user defined states Resets Min and Max registers to 0 Resets all Counters Resets the Counter Overflow registers Clears all Status and Diagnostic registers
Reset-to-Default	All parameters listed under Standard Reset, plus: Sets Excitations to zero Sets Pulses Per Revolution to 1 Sets Internal Edge Trigger to 0 (Positive Edge) 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 or write 255 to perform Reset-to-Default.

NOTE:

The MAQ20 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

MAQ20 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.

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18.0 Module Identification and Status Registers

Module identification including model number, serial number, date code and firmware revision are stored in registers at addresses 0 – 41.

I/O modules in a system are identified in general by their model number (MAQ20-FREQ, MAQ20-VDN, 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 (FREQ, V, 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 a utility to provide a visual 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 are monitored and made available to the user. Diagnostic registers at addresses 1900 – 1910 hold this information.

19.0 LED Indicators

A set of 5 LEDs on the top panel of the MAQ20 I/O modules indicate module power, operation, communication and alarm status.



MAQ®20 Faceplate

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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 offset from 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

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 MAQ20 I/O module and/or MAQ20-COMx module to verify proper insertion into Backbone.
- Remove and reinstall MAQ20 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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20.0 Specifications

FREQUENCY INPUT MODULE	Typical at T_A = +25°C and +24V system power
Model Number, Input Range	
MAQ20-FREQ	
Frequency	1Hz to 1MHz
Counts	0 to 4.29 x 10^9
State Change	State change detect
Input Signal	
DC + Signal, Zero-crossing and TTL	75mV min to 300Vrms max
Hysteresis	50mV
Excitation	Four +5V sources @ 8mA
	Use for sensor excitation or 5V logic compatible output
Number of Channels	8
Per Channel Setup	Measure Frequency, RPM, and Counts
	Individually configurable for alarms
Input Protection	
Continuous	300Vrms max, Signal Inputs
	40Vrms max, Excitation Outputs
Transient	ANSI/IEEE C37.90.1
CMV	
Channel-to-Bus	1500Vrms, 1 min
Channel-to-Channel	0V
Transient	ANSI/IEEE C37.90.1
Resolution and Accuracy	32 bits
Clock Accuracy, +25°C	±0.003%
Clock Accuracy, -40°C to +85°C	±0.01%
Timebase	1s / 100ms / 10ms
Signal Update Rate at Timebase 1s / 0.1s / 0.01s	1.6s / 170ms / 100ms
Scan Rate	500 Ch/s
Alarms	High / High-High / Low / Low-Low
Power Supply Current	230mA
Dimensions (h)(w)(d)	3.27” x 4.51” x 0.60” (83.1mm x 114.6mm x 15.3mm)
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

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21.0 MAQ20-FREQ Address Map

The table in this section outlines the MAQ20-FREQ 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-FREQ 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-FREQ	Characters, Numbers, "-" and Space	ASCII
19	R	11	Serial Number	S1234567-89	Characters, Numbers, "-" and Space	ASCII
30	R	5	Date Code	D0915 (D<week><year>)	Characters, Numbers	ASCII
35	R	5	Firmware Rev	F1.00	Characters, 0-9 and "."	ASCII
40	R	1	Input Channels	8 Input Channels	8	ASCII
41	R	1	Output Channels	4 Output Channels	4	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**
110	R/W	4	Default Excitation Output Configuration	EXC0/OUT0 - EXC3/OUT3 Excitation Output Default State. 0 = 0V, 1 = 5V. Default = 0V for all channels.	0 or 1	INT16
119	W	1	Save to EEPROM	1 = Default Output	1	INT16
150	R/W	4	Excitation Output	EXC0/OUT0 - EXC3/OUT3 Excitation Output. 0 = 0V, 1 = 5V.	0 or 1	INT16
160	R/W	1	Time Base	0 = 1s, 1 = 100ms, 2 = 10ms. Default = 1s	0, 1, 2	INT16
170	R/W	8	Pulses Per Revolution	For RPM measurement. Number of pulses per revolution. Configure per channel.	1 to 65,535 Default = 1	INT16
180	R/W	8	Internal Trigger for State Change	Sets the edge to trigger on for state change. 0 = Positive Edge (default), 1 = Negative Edge	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	Low-Low Alarm, Frequency or RPM	Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Alarm, 1 = Alarm Condition Met. To clear a Latched alarm, write a 0 to the corresponding channel bit.	0 to 255	INT16
701	R/W	1	Low Alarm, Frequency or RPM	Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Alarm, 1 = Alarm Condition Met. To clear a Latched alarm, write a 0 to the corresponding channel bit.	0 to 255	INT16
702	R/W	1	High Alarm, Frequency or RPM	Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Alarm, 1 = Alarm Condition Met. To clear a Latched alarm, write a 0 to the corresponding channel bit.	0 to 255	INT16
703	R/W	1	High-High Alarm, Frequency or RPM	Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Alarm, 1 = Alarm Condition Met. To clear a Latched alarm, write a 0 to the corresponding channel bit.	0 to 255	INT16
704	R/W	1	Alarm Enable, Frequency or RPM	Bitwise 8-bit representation. 1 = Enabled 0 = Disabled	See Section 15.0	INT16
709	W	1	Save Alarm Parameters for Frequency or RPM to EEPROM	Writing 1 saves the Alarm Configuration, High Limit, Low Limit, High-Low Deadband, High-High Limit, Low-Low Limit and HHLL Deadband to local non-volatile memory.	1	INT16
710	R/W	8	Alarm Configuration, Frequency or RPM	Alarm Configuration for Frequency	See Section 15.0	INT16
730	R/W	16	High Limit, Frequency or RPM	High Alarm Limit. 32-bit data. LSB at 7xx, MSB at 7xx+1.	0 to 1 million	INT32

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Address Range 700 - 999: Alarm Configuration						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
750	R/W	16	Low Limit, Frequency or RPM	Low Alarm Limit. 32-bit data. LSB at 7xx, MSB at 7xx+1.	0 to 1 million	INT32
770	R/W	8	High Low Deadband, Frequency or RPM	Deadband for High Low Alarm. 32-bit data. LSB at 7xx, MSB at 7xx+1.	0 to 65,535	INT16
790	R/W	16	High-High Limit, Frequency or RPM	High-High Alarm Limit. 32-bit data. LSB at xxx, MSB at xxx+1.	0 to 1 million	INT32
810	R/W	16	Low-Low Limit, Frequency or RPM	Low-Low Alarm Limit. 32-bit data. LSB at 8xx, MSB at 8xx+1.	0 to 1 million	INT32
830	R/W	8	High-High Low-Low Deadband, Frequency or RPM	Deadband for High-High Low-Low Alarm. 32-bit data. LSB at 8xx, MSB at 8xx+1.	0 to 65,535	INT16
850	R/W	1	Low-Low Alarm, Counter	Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Alarm, 1 = Alarm Condition Met. To clear a Latched alarm, write a 0 to the corresponding channel bit.	0 to 255	INT16
851	R/W	1	Low Alarm, Counter	Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Alarm, 1 = Alarm Condition Met. To clear a Latched alarm, write a 0 to the corresponding channel bit.	0 to 255	INT16
852	R/W	1	High Alarm, Counter	Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Alarm, 1 = Alarm Condition Met. To clear a Latched alarm, write a 0 to the corresponding channel bit.	0 to 255	INT16
853	R/W	1	High-High Alarm, Counter	Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Alarm, 1 = Alarm Condition Met. To clear a Latched alarm, write a 0 to the corresponding channel bit.	0 to 255	INT16

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Address Range 700 - 999: Alarm Configuration						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
854	R/W	1	Alarm Enable, Counter	1 = Enabled 0 = Disabled	See Section 15.0	INT16
859	W	1	Save Alarm Parameters for Counter to EEPROM	Writing 1 saves the Alarm Configuration, High Limit, Low Limit, High-Low Deadband, High-High Limit, Low-Low Limit and HHLL Deadband to local non-volatile memory.	1	INT16
860	R/W	8	Alarm Configuration, Counter	Alarm Configuration for Frequency	See Section 15.0	INT16
880	R/W	16	High Limit, Counter	High Alarm Limit. 32-bit data. LSB at 8xx, MSB at 8xx+1.	4,294,967,295	INT32
900	R/W	16	Low Limit, Counter	Low Alarm Limit. 32-bit data. LSB at 9xx, MSB at 9xx+1.	4,294,967,295	
920	R/W	8	High Low Deadband, Counter	Deadband for High Low Alarm. 32-bit data. LSB at 9xx, MSB at 9xx+1.	0 to 65,535	
940	R/W	16	High-High Limit, Counter	High-High Alarm Limit. 32-bit data. LSB at 9xx, MSB at 9xx+1.	4,294,967,295	
960	R/W	16	Low-Low Limit, Counter	Low-Low Alarm Limit. 32-bit data. LSB at 9xx, MSB at 9xx+1.	4,294,967,295	
980	R/W	8	High-High Low-Low Deadband, Counter	Deadband for High-High Low-Low Alarm. 32-bit data. LSB at 9xx, MSB at 9xx+1.	0 to 65,535	

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Address Range 1000 - 1699: Module Data						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1000	R	16	Channel Data, Frequency or RPM	Frequency Data for 8 Channels. 32-bit data. LSB at 10xx, MSB at 10xx+1.	0 to 1 million	INT32
1016	R	1	Low-Low Alarm Status, Frequency or RPM	Status of Low-Low Alarm. Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Alarm, 1 = Alarm Condition Met.	0 to 255	INT16
1017	R	1	Low Alarm Status, Frequency or RPM	Status of Low Alarm. Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Alarm, 1 = Alarm Condition Met.	0 to 255	INT16
1018	R	1	High Alarm Status, Frequency or RPM	Status of High Alarm. Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Alarm, 1 = Alarm Condition Met.	0 to 255	INT16
1019	R	1	High-High Alarm Status, Frequency or RPM	Status of High-High Alarm. Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Alarm, 1 = Alarm Condition Met.	0 to 255	INT16
1030	R/W	16	Channel Data Minimum, Frequency or RPM	Minimum value for each of 8 channels. 32-bit data LSB at 10xx, MSB at 10xx+1.	0 to 1 million	INT32
1050	R/W	16	Channel Data Maximum, Frequency or RPM	Maximum value for each of 8 channels. 32-bit data LSB at 10xx, MSB at 10xx+1.	0 to 1 million	INT32
1100	R	16	Channel Data, Counter	Counter Data for 8 Channels. 32-bit data. LSB at 11xx, MSB at 11xx+1.	4,294,967,295	INT32
1116	R	1	Low-Low Alarm Status, Counter	Status of Low-Low Alarm. Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Alarm, 1 = Alarm Condition Met.	0 to 255	INT16
1117	R	1	Low Alarm Status, Counter	Status of Low Alarm. Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Alarm, 1 = Alarm Condition Met.	0 to 255	INT16

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Address Range 1000 - 1699: Module Data						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1118	R	1	High Alarm Status, Counter	Status of High Alarm. Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Alarm, 1 = Alarm Condition Met.	0 to 255	INT16
1119	R	1	High-High Alarm Status, Counter	Status of High-High Alarm. Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Alarm, 1 = Alarm Condition Met.	0 to 255	INT16
1150	R/W	16	Channel Data Maximum, Counter	Maximum value for each of 8 channels. 32-bit data LSB at 10xx, MSB at 10xx+1.	4,294,967,295	INT32
1170	R	1	State Detect	Channel State. Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = Low, 1 = High.	0 to 255	INT16
1171	R/W	1	Counter Reset	Resets the count value for all channels or a single channel	0 -7 = Reset an individual channel 8 = Reset all channels	INT16
1172	R	1	Counter Overflow Status	Status of Counter Overflow. Bitwise 8-bit representation. LSB = Ch 0, MSB = Ch 7. 0 = No Overflow, 1 = Overflow.	0 to 255	INT16

Address Range 1900 - 1999: Status Registers						
Start Address	**Read/Write**	**Number of Registers**	**Type**	**Example**	**Range**	**Data type**
1900	R/W	1	Watchdog Reset	0 = Normal 1 = Watchdog Reset	0 or 1	INT16
1901	R/W	1	Brownout Flag	0 = Normal 1 = Brownout Reset	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

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