MAQ®20

Industrial Data Acquisition and Control System

MA1046

MAQ20-BRDG1
Hardware User Manual

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MAQ20-BRDG1 Hardware User Manual
MA1046 Rev. B – November 2018
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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 Listing and 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

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

- Intuitive Graphical Control Software
  - ➢ ReDAQ Shape Graphical HMI Design & Runtime Solution
  - ➢ IPEmotion Muli-Vendor and Multi-Language Solution
  - ➢ Programming examples and LabVIEW VIs
  - ➢ OPC Server
  - ➢ Application Program Interface (API)

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-COM2, -COM4 Communications Module, Ethernet, USB & RS-232 or RS-485 Interface

MAQ20-JTC, -KTC, -TTC, -RSTC Type J, K, T, R, or S Thermocouple Input Module

MAQ20-mVDN, -VSN, -VDN Voltage Input Module

MAQ20-ISN, -IDN Process Current Input Module

MAQ20-IO, -VO Process Current Output and Process Voltage Output Module

MAQ20-BKPL4, -BKPL8, -BKPL16, -BKPL24 4, 8, 16, or 24 Channel System Backbone

Refer to Dataforth MAQ20 Industrial Data Acquistion & Control System for a complete listing of available modules and accessories.

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 Load Share 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 strain gage input module, MAQ20-BRDG1, has 4 input channels and can interface to full, half, and quarter bridge sensors using 4-wire or 6-wire connections. All channels are individually configurable for range, alarms, and averaging to match the most demanding applications. In addition, sampling rate, resolution, bandwidth, excitation voltage, and shunt calibration are user settable parameters. 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 unwanted frequencies. Field connections are made through high density spring cage terminal blocks with positions designated for the termination of wiring shields.

Input-to-Bus isolation is a robust 1500Vrms and each individual channel is protected up to 30Vrms continuous overload in the case of inadvertent wiring errors. Overloaded channels do not adversely affect other channels in the module which preserves data integrity.

MAQ20 system literature and software is available for download from the MAQ20 Software & User Manual Download Center. This includes, but is not limited to:

MA1036	MAQ20 Quick Start Guide
MA1040	MAQ20 Communications Module Hardware User Manual
MA1041	MAQ20 milliVolt, Volt and Current Input Module Hardware User Manual
MA1038	MAQ20 ReDAQ Shape for MAQ20 User Manual
MA1064	MAQ20 API User Manual

MAQ20-940/-941	ReDAQ Shape Software for MAQ20 – Developer Version/User Version
MAQ20-951/952	IPEMotion Software for MAQ20
MAQ20-960	MAQ20 API (Python)

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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.
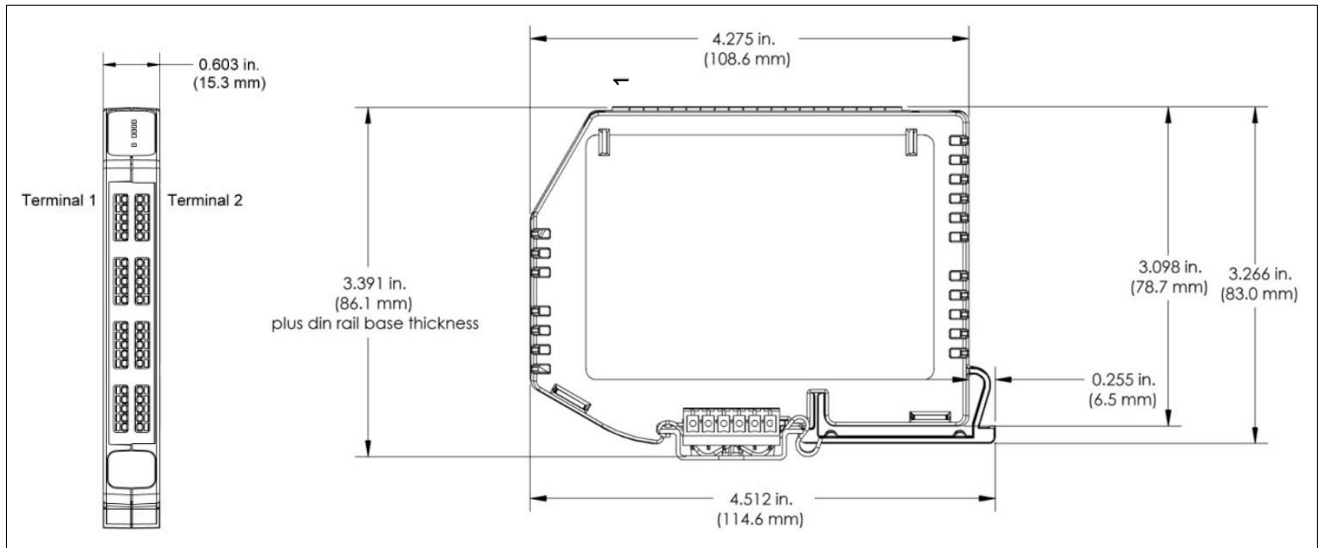
4.0 Module Dimensions and I/O Connections

Figure 1: Module Dimensions

Table 1: MAQ20-BRDG1 Input Terminal Block Connections
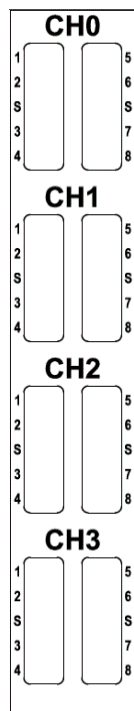
		FIELD CONNECTION	TERMINAL	TERMINAL	FIELD CONNECTION
	CHANNEL 0	+EXC	1	5	+REMOTE SENSE
		-EXC	2	6	-REMOTE SENSE
		SHIELD	S	S	SHIELD
		+IN	3	7	+SHUNT CAL
		-IN	4	8	-SHUNT CAL
	CHANNEL 1	+EXC	1	5	+REMOTE SENSE
		-EXC	2	6	-REMOTE SENSE
		SHIELD	S	S	SHIELD
		+IN	3	7	+SHUNT CAL
		-IN	4	8	-SHUNT CAL
	CHANNEL 2	+EXC	1	5	+REMOTE SENSE
		-EXC	2	6	-REMOTE SENSE
		SHIELD	S	S	SHIELD
		+IN	3	7	+SHUNT CAL
		-IN	4	8	-SHUNT CAL
	CHANNEL 3	+EXC	1	5	+REMOTE SENSE
		-EXC	2	6	-REMOTE SENSE
		SHIELD	S	S	SHIELD
		+IN	3	7	+SHUNT CAL
		-IN	4	8	-SHUNT CAL

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The high density spring cage terminal blocks can accept the following wire sizes:

Solid Wire   AWG 26 to AWG 20
Stranded Wire   AWG 24 to AWG 20

MAQ20-BRDG1 modules and MAQ20 systems which contain MAQ20-BRDG1 modules are shipped with an accessory screwdriver which is used for sensor wire insertion and removal. If this screwdriver is not available, contact the factory for purchase, or use any screwdriver or slotted driver with 1/16" (1.6mm) tip.

Sensor Wire Connection

- Insert the slotted driver in the rectangular opening adjacent to the wire hole.

- Ensure the driver is perpendicular to the terminal block.

- Press the driver firmly into the opening.

- While holding the driver in place, insert the sensor solid or stranded wire into the round opening.

- Hold the sensor wire in place and remove the driver.

- Pull on the sensor wire to ensure it was captured.

Figure 2: Sensor Wire Connection and Removal

Sensor Wire Removal

- Insert the slotted driver in the rectangular opening adjacent to the wire hole.

- Ensure the driver is perpendicular to the terminal block.

- Press the driver firmly into the opening.

- While holding the driver in place, pull the sensor solid or stranded wire out of the round opening.

- Remove the driver.

5.0 Module Installation and Removal

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 below.
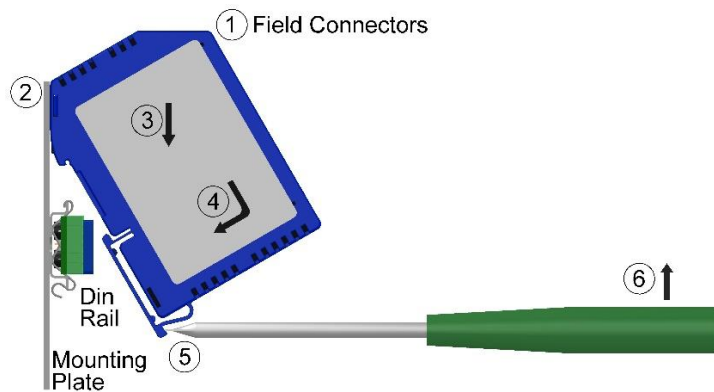
Figure 3: Module Installation and Removal

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 below.
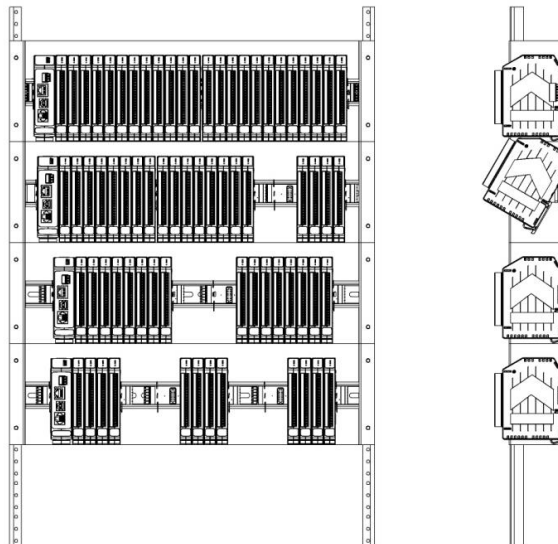
Figure 4: Possible System Configurations

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., allowing 1 second for registration. 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. Registration is complete when module TX and RX LEDs all have a repeating blink pattern. All modules have now been assigned Registration Numbers, but in a random sequence not associated with the physical position on the backbone.

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. If I/O modules are removed while the system is powered, they will be unregistered and the slots or registration numbers become available to register new modules once inserted. If I/O modules are removed while the system is powered and then the power is cycled, the remaining modules will remain registered with their originally assigned Registration Numbers.

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, TC, 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 the 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.

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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.) <u>CASE 1: I/O module is replaced with one having a different model number or serial number</u>

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 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.**

<u>CASE 2: I/O module is suspected faulty and is to be replaced with the same model number</u>

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.**

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 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 <u>not associated with the physical position on the backbone</u>. 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 <u>Section 9.0</u>.

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 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. If I/O modules are removed while the system is powered, they will be unregistered and the slots or registration numbers become available to register modules once inserted. If I/O modules are removed while the system is powered and then the power is cycled, the remaining modules will remain registered with their assigned Registration Numbers. Tools within MAQ20-940 ReDAQ Shape Software for MAQ20 allow the user to reassign Registration Numbers. For further details, see Section 9.0 MAQ20 I/O Module Registration.

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.

9.0 MAQ20 I/O Module Registration and Reading Input and Excitation Signals

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 Section 6.0 Building a System, Section 7.0 Maintaining a System, and Section 8.0 Expanding a System.

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.

The automated registration process can be disabled and I/O modules can be registered using a manual process if required by an application. Refer to MA1040 MAQ20 Communications Module Hardware User Manual for details.

The standard mode of operation is called Continuous Scan Mode. All channels are enabled and input readings are taken by sending a read request command to the module. In Burst Scan Mode, channels can be selectively enabled.

The MAQ20-BRDG1 Address Map 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.

Address Range 1000 - 1699 : Module Data						
Start Address	Read/Write	Number of Registers	Contents	Description	Data Range	Data type
1000	R	8	Channel Data	Data for 4 Signal Channels. 24-bit data LSB at 100x, MSB at 100x+1. 16-bit data at 100x, 100x+2.	0 to 2^32-1 or 0 to 2^16-1	INT32 / INT16
1008	R	8	Excitation Data	Data for 4 Excitation Channels. 24-bit data LSB at 10xx, MSB at 10xx+1. 16-bit data at 10xx, 10xx+2.	0 to 2^32-1 or 0 to 2^16-1	INT32 / INT16

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Example: A MAQ20-BRDG1 module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 6. Assume 24-bit data and read Signal Data and Excitation Data for Channel 0.

The MAQ20-BRDG1 module with s/n 1234567-89 has an address offset of 2000 * 6 = 12000

Read from register address 12000 + 1000 = 13000 the Channel 0 Signal Data LSB
Read from register address 12000 + 1001 = 13001 the Channel 0 Signal Data MSB

Read from register address 12000 + 1008 = 13008 the Channel 0 Excitation Data LSB
Read from register address 12000 + 1009 = 13009 the Channel 0 Excitation Data MSB

The 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 have been used instead of the Standard Registration Processes. These are described in Section 6.0 Building a System, Section 7.0 Maintaining a System and Section 8.0 Expanding a System.

ReDAQ Shape Software for MAQ20 presents a graphical representation of the system on the Acquire panel as shown in Figure 5. I/O modules are displayed sequentially left to right in the order they were registered. The display does not represent physical position and will not show physical vacant positions between I/O modules. The system graphic shows a 24 position backbone regardless of the backbone or combination of backbones used in a system.
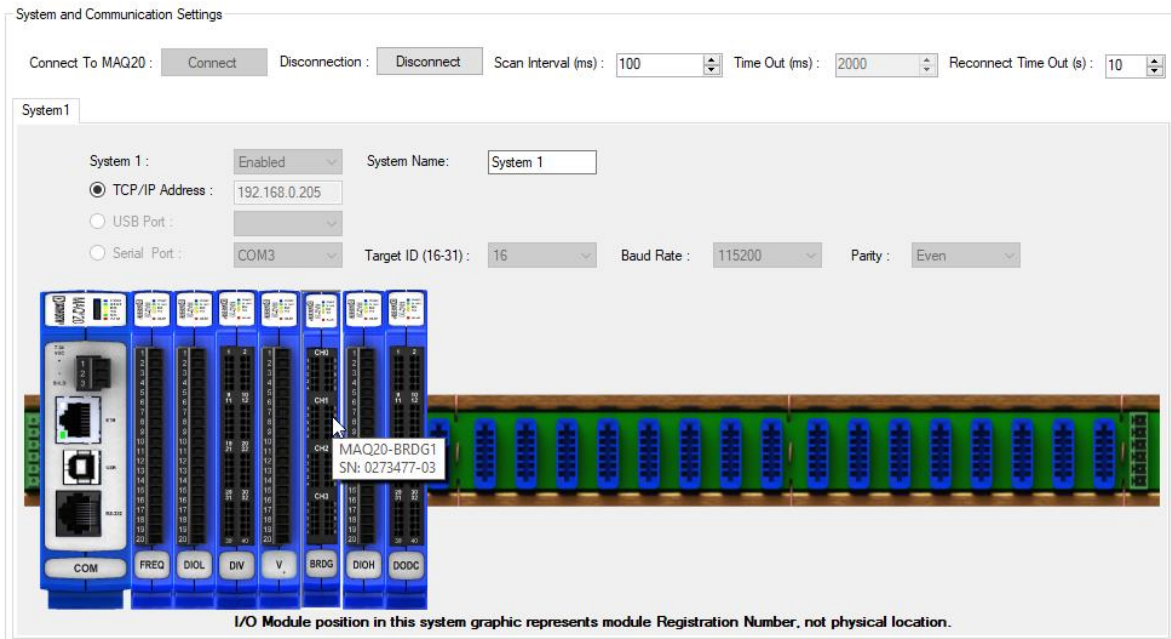

Figure 5: MAQ20-940 ReDAQ Shape for MAQ20 Main Configuration Screen

To view the registration sequence, click on the MAQ20-COMx graphic to obtain the system panel shown in Figure 6.

Device: MAQ20-COM4, Serial Number: 0074248-10, MAC: 70:B3:D5:6F:A0:59, Date Code: D0815, Firmware version: F5.51, Temperature: 0°C

Return

System Summary Setup COM SD Memory Card Data Converter

Up   Down   Save

Registration #	Start Address	Model Number	Serial Number	Date Code	Firmware	Inputs	Outputs
1	2000	MAQ20-FREQ	0120772-07	D0517	F1.20	8	4
2	4000	MAQ20-DIOL	0104527-01	D0415	F1.12	5	5
3	6000	MAQ20-DIV20	0101471-03	D0617	F1.02	20	0
4	8000	MAQ20-VDN	0092139-01	D1113	F2.02	8	0
5	10000	MAQ20-BRDG1	0273477-03	D1118	F1.61	8	0
6	12000	MAQ20-DIOH	0109971-01	D0116	F1.21	4	4
7	14000	MAQ20-DODC20SK	0104672-05	D0317	F1.02	0	20
8							
9							
10							
11							
12							
13							
14							
15							

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

Registration Numbers listed in the left column refer to the position where the software has registered the I/O module. Registration Number will not necessarily be the same as the physical position of the module in the system. 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 across power cycles and any other system configuration as long as I/O modules are not removed from or added to a system.

10.0   Signal Gain and Conversion to Engineering Units

The MAQ20-BRDG1 module has a factory default input signal range of -100mV to +100mV. 24-bit data conversion provides a high level of accuracy and resolution over this signal range. The input signal range can be set independently for each channel to ±100mV, ±50mV, ±25mV, ±12.5mV or ±8.33mV. Over-range and Under-range up to 2% beyond the specified input values will be measured. Input signal range is set on a channel-by-channel basis by writing the appropriate code to a register. The Range Table following the Address Map at the end of this manual shows the signal ranges and the signal to counts mapping. An excerpt from the Range Table is shown below.

Sampling Rate = 1kS/s, 2kS/s, 4kS/s, 8kS/s, 16kS/s

Signal Gain Code	Signal Gain	Standard Input Voltage	Equivalent Counts	Over/Under Range	Equivalent Counts
0 (Default)	1	-100mV to +100mV	-8197767 to 8197767	-102.328mV to +102.328mV	-8388608 to 8388607
1	2	-50mV to +50mV	-8197767 to 8197767	-51.164mV to +51.164mV	-8388608 to 8388607
2	4	-25mV to +25mV	-8197767 to 8197767	-25.582mV to +25.582mV	-8388608 to 8388607
3	8	-12.5mV to +12.5mV	-8197767 to 8197767	-12.791mV to +12.791mV	-8388608 to 8388607
4	12	-8.33mV to +8.33mV	-8197767 to 8197767	-8.527mV to +8.527mV	-8388608 to 8388607

Sampling Rate = 32kS/s

Signal Gain Code	Signal Gain	Standard Input Voltage	Equivalent Counts	Over/Under Range	Equivalent Counts
0 (Default)	1	-100mV to +100mV	-32023 to 32023	-102.328mV to +102.328mV	-32768 to 32767
1	2	-50mV to +50mV	-32023 to 32023	-51.164mV to +51.164mV	-32768 to 32767
2	4	-25mV to +25mV	-32023 to 32023	-25.582mV to +25.582mV	-32768 to 32767
3	8	-12.5mV to +12.5mV	-32023 to 32023	-12.791mV to +12.791mV	-32768 to 32767
4	12	-8.33mV to +8.33mV	-32023 to 32023	-8.527mV to +8.527mV	-32768 to 32767

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The MAQ20-BRDG1 Address Map is found at the end of this manual. An excerpt from the Address Map is shown below.

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 MAQ20 I/O Module Registration 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	4	Input Range	0 = ±100mV (Default) 1 = ±50mV 2 = ±25mV 3 = ±12.5mV 4 = ±8.33mV	0 to 4	INT16
119	W	1	Save to Local Memory	Writing 0 will save Signal Gain, Average Weight, Vexc, Half Bridge, Shunt Calibration, Auto Zero, Sampling Rate.		INT16

Address Range 1000 - 1699 : Module Data						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1000	R	8	Channel Data	Data for 4 Signal Channels. 24-bit data LSB at 100x, MSB at 100x+1. 16-bit data at 100x, 100x+2.	0 to 2^32-1 or 0 to 2^16-1	INT32 / INT16

To change the input range for each of the four input channels, write 0 to 4 to the registers at Address 100 to 103. Note that this address block is offset by 2000 * R. Once an input range selection is made it can be saved to local memory by writing a 0 to register 119.

Input signal readings are stored starting at module address 1000.

Example: A MAQ20-BRDG1 module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 2. Set channel 0 for an input range of ±100mV, channel 1 for an input range of ±25mV and channels 2 and 3 for an input range of ±12.5mV. Obtain the current reading in counts for channel 0 input signal and convert to Engineering units.

The MAQ20-BRDG1 module with s/n 1234567-89 has an address offset of 2000 * 2 = 4000

Write to register address 4000 + 100 = 4100 a data value of 0 to set Ch 0 input range = ±100mV
Write to register address 4000 + 101 = 4101 a data value of 2 to set Ch 1 input range = ±25mV
Write to register address 4000 + 102 = 4102 a data value of 3 to set Ch 2 input range = ±12.5mV
Write to register address 4000 + 103 = 4103 a data value of 3 to set Ch 3 input range = ±12.5mV

When signal sample rates of 1kS/s, 2kS/s, 4kS/s, 8kS/s and 16kS/s are used, sampled data will be 24 bits. LSB data is stored at the lower address and MSB data is stored at the higher address.

Assume the data is 24-bit.

Read from register address 4000 + 1000 = 5000 the Channel 0 Signal Data LSB
Read from register address 4000 + 1001 = 5001 the Channel 0 Signal Data MSB

If the data read from Channel 0 Signal Data LSB is 23154 counts and the data read from Channel 0 Signal Data MSB is 106 counts, the input signal is:

Ch 0 LSB convert to binary	0101101001110010
Ch 0 MSB convert to binary	0000000001101010
Ch 0 24-bit representation	MSB + LSB = 011010100101101001110010
Ch 0 Decimal equivalent	6969970

6969970 counts * (+100mV - -100mV)/(8197767 counts - -8197767 counts) = 85.023mV

When the signal sample rate of 32kS/s is used, sampled data will be 16 bits.

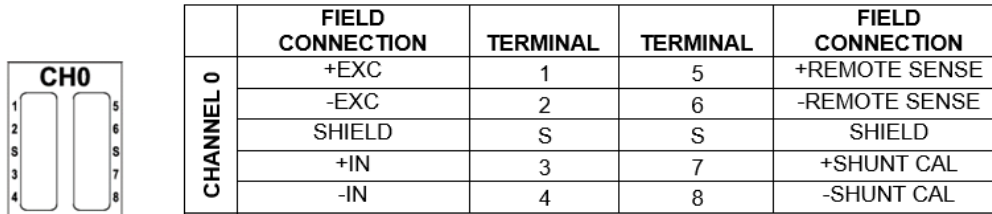Assume a sample rate of 32kS/s is used and obtain 16-bit data.

Read from register address 4000 + 1000 = 5000 the Channel 0 Signal Data

If the data read from Channel 0 is 23154 counts, the input signal is:

23154 counts * (+100mV - -100mV)/(32023 counts - -32023 counts) = 72.304mV

11.0 Sensor Excitation

A single source is provided for excitation of one to four strain gages. Internal to the module, the +EXC and –EXC source connections for each channel are common. Each of the four channels has a dedicated excitation sense connection which measures the excitation voltage at the field terminal blocks. See Section 13.0 Remote Sense for sensor excitation remote sense. The excitation voltage source can be set to 2.5V, 3.3V, 5.0V or 10.0V. The value selected will be the same for all four channels. The excitation is provided on Terminals 1 and 2 for each of the four channels. Sensor Excitation is set by writing the appropriate code to a register.

	FIELD CONNECTION	TERMINAL	TERMINAL	FIELD CONNECTION
CHANNEL 0	+EXC	1	5	+REMOTE SENSE
	-EXC	2	6	-REMOTE SENSE
	SHIELD	S	S	SHIELD
	+IN	3	7	+SHUNT CAL
	-IN	4	8	-SHUNT CAL

Each channel has continuous excitation overload protection up to 30Vrms as well as transient overload protection to prevent module or system damage in cases of inadvertent wiring errors, ESD, or other external faults. Basic circuit topology and full bridge sensor connection is shown in Figure 7 below.

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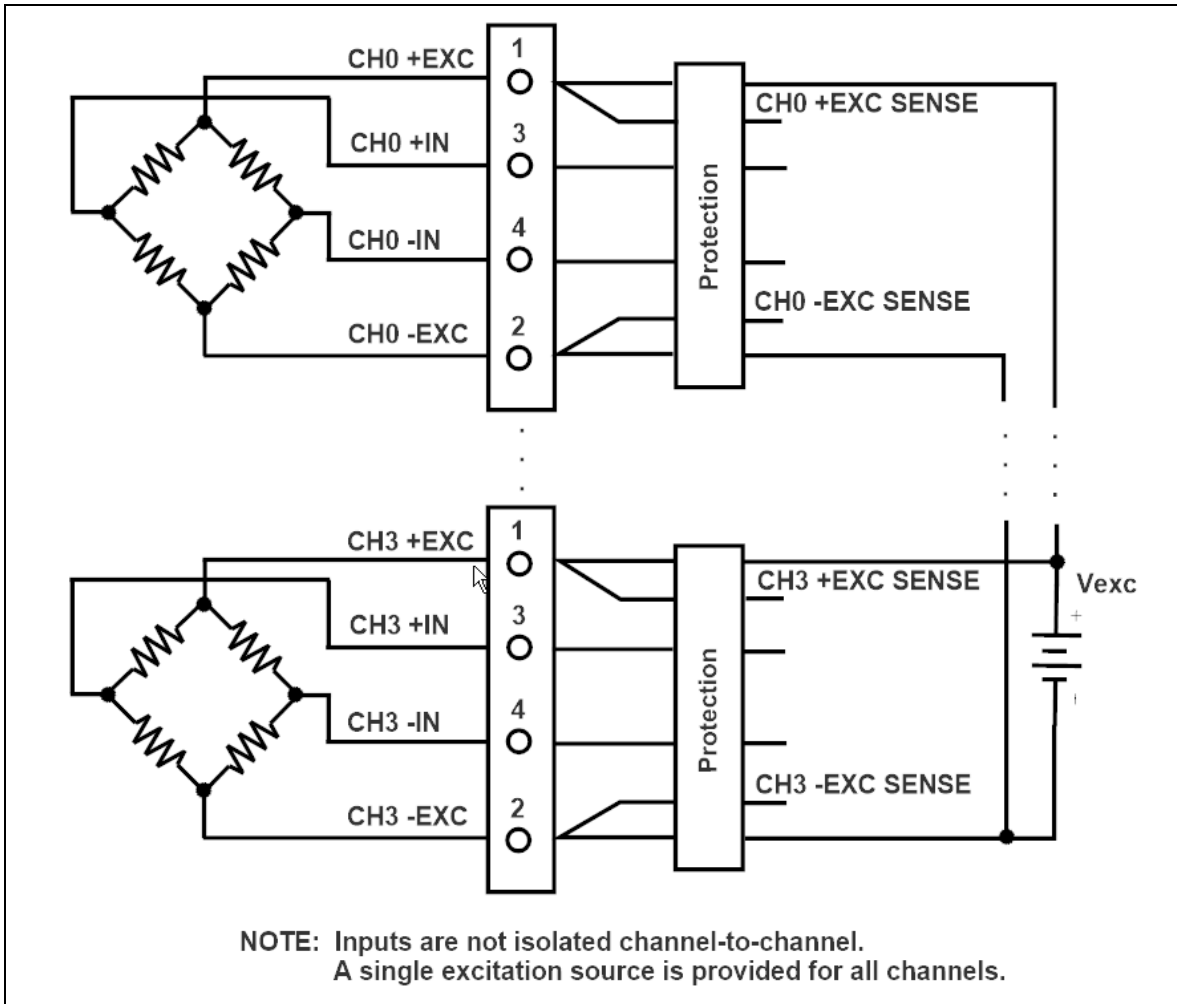
Figure 7: Excitation Circuit Topology

The total load that can be delivered by the source is 80mA for normal operating conditions. If the ambient temperature of the module is +80°C or higher, the total load is de-rated to 60mA. Bridge resistance is specified as 100Ω to 1kΩ. Assuming identical sensors are used on each channel, the minimum bridge element resistance can be expressed using this formula with results shown in Table 2.

Full Bridge Sensor, Tambient = +25°C to +80°C
Rbridge element (min) = Vexc / 80mA * Number of Sensors

Full Bridge Sensor, Tambient = +80°C to +85°C
Rbridge element (min) = Vexc / 60mA * Number of Sensors

Half or Quarter Bridge Sensor, Tambient = +25°C to +80°C
Rbridge element (min) = Vexc / 80mA * Number of Sensors / 2

Half or Quarter Bridge Sensor, Tambient = +80°C to +85°C
Rbridge element (min) = Vexc / 60mA * Number of Sensors / 2

Table 2: Minimum Bridge Resistance, Full Bridge Sensor, Tambient = +25°C to +80°C

Vexc	Min Bridge Element Resistance vs. Number of Full Bridge Sensors				Min Bridge Element Resistance vs. Number of Half or Quarter Bridge Sensors			
	1	2	3	4	1	2	3	4
2.5V	100Ω	100Ω	100Ω	125Ω	100Ω	100Ω	100Ω	100Ω
3.333V	100Ω	100Ω	125Ω	167Ω	100Ω	100Ω	100Ω	100Ω
5.0V	100Ω	125Ω	188Ω	250Ω	100Ω	100Ω	100Ω	125Ω
10.0V	125Ω	250Ω	375Ω	500Ω	100Ω	125Ω	188Ω	250Ω

The MAQ20-BRDG1 Address Map is found at the end of this manual. An excerpt from the Address Map is shown below.

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 MAQ20 I/O Module Registration 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
119	W	1	Save to Local Memory	Writing 0 will save Signal Gain, Average Weight, Vexc, Half Bridge, Shunt Calibration, Auto Zero, Sampling Rate.		INT16
600	R/W	1	Excitation Voltage	0 = 2.5V, 1 = 3.3V, 2 = 5V, 3 = 10V. Default = 0.	0 to 3	INT16

	Address Range 1000 - 1699 : Module Data					
Start Address	Read/Write	Number of Registers	Contents	Description	Data Range	Data type
1008	R	8	Excitation Data	Data for 4 Excitation Channels. 24-bit data LSB at 10xx, MSB at 10xx+1. 16-bit data at 10xx, 10xx+2.	0 to 2^32-1 or 0 to 2^16-1	INT32 / INT16

To change the sensor excitation voltage, write 0 to 3 to Address 600. Note that this address is offset by 2000 * R. Once an excitation selection is made it can be saved to local memory by writing a 0 to register 119.

Excitation voltage measurements are stored starting at module address 1008.

Example: A MAQ20-BRDG1 module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 2. Set the sensor excitation voltage for all channels to 3.333V. Obtain the current reading in counts for channel 0 excitation voltage and convert to Engineering units.

The MAQ20-BRDG1 module with s/n 1234567-89 has an address offset of 2000 * 2 = 4000

Write to register address 4000 + 600 = 4600 a data value of 1 to set Vexc = 3.333V

When signal sample rates of 1kS/s, 2kS/s, 4kS/s, 8kS/s and 16kS/s are used, sampled data will be 24 bits. LSB data is stored at the lower address and MSB data is stored at the higher address.

Assume the default sample rate of 4kS/s is used and obtain 24-bit data.

Read from register address 4000 + 1008 = 5008 the Channel 0 Excitation Data LSB
Read from register address 4000 + 1009 = 5009 the Channel 0 Excitation Data MSB

If the data read from Channel 0 Excitation Data LSB is 43516 counts and the data read from Channel 0 Excitation Data MSB is 26 counts, the excitation signal is:

Ch 0 LSB convert to binary	1010100111111100
Ch 0 MSB convert to binary	0000000000011010
Ch 0 24-bit representation	MSB + LSB = 000110101010100111111100
Ch 0 Decimal equivalent	1747452

$V_{exc} = 1747452 / 8388608 * 16 = 3.333V$

When the signal sample rate of 32kS/s is used, sampled data will be 16 bits.

Assume a sample rate of 32kS/s is used and obtain 16-bit data.

Read from register address 4000 + 1008 = 5008 the Channel 0 Excitation Data

If the data read from Channel 0 Excitation Data is 6826 counts, the excitation signal is:

$V_{exc} = 6826 / 32768 * 16 = 3.333V$

12.0 Full Bridge, Half Bridge & Quarter Bridge Sensors

The MAQ20-BRDG1 module interfaces to full bridge sensors using the +EXC, -EXC, +IN and –IN terminals. The module has internal bridge completion circuits on each of the four input channels for interfacing to half bridge and quarter bridge sensors using the +EXC, -EXC and +IN terminals. Half bridge completion is enabled on a channel-by-channel basis by writing to a register.

	FIELD CONNECTION	TERMINAL	TERMINAL	FIELD CONNECTION
CHANNEL 0	+EXC	1	5	+REMOTE SENSE
	-EXC	2	6	-REMOTE SENSE
	SHIELD	S	S	SHIELD
	+IN	3	7	+SHUNT CAL
	-IN	4	8	-SHUNT CAL
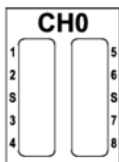
Each channel has continuous signal and excitation overload protection up to 30Vrms as well as transient overload protection to prevent module or system damage in cases of inadvertent wiring errors, ESD, or other external faults.

A single source is provided for excitation of one to four strain gages. Internal to the module, the +EXC and –EXC source connections for each channel are common. A single set of bridge completion resistors is provided for connection to one to four strain gages. If bridge completion is enabled on more than one channel, the –IN terminals for all channels with bridge completion enabled will be connected together. This may affect signal integrity in some applications. The resistance of the internal bridge completion resistors, R, is 4.9kΩ. Basic circuit topology and sensor connection is shown in Figure 8, Figure 8 and Figure 10.

NOTES: Rg represents active strain elements.
        SW1 is open for connection to Full Bridge sensors.

Figure 8: Full Bridge Sensor Connection

NOTES: Rg represents active strain elements.
        SW1 is closed for connection to Half Bridge sensors.
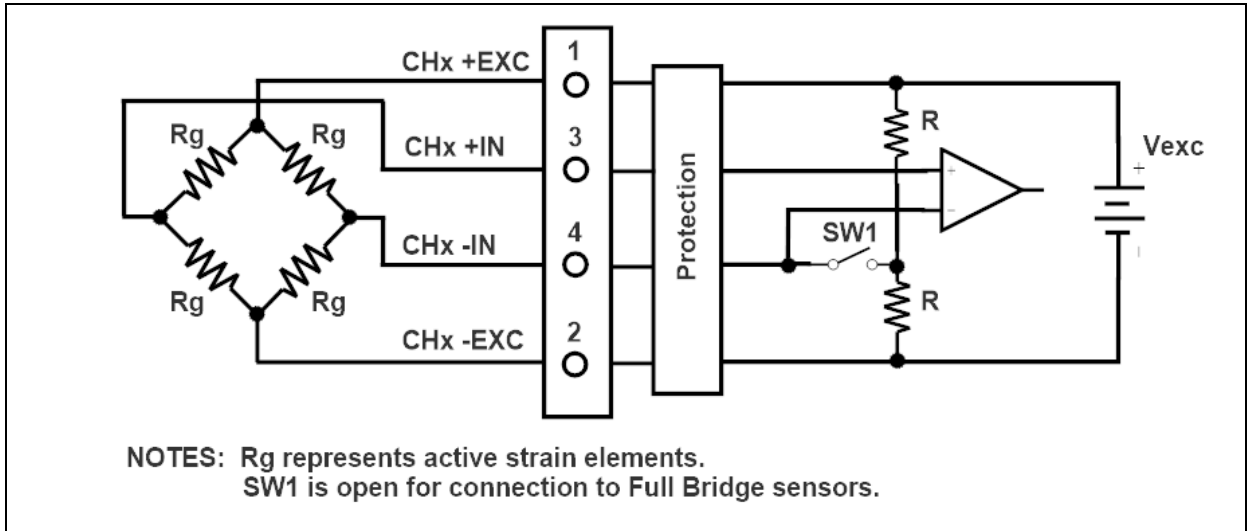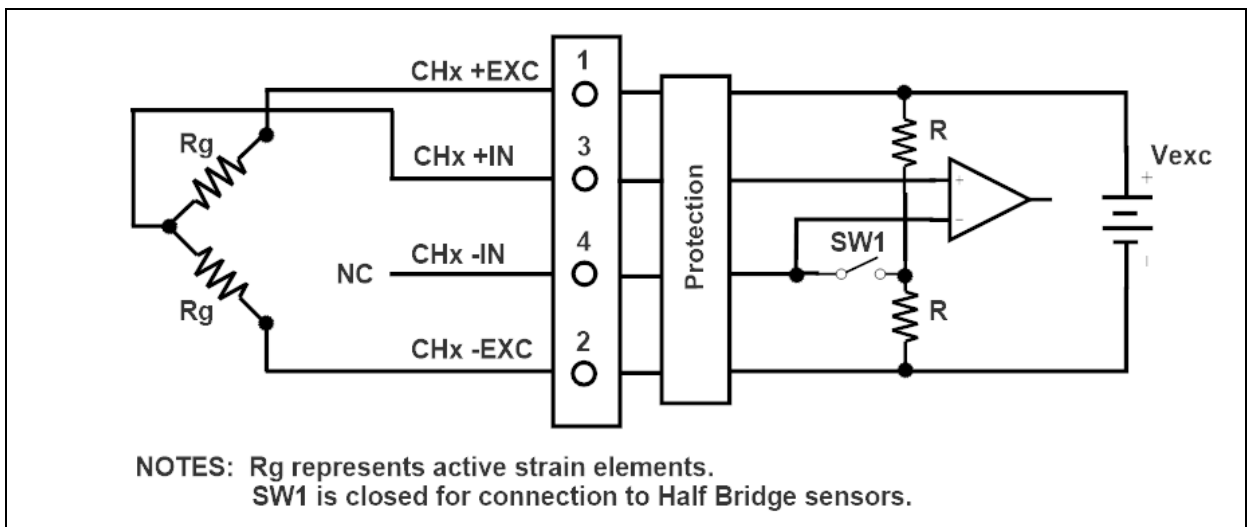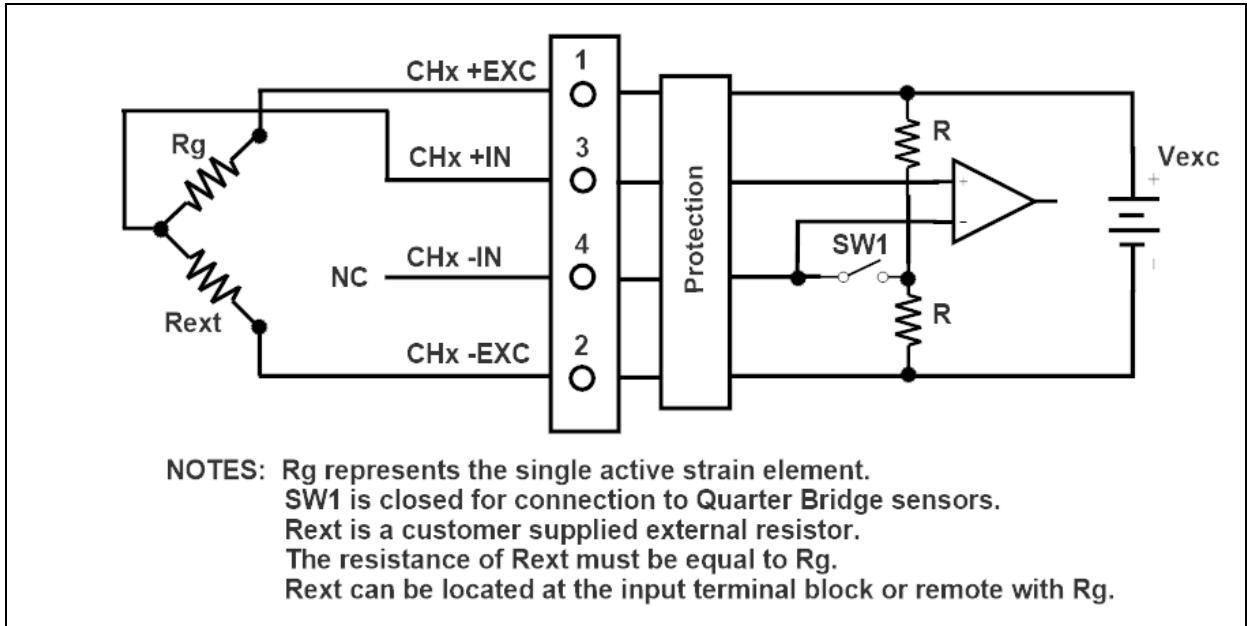
Figure 9: Half Bridge Sensor Connection

Figure 10: Quarter Bridge Sensor Connection

The MAQ20-BRDG1 Address Map is found at the end of this manual. An excerpt from the Address Map is shown below. Channel Data is stored starting at module 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 MAQ20 I/O Module Registration 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**
119	W	1	Save to Local Memory	Writing 0 will save Signal Gain, Average Weight, Vexc, Half Bridge, Shunt Calibration, Auto Zero, Sampling Rate.		INT16
610	R/W	4	Half Bridge Configuration	0 = Half Bridge, 1 = Full Bridge. Default = 1.	0 or 1	INT16

To enable or disable the internal bridge completion resistors for each of the four input channels, write a 0 or 1 to the registers at Address 610 to 613. Note that this address block is offset by 2000 * R. Once a half bridge completion selection is made it can be saved to local memory by writing a 0 to register 119.

Example: A MAQ20-BRDG1 module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 2. Assume full bridge sensors are used on Channels 0 and 1, a half bridge sensor is used on Channel 2, and a quarter bridge sensor is used on Channel 3. Enable the Half Bridge completion resistors on Channels 2 and 3 for correct interface to the sensors.

The MAQ20-BRDG1 module with s/n 1234567-89 has an address offset of 2000 * 2 = 4000

Write to register address 4000 + 612 = 4612 a data value of 0 to enable bridge completion on Ch 2
Write to register address 4000 + 613 = 4613 a data value of 0 to enable bridge completion on Ch 3

13.0 Remote Sense

Common excitation voltages for strain gages are 2.5V to 10V. Most strain gage signal conditioners use a four wire connection to the bridge to simplify field wiring. Four wire connections require the excitation voltage source to be accurate and stable over temperature, time, and load. They also require short connections between the strain gage and signal conditioner to reduce errors caused by voltage drops across wiring resistance. The MAQ20-BRDG1 module has the ability to use remote sensing to eliminate the requirement for a precision excitation source and concerns over leadwire resistance.

Standard connection between the MAQ20-BRDG1 module and a strain gage is made using a four wire connection as shown in Section 11.0 Sensor Excitation. This connection is recommended for most applications. When high precision is required or leadwire resistance is a concern, remote sense using six wire connection will eliminate errors. Another method used to eliminate errors is outlined in Section 20.0 V/V Ratiometric Signal Representation.   To use the Remote Sense feature, simply connect field terminals 5 and 6 to the strain gage remotely at the location where the strain gage is installed.
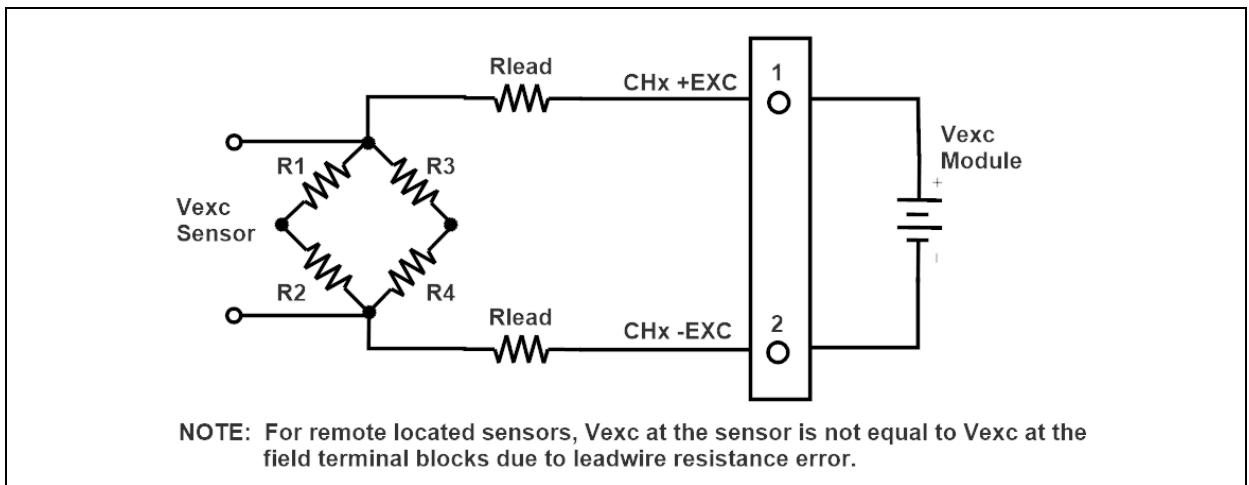
Figure 11: Remote Sensor Error Sources

A single source is provided for excitation of one to four strain gages. Internal to the module, the +EXC and –EXC source connections for each channel are common. Each of the four channels has a dedicated excitation remote sense connection for measurement of the excitation voltage at the remote located sensor.

	FIELD CONNECTION	TERMINAL	TERMINAL	FIELD CONNECTION
CHANNEL 0	+EXC	1	5	+REMOTE SENSE
	-EXC	2	6	-REMOTE SENSE
	SHIELD	S	S	SHIELD
	+IN	3	7	+SHUNT CAL
	-IN	4	8	-SHUNT CAL
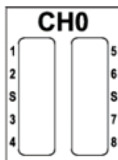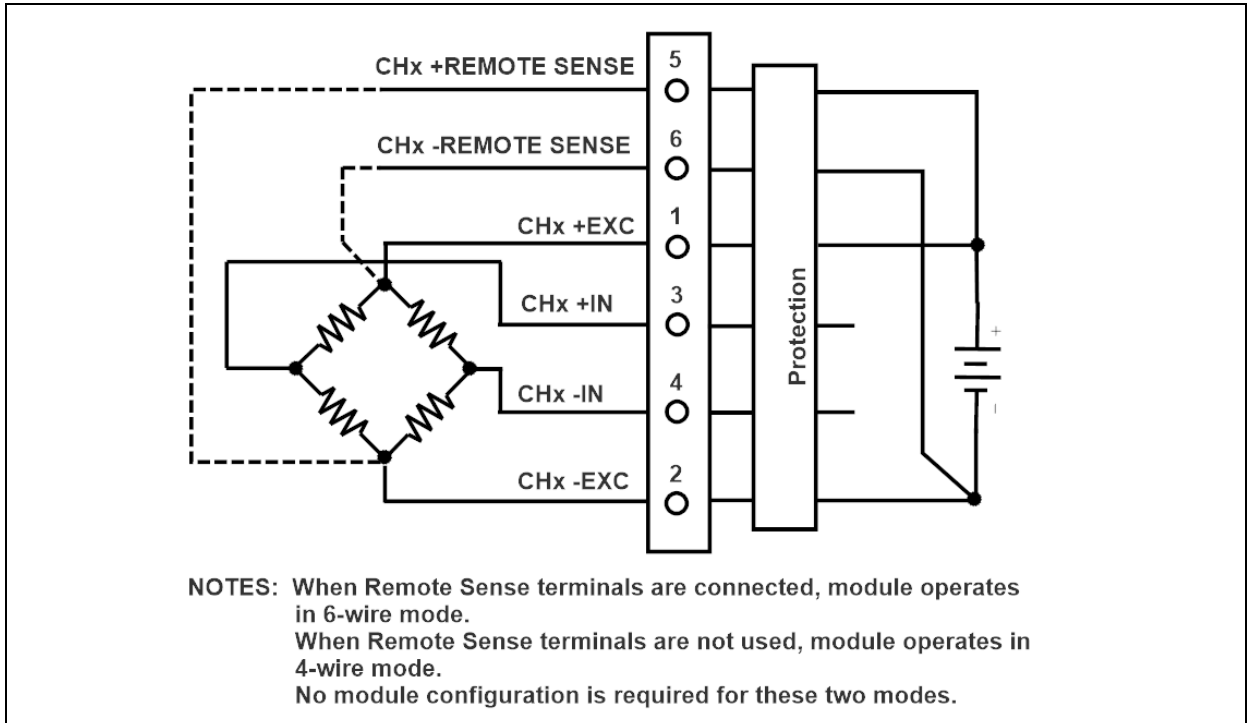
Figure 12: MAQ20-BRDG1 Remote Sense Connection

14.0 Shunt Calibration

When strain gages are used to measure stress and strain, calibration is required to attain the highest levels of accuracy and linearity. Typical sources of error that require compensation are leadwire resistance and variance between sensors. Once a strain gage is fixed in place to measure a given stress or strain, it can be difficult to force the bridge into the full scale positive or negative conditions for the purposes of calibration or verification by applying precision mechanical input. A commonly used alternative is to force a known imbalance in the strain gage using fixed resistors, creating a precise and predictable strain gage output. This indirect method of calibration is called Shunt Calibration.
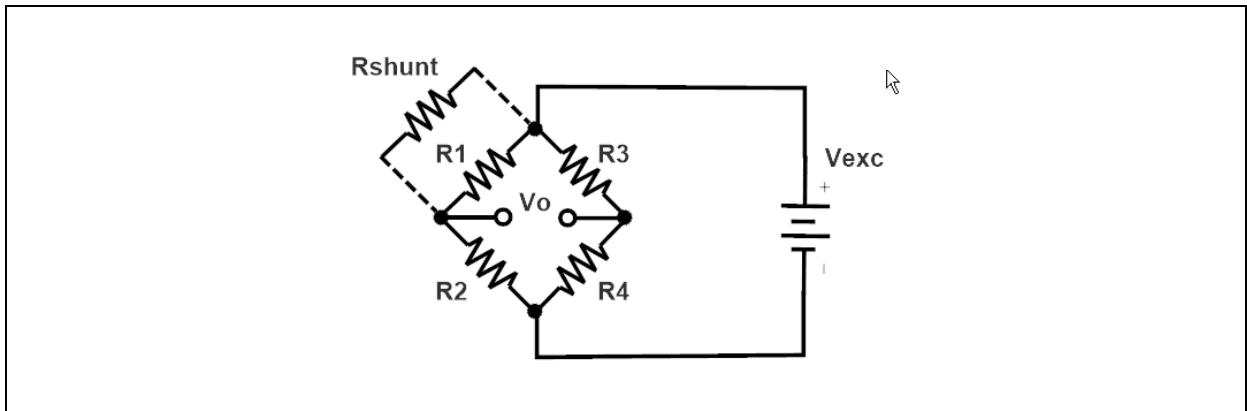
Figure 13: Shunt Calibration

Each input channel on the MAQ20-BRDG1 module has three internal resistors accessible through Terminals 7 and 8 for use in shunt calibration. Each channel also has the option to use an external resistor for shunt calibration. These four options are set by writing the appropriate code to a register.

		FIELD CONNECTION	TERMINAL	TERMINAL	FIELD CONNECTION
CH0	CHANNEL 0	+EXC	1	5	+REMOTE SENSE
		-EXC	2	6	-REMOTE SENSE
		SHIELD	S	S	SHIELD
		+IN	3	7	+SHUNT CAL
		-IN	4	8	-SHUNT CAL
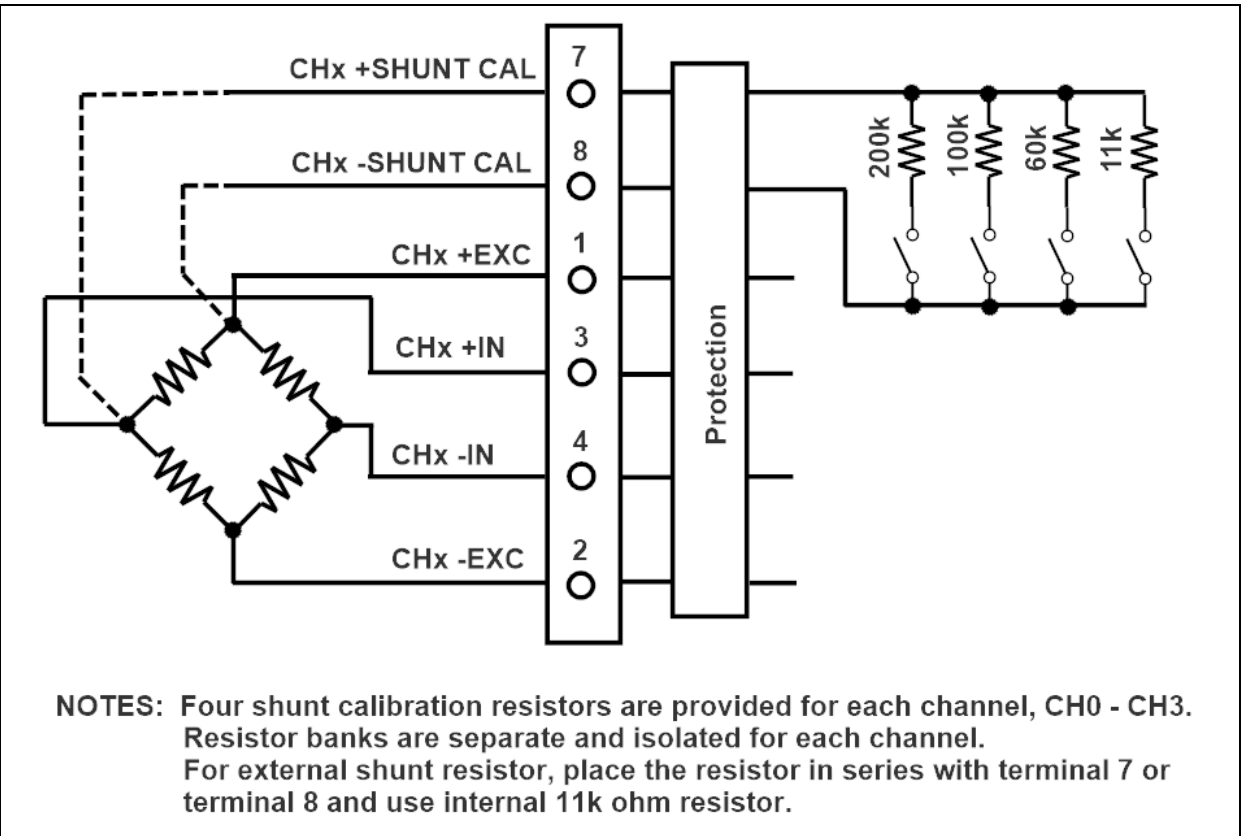
Figure 14: MAQ20-BRDG1 Internal Shunt Calibration Resistors

Formulas for use of shunt calibration resistors to simulate microstrain are:
When the bridge is balanced, (Vout/Vin)unstrained = 0

Vr = [(Vout/Vin)strained - (Vout/Vin)unstrained]

Full Bridge   Ɛ = -Vr/GF
Half Bridge   Ɛ = -2Vr/GF
Quarter Bridge   Ɛ = -4Vr/(GF(1+2Vr))

GF = Gage Factor. Common value used is 2.
Rg = Gage element nominal resistance. Typical values are 120 ohm, 350 ohm, 1000 ohm.

Shunt calibration resistor value for simulated microstrain, Ɛ

Rc = Rg*10^6/GF*Ɛ - Rg

The MAQ20-BRDG1 Address Map is found at the end of this manual. An excerpt from the Address Map is shown below. Channel Data is stored starting at module 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 MAQ20 I/O Module Registration 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
119	W	1	Save to Local Memory	Writing 0 will save Signal Gain, Average Weight, Vexc, Half Bridge, Shunt Calibration, Auto Zero, Sampling Rate.		INT16
620	R/W	4	Shunt Calibration Resistors	0 = 60kohm, 1 = 100kohm, 2 = 200kohm and 3 = External. Default = 0.	0 to 3	INT16
624	R/W	1	Shunt Calibration On/Off	0 = On, 1 = Off Default = 1	0 or 1	INT16

To set an internal shunt calibration resistor for each of the four input channels, write 0 to 3 to the registers at Address 620 to 623. Note that this address block is offset by 2000 * R. To enable or disable all internal shunt calibration resistors for each of the four input channels, write a 0 or 1 to Address 624. Note that this address is offset by 2000 * R. Once a shunt calibration resistor and On/Off state selection is made, it can be saved to local memory by writing a 0 to register 119.

Example: A MAQ20-BRDG1 module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 2. Assume input terminals 7 and 8 have been connected to one of the sensor gage elements. Set shunt calibration resistance of 60k ohm on Channel 0 and 200k ohm on Channel 3. Enable the shunt calibration function to provide simulated bridge strain.

The MAQ20-BRDG1 module with s/n 1234567-89 has an address offset of 2000 * 2 = 4000

Write to register address 4000 + 620 = 4620 a data value of 0 to set 60k ohm shunt cal on Ch 0
Write to register address 4000 + 623 = 4623 a data value of 2 to set 200k ohm shunt cal on Ch 3
Write to register address 4000 + 624 = 4624 a data value of 0 to enable shunt calibration function

15.0 Auto Zero

When strain gages are used to measure stress and strain, calibration is required to attain the highest levels of accuracy and linearity. One typical source of error that requires compensation is bridge imbalance. Once a strain gage is fixed in place to measure a given stress or strain, variations in nominal resistance of bridge elements and leadwire resistance for remote located bridge elements will result in a non-zero bridge output when no stress or strain is applied. Another common situation is the need to measure a stress or strain from a given reference state, such as the tare function on a weigh scale.
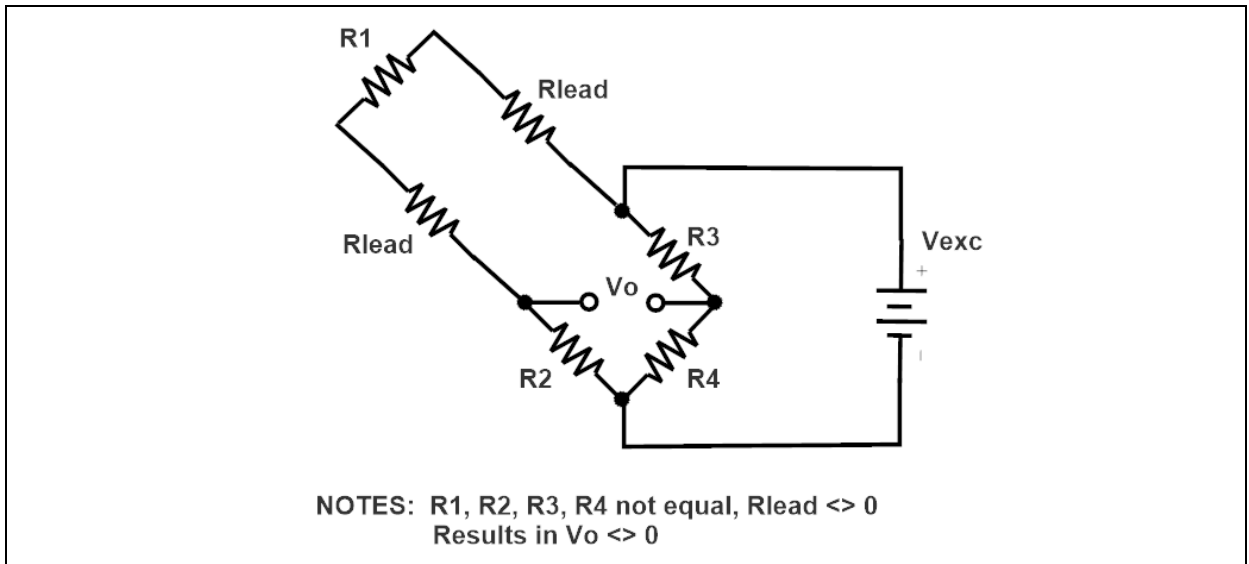
Figure 15: Bridge Imbalance

The MAQ20-BRDG1 module simplifies compensation for this error source by providing independent Auto Zero on each of the four input channels. With the bridge in a reference state, enabling the Auto Zero function will null out bridge imbalance and the module will report a reading of zero. Disabling the Auto Zero function will result in the module reporting the true bridge imbalance reading.

The MAQ20-BRDG1 Address Map is found at the end of this manual. An excerpt from the Address Map is shown below. Channel Data is stored starting at module 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 MAQ20 I/O Module Registration 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
626	R/W	1	Auto Zero Ch 0 Enable	1 = Set new zero value 0 = Clear zero Default = 0	0 or 1	INT16
627	R/W	1	Auto Zero Ch 1 Enable	1 = Set new zero value 0 = Clear zero Default = 0	0 or 1	INT16
628	R/W	1	Auto Zero Ch 2 Enable	1 = Set new zero value 0 = Clear zero Default = 0	0 or 1	INT16
629	R/W	1	Auto Zero Ch 3 Enable	1 = Set new zero value 0 = Clear zero Default = 0	0 or 1	INT16
630	R/W	8	Auto Zero Values	4 channel Auto Zero values. 24-bit data LSB at 63x, MSB at 63x+1. 16-bit data at 63x.		INT32 / INT16

To enable auto zero for each of the four input channels, write a 1 to the registers at Address 626 to 629. Note that this address block is offset by 2000 * R. When auto zero is enabled, the current readings at registers 1000 to 1008 for the channel selected are stored at registers 630 to 637 and new readings stored at registers 1000 to 1008 are compensated using the stored auto zero reading. Once an auto zero selection is made it can be saved to local memory by writing a 0 to register 119.

Example: A MAQ20-BRDG1 module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 2. Assume bridge imbalance results in a 24-bit reading of 25000 counts on Channel 0 and 50000 counts on Channel 3. Enable the auto zero function on Channel 0 and Channel 3 to provide compensation for bridge imbalance.

The MAQ20-BRDG1 module with s/n 1234567-89 has an address offset of 2000 * 2 = 4000

Write to register address 4000 + 626 = 4626 a data value of 1 to enable auto zero on Ch 0
The previous value of 25000 counts at registers 4000 + 1000 = 5000 and 4000 + 1001 = 5001 will be stored at registers 4000 + 630 = 4630 and 4000 + 631 = 4631.
New readings at registers 5000 and 5001 will be zero counts. Any change in bridge output from 25000 counts will show at registers 5000 and 5001 as a change from zero counts.

Write to register address 4000 + 629 = 4629 a data value of 1 to enable auto zero on Ch 3
The previous value of 50000 counts at registers 4000 + 1006 = 5006 and 4000 + 1007 = 5007 will be stored at registers 4000 + 636 = 4636 and 4000 + 637 = 4637.
New readings at registers 5006 and 5007 will be zero counts. Any change in bridge output from 50000 counts will show at registers 5006 and 5007 as a change from zero counts.

Write to register address 4000 + 626 = 4626 a data value of 0 to disable auto zero on Ch 0
Values at registers 4630 and 4631 will be zero counts and new readings at registers 5000 and 5001 will be 25000 counts.

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16.0 Signal Sample Rate

The MAQ20-BRDG1 module uses eight analog-to-digital converters to measure signal and excitation for the four input channels. The ADCs have configurable sample rate for storage of data internal to the module. All ADCs are set to the same sample rate. Sampled data is normally retrieved from the module as described in Section 17.0 Continuous Scan Mode. In Continuous Scan Mode, channel scan rate is limited by the system backbone communications rate and the number of MAQ20 I/O modules in a system. When faster data capture rates are required, the MAQ20-BRDG1 module offers another mode described in Section 18.0 Burst Scan Mode. Burst Scan stores short periods of high speed data capture in module volatile memory, then data is downloaded to a host PC.

Sample rate ranges from 1kS/s to 32kS/s. When signal sample rates of 1kS/s, 2kS/s, 4kS/s, 8kS/s and 16kS/s are used, sampled data will be 24 bits with LSB data stored at the lower address and MSB data is stored at the higher address. When the signal sample rates of 32kS/s is used, sampled data will be 16 bits.

The MAQ20-BRDG1 Address Map is found at the end of this manual. An excerpt from the Address Map is shown below.

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 MAQ20 I/O Module Registration 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
119	W	1	Save to Local Memory	Writing 0 will save Signal Gain, Average Weight, Vexc, Half Bridge, Shunt Calibration, Auto Zero, Sampling Rate.		INT16
678	R/W	1	Sampling Rate & Resolution	0 = future use 1 = 16bit, 32kS/s 2 = 24bit, 16kS/s 3 = 24bit, 8kS/s 4 = 24bit, 4kS/s (Default) 5 = 24bit, 2kS/s 6 = 24bit, 1kS/s	1 to 6	INT16

Address Range 1000 - 1699 : Module Data						
Start Address	Read/Write	Number of Registers	Contents	Description	Data Range	Data type
1000	R	8	Channel Data	Data for 4 Signal Channels. 24-bit data LSB at 100x, MSB at 100x+1. 16-bit data at 100x, 100x+2.	0 to 2^32-1 or 0 to 2^16-1	INT32 / INT16

To set the module internal sampling rate and data conversion resolution, write 1 to 6 to Address 678. Note that this address is offset by 2000 * R. Once an internal sample rate selection is made it can be saved to local memory by writing a 0 to register 119.

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Example: A MAQ20-BRDG1 module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 2. Input signal range is ±100mV. Set the internal sampling rate to 1kS/s and convert the measured Ch 0 input signal counts to engineering units.

The MAQ20-BRDG1 module with s/n 1234567-89 has an address offset of 2000 * 2 = 4000

Write to register address 4000 + 678 = 4678 a data value of 6 to set 1kS/s sampling rate and 24-bit data conversion

Read from register address 4000 + 1000 = 5000 the Channel 0 Signal Data LSB
Read from register address 4000 + 1001 = 5001 the Channel 0 Signal Data MSB

If the data read from Channel 0 Signal Data LSB is 23154 counts and the data read from Channel 0 Signal Data MSB is 106 counts, the input signal is:

Ch 0 LSB convert to binary	0101101001110010
Ch 0 MSB convert to binary	0000000001101010
Ch 0 24-bit representation	MSB + LSB = 011010100101101001110010
Ch 0 Decimal equivalent	6969970

6969970 counts * (+100mV - -100mV)/(8197767 counts - -8197767 counts) = 85.023mV

Example: A MAQ20-BRDG1 module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 2. Input signal range is ±100mV. Set the internal sampling rate to 32kS/s and convert the measured Ch 0 input signal counts to engineering units.

The MAQ20-BRDG1 module with s/n 1234567-89 has an address offset of 2000 * 2 = 4000

Write to register address 4000 + 678 = 4678 a data value of 1 to set 32kS/s sampling rate and 16-bit data conversion

Read from register address 4000 + 1000 = 5000 the Channel 0 Signal Data

If the data read from Channel 0 is 23154 counts, the input signal is:

23154 counts * (+100mV - -100mV)/(32023 counts - -32023 counts) = 72.304mV

17.0 Continuous Scan Mode

MAQ20-BRDG1 modules have eight analog-to-digital converters which continuously scan the four input channels and excitation voltage source and store the data in local memory. As new data is acquired, previous sampled data is continuously overwritten such that local memory always has the most recent data. Sample rate is 4kS/s default and is user configurable from 1kS/s to 32kS/s as described in Section 16.0 Signal Sample Rate. When a channel data read command is received, data for all channels is retrieved from local memory and returned in a single response. A standard command-response cycle to acquire data from a single input module takes 6ms. Channel scan rate at the system level depends on the number of MAQ20 I/O modules installed in a system. As more modules are added to a system, the scan rate for an individual channel decreases.

The following calculation is used to determine channel scan rate for each of the four input channels.

Module Scan Rate = Scans / s = Number of MAQ20 I/O modules in a system / 6ms

Each command/response cycle, four channels of data are acquired. Net scan rate is then expressed as:

Net Scan Rate = Scans / s * Number of channels

Example: Determine the MAQ20-BRDG1 per channel scan rate for the following system:
MAQ20-COM4
MAQ20-BRDG1

Scan rate for each of the input channels is:

Scan Rate, Ch0 – Ch4 = 1 / 6ms = 167 Scans / s = 167 Hz

Each command/response cycle, four channels of data are acquired. Net scan rate is then expressed as:

Net Scan Rate = 167 Hz * 4 channels = 668 Ch / s

Example: Determine the MAQ20-BRDG1 per channel scan rate for the following system:
MAQ20-COM4
MAQ20-BRDG1 #1   (4 channels)
MAQ20-BRDG1 #2   (4 channels)
MAQ20-VDN   (8 channels)
MAQ20-BRDG1 #3   (4 channels)

Scan rate for each of the input channels is:

Scan Rate, Ch0 – Ch4 = 1 / (6ms * 4 modules) = 42 Scans / s = 42 Hz

Each command/response cycle, four channels of data are acquired. Net scan rate is then expressed as:

Net Scan Rate, MAQ20-BRGD1 #1 = 42 Hz * 4 channels = 168 Ch / s
Net Scan Rate, entire system = 42 Hz * 20 channels = 840 Ch / s

18.0 Burst Scan Mode

MAQ20-BRDG1 modules have eight analog-to-digital converters which continuously scan the four input channels and excitation voltage source and store the data in local memory. Sample rate is 4kS/s default and is user configurable from 1kS/s to 32kS/s as described in Section 16.0 Signal Sample Rate. Burst Scan Mode allows storage of all samples acquired over a short time period in internal volatile memory. Stored data is then transferred to the host computer in a separate operation. Upon power cycle or reset, all stored burst scan data is erased.

Burst Scan Mode user settable parameters are Channel Enable, Number of Samples to Read at the configured sample rate, FIR Filter Enable, and V/V Calculation Enable. Available Storage, Read Counter, and Read Data Buffer are used for status and data transfer operations.

The MAQ20-BRDG1 Address Map is found at the end of this manual. An excerpt from the Address Map is shown below. Channel Data is stored starting at module address 1000.

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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 MAQ20 I/O Module Registration for further details on Registration Number.

Start Address	Read/Write	Number of Registers	Contents	Description	Data Range	Data type
			Address Range 1000 - 1699 : Module Data			
1096	R/W	1	FIR filter Enable	Burst Scan Mode only 1 = Enabled 0 = Disabled Default = 0	0 or 1	INT16
1097	R/W	1	V/V Calculation Enable	Burst Scan Mode only 1 = Enabled 0 = Disabled Default = 0	0 or 1	INT16
1098	R/W	2	Number of Samples to Read	Burst Scan Mode Only 24-bit data, 2M sample max. 16-bit data, 4M sample max. LSB at 1098, MSB at 1099. Default = 1000000	24-bit data 0 to 2000000, 16-bit data 0 to 4000000	INT32
1100	R/W	1	Scan Start	Burst Scan Mode Only 1 = Start, 0 = Stop Default = 0	0 or 1	INT16
1101	R/W	4	Channel Enable	Burst Scan Mode Only Channels to be included in Burst Scan 1 = Enable, 0 = Disable Default = 0	0 or 1	INT16
1105	R	2	Available Storage	Burst Scan Mode Only Storage space remaining, expressed in number of samples. 24-bit data, 2M sample max. 16-bit data 4M sample max. LSB at 1105, MSB at 1106. Default = 2000000	24-bit data 0 to 2000000, 16-bit data 0 to 4000000	INT32
1107	R/W	2	Read Counter	Burst Scan Mode Only Sample read counter. 24-bit data, 2M sample max. 16-bit data 4M sample max. LSB at 1107, MSB at 1108. Default = 0	24-bit data 0 to 2000000, 16-bit data 0 to 4000000	INT32
1110	R	100	Read Data Buffer	Burst Scan Mode Only Used for data transfer from internal memory. INT32: 24-bit data LSB at 1xxx, MSB at 1xxx+1. INT16:16-bit data at 1xxx. Float32: Integer part at 1xxx, fractional part at 1xxx+1.	0 to 2^32-1 or 0 to 2^16-1 or -0.10 to +0.10	INT32 / INT16 / Float32

To configure and run burst scan mode, write to Addresses 1098 to 1101. Note that these addresses are offset by 2000 * R. Once burst scan settings are made they can be saved to local memory by writing a 0 to register 119.

Example: A MAQ20-BRDG1 module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 2. Assume the internal sampling rate is 1kS/s. Configure and run a burst scan of 10,000 samples (10 seconds) on Channel 0 and Channel 1. Retrieve the data from module memory.

The MAQ20-BRDG1 module with s/n 1234567-89 has an address offset of 2000 * 2 = 4000

Write to register address 4000 + 1098 = 5098 a data value of 10000 to set the scan size
Write to register address 4000 + 1100 = 5100 a data value of 1 to start the burst scan

Wait 10 seconds for the burst scan to complete

Write to register address 4000 + 1107 = 5107 a data value of 0 to initialize the data read counter

Read from register address block 4000 + 1110 to 4000 + 1210 = 5110 to 5210 the first 100 samples
Read from register address 4000 + 1107 = 5107 a data value of 100 which indicates read success
Save the samples to a file

Repeat the block read from 5110 to 5210 a total of 100 times to retrieve the 10000 samples
After each block read, append the samples to the saved file

The consolidated saved data can then be reviewed, plotted, analyzed, and used for any purpose.

The captured data will remain in the MAQ20-BRDG1 module memory and can be retrieved again using the steps above. Data is volatile and will be erased upon module power cycle or reset command.

To capture a new set of data, write a 1 to register 1100.

To post process the data using the FIR filter function, write a 1 to register 1096.

To post process the data using the V/V Calculation function, write a 1 to register 1097. When V/V Calculation is enabled, data retrieved will be in Float32 format with integer part at register 1xxx and fractional part at register 1xxx+1.

19.0 Signal Average, Minimum & Maximum

The MAQ20-BRDG1 input circuitry is designed for low noise amplification of sensor signals. In some applications, sensor wiring and other environmental factors may induce noise on signal lines, or certain signal characteristics may want to be rejected. Applications may also require recording of minimum and maximum signal deviation for characterization or reporting purposes. For these reasons, user configurable signal averaging within the module is provided and minimum and maximum signal values are stored.

Signal averaging is set on a per-channel basis using the Average Weight coefficient. 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:

Average = Average + ((Sampled Value – Average) / Average Weight)

The MAQ20-BRDG1 Address Map 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 module 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 MAQ20 I/O Module Registration 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
119	W	1	Save to Local Memory	Writing 0 will save Signal Gain, Average Weight, Vexc, Half Bridge, Shunt Calibration, Auto Zero, Sampling Rate.		INT16
120	R/W	8	Average Weight	Weight for Average Calculation. Default = 0.	0 to 15	INT16

Address Range 1000 - 1699 : Module Data
Start Address	Read/Write	Number of Registers	Contents	Description	Data Range	Data type
1030	R/W	8	Signal Data Minimum	Minimum value for each of 4 signal channels. 24-bit data LSB at 10xx, MSB at 10xx+1. 16-bit data at 10xx. Default = -f.s.	0 to 2^32-1 or 0 to 2^16-1	INT32 / INT16
1050	R/W	8	Signal Data Maximum	Maximum value for each of 4 signal channels. 24-bit data LSB at 10xx, MSB at 10xx+1. 16-bit data at 10xx. Default = +f.s.	0 to 2^32-1 or 0 to 2^16-1	INT32 / INT16
1070	R/W	8	Signal Data Average	Average value for each of 4 signal channels. 24-bit data LSB at 10xx, MSB at 10xx+1. 16-bit data at 10xx. Default 0.	0 to 2^32-1 or 0 to 2^16-1	INT32 / INT16
1078	R/W	8	Excitation Data Average	Average value for each of 4 excitation channels. 24-bit data LSB at 10xx, MSB at 10xx+1. 16-bit data at 10xx. Default 0.	0 to 2^32-1 or 0 to 2^16-1	INT32 / INT16

To set the average weight, write 0 to 15 to the registers at Address 120-127. Note that this address block is offset by 2000 * R. Once an Average Weight selection is made it can be saved to local memory by writing a 0 to register 119.

Example: A MAQ20-BRDG1 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 2 to a value of 4. Assume an internal sample rate of 4kS/s and 24-bit data, and read the following parameters for Channel 2: Minimum Data, Maximum Data, and Average Data.

The MAQ20-BRDG1 module with s/n 1234567-89 has an address offset of 2000 * 4 = 8000

Write to register address 8000 + 122 = 8122 a data value of 4 to set Signal Data Average Weight
Write to register address 8000 + 126 = 8126 a data value of 4 to set Excitation Data Average Weight

Read from register address 8000 + 1034 = 9034 the Channel 2 signal minimum data LSB
Read from register address 8000 + 1035 = 9035 the Channel 2 signal minimum data MSB

Read from register address 8000 + 1054 = 9054 the Channel 2 signal maximum data LSB
Read from register address 8000 + 1055 = 9055 the Channel 2 signal maximum data MSB

Note that minimum and maximum data is not stored for the excitation

Read from register address 8000 + 1074 = 9074 the Channel 2 signal average data LSB
Read from register address 8000 + 1075 = 9075 the Channel 2 signal average data MSB

Read from register address 8000 + 1082 = 9082 the Channel 2 excitation average data LSB
Read from register address 8000 + 1083 = 9083 the Channel 2 excitation average data MSB

20.0 V/V Ratiometric Signal Representation

Many strain gage signal conditioners use a four wire connection to the bridge to simplify field wiring. Four wire connections require the excitation voltage source to be accurate and stable over temperature, time, and load. They also require short connections between the strain gage and signal conditioner to reduce errors caused by voltage drops across wiring resistance. One method to reduce these errors is outlined in Section 13.0 Remote Sense. Another method to eliminate these errors is ratiometric signal representation. Because a Wheatstone bridge output is directly related to the bridge excitation voltage, by using a ratiometric measurement, variations in bridge output due to excitation changes over time, temperature, load, or leadwire resistance cancel out.

The MAQ20-BRDG1 module offers the option to return measured data in ratiometric format, or V/V representation. When this option is selected, data is presented as:

V/V = Measured Voltage Input Signal / Measured Voltage Excitation

This measurement is dimensionless and is a 32-bit floating point number.

V/V ratiometric measurement is calculated and stored in a separate set of registers during standard operation as outlined in Section 17.0 Continuous Scan Mode. This data can be retrieved at any time by accessing these registers. Additionally, V/V can be selectively applied to measured data captured in short time periods as outlined in Section 18.0 Burst Scan Mode. This selection is made by writing a code to a register.

The MAQ20-BRDG1 Address Map 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 module 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 MAQ20 I/O Module Registration 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
1020	R/W	8	V/V output	4 channels V/V reading. Integer part at 1xxx, fractional part at 1xxx+1.	-0.04 to +0.04	Float32
1097	R/W	1	V/V Calculation Enable	Burst Scan Mode Only 1 = Enabled 0 = Disabled Default = 0	0 or 1	INT16
1110	R	100	Read Data Buffer	Burst Scan Mode Only Used for data transfer from internal memory. INT32: 24-bit data LSB at 1xxx, MSB at 1xxx+1. INT16:16-bit data at 1xxx. Float32: Integer part at 1xxx, fractional part at 1xxx+1.	0 to 2^32-1 or 0 to 2^16-1 or -0.10 to +0.10	INT32 / INT16 / Float32

To enable V/V calculation for burst scan mode, write 1 to register Address 1097. Note that this address block is offset by 2000 * R. Once burst scan configuration is chosen, it can be saved to local memory by writing a 0 to register 119.

Example: A MAQ20-BRDG1 module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 4. Enable V/V calculation for burst scan mode and retrieve ratiometric data for continuous scan and burst scan acquisitions.

The MAQ20-BRDG1 module with s/n 1234567-89 has an address offset of 2000 * 4 = 8000

Write to register address 8000 + 1097 = 9097 a data value of 1 to enable V/V calculation for burst scan

Read from register address 8000 + 1020 to 1027 = 9020 to 9027 the Channel 0 to Channel 3 ratiometric measurements. Data retrieved will be in Float32 format with integer part at register 1xxx and fractional part at register 1xxx+1.

Configure a burst scan and retrieve the collected data by following the instructions outlined in Section 18.0 Burst Scan Mode. Data retrieved will be in Float32 format with integer part at register 1xxx and fractional part at register 1xxx+1.

21.0 FIR (Finite Impulse Response) Filter

The MAQ20-BRDG1 module has an internal signal filter which scales with the internal sampling rate chosen. To set sample rate, refer to Section 16.0 Signal Sample Rate. This filter has notches or zeros at multiples of the sample rate.
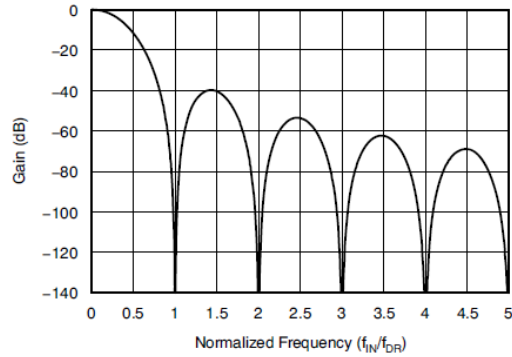
Signal attenuation follows this characteristic.
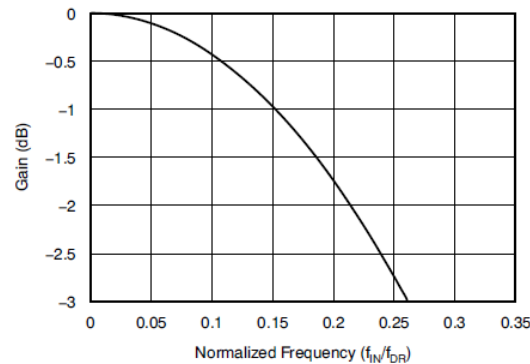
The MAQ20-BRDG1 module offers the option to use an FIR filter to increase the signal bandwidth. This option is not available in continuous scan mode. The FIR filter can be selectively applied to measured data captured in short time periods as outlined in Section 18.0 Burst Scan Mode. This selection is made by writing a code to a register.

When the FIR filter is enabled, signal filter passband attenuation is reduced to produce a flat characteristic up to 40% of the sampling rate.

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The MAQ20-BRDG1 Address Map 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 module 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 MAQ20 I/O Module Registration 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
1096	R/W	1	FIR filter Enable	Burst Scan Mode Only 1 = Enabled, 0 = Disabled Default = 0	0 or 1	INT16
1110	R	100	Read Data Buffer	Burst Scan Mode Only Used for data transfer from internal memory. INT32: 24-bit data LSB at 1xxx, MSB at 1xxx+1. INT16:16-bit data at 1xxx. Float32: Integer part at 1xxx, fractional part at 1xxx+1.	0 to 2^32-1 or 0 to 2^16-1 or -0.10 to +0.10	INT32 / INT16 / Float32

To enable FIR filter for burst scan mode, write 1 to register Address 1096. Note that this address block is offset by 2000 * R. Once FIR filter configuration is chosen, it can be saved to local memory by writing a 0 to register 119.

Example: A MAQ20-BRDG1 module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 4. Enable FIR filter for burst scan mode and retrieve data from a burst scan acquisition.

The MAQ20-BRDG1 module with s/n 1234567-89 has an address offset of 2000 * 4 = 8000

Write to register address 8000 + 1097 = 9096 a data value of 1 to enable FIR filter for burst scan

Configure a burst scan and retrieve the collected data by following the instructions outlined in Section 18.0 Burst Scan Mode. The data retrieved will have the filter compensation applied.

22.0 Alarm Functions

Alarms in the MAQ20-BRDG1 module can be set for input signal or V/V measurements acquired in continuous scan mode. Alarms have the following parameters which can be set 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 Setting and Monitoring Alarms 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.

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 16 below for graphical representations of alarm parameters and functionality.

Latching Alarm
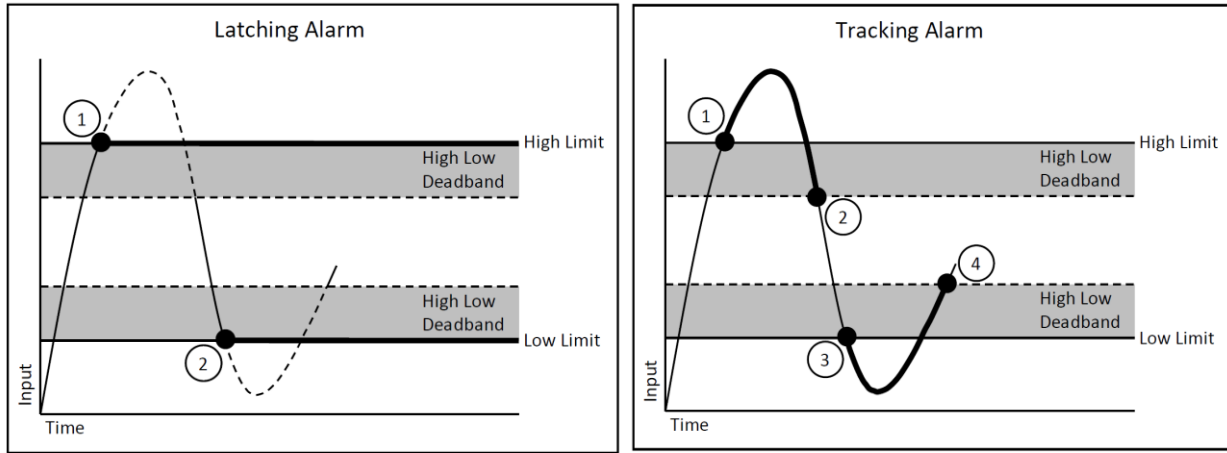
1. High Alarm Tripped
2. Low Alarm Tripped

Tracking Alarm

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

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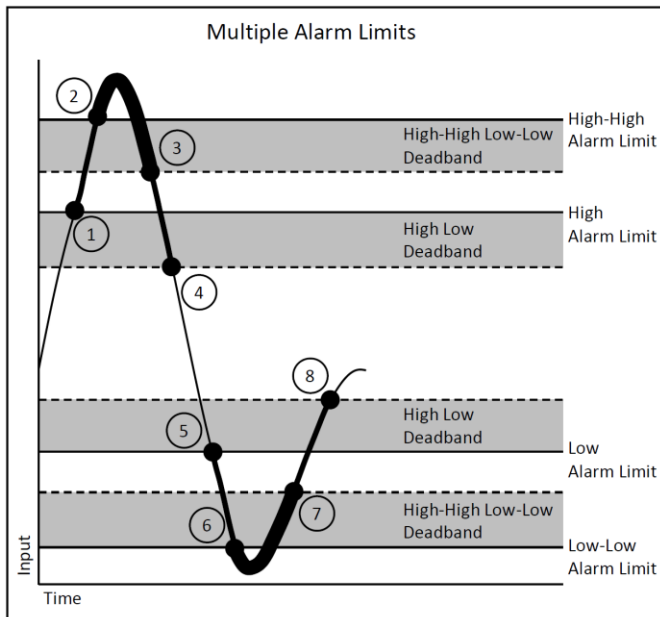
1. High Alarm Trip
2. High-High Alarm Trip
3. High-High Alarm Reset
4. High Alarm Reset
5. Low Alarm trip
6. Low-Low Alarm Trip
7. Low-Low Alarm Reset
8. Low Alarm Reset

Deadband Eliminates False Trip
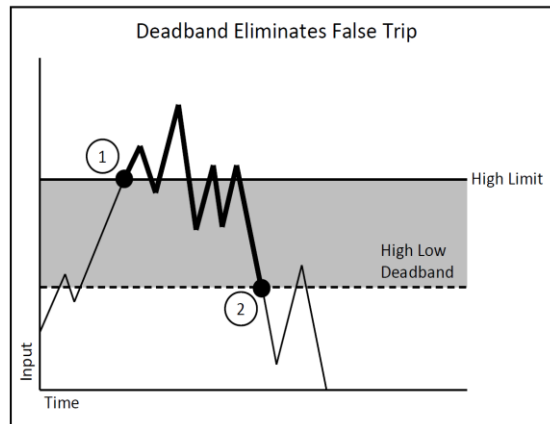
1. High Alarm Trip
2. High Alarm Reset

Figure 16: Alarm Parameters and Functionality

23.0   Setting and Monitoring Alarms

Alarm settings can be individually set for each signal input channel. Alarm type and limit type are set by writing a value to a configuration register which is the sum of a number representing the type of alarm and a number representing the alarm limits to be monitored. Alarms are enabled and disabled by writing a 1 or 0 to an enable register. Alarm Status is stored in a register block next to the configuration registers and is mirrored to a register block next to the input channel readings. When an alarm condition occurs, the appropriate status register is updated and the red LED on the top panel of the module will light. The status registers can be monitored by host software for alarm detection. In addition, the MAQ20-BRDG1 module has the ability to map alarm events to other actions with the system.

Alarm Configuration Value = Alarm Type Code + Alarm Limit Code

Alarm Type	**Code**	**Alarm Limit**	**Code**
Tracking	1000	Low Limit	100
Latching	2000	High Limit	200
		High Low Limits	300
		Low-Low Limit	400
		High-High Limit	500
		High-High Low-Low Limits	600

The MAQ20-BRDG1 Address Map is found at the end of this manual. An excerpt from the Address Map is shown below. Alarm status registers and configuration parameters are stored in registers at addresses 700 – 837. In addition, alarm status registers are repeated at module addresses 1016 – 1019.

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 MAQ20 I/O Module Registration for further details on Registration Number.

Address Range 700 - 999 : Module Configuration						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
700	R/W	1	Alarm Status, Low-Low Bitwise	0 = No Alarm 1 = Alarm Limit Exceeded To clear a Latched alarm write a 0 to the corresponding channel bit. Default = 0.	0 to 15	INT16
701	R/W	1	Alarm Status, Low Bitwise	0 = No Alarm 1 = Alarm Limit Exceeded To clear a Latched alarm write a 0 to the corresponding channel bit. Default = 0.	0 to 15	INT16
702	R/W	1	Alarm Status, High Bitwise	0 = No Alarm 1 = Alarm Limit Exceeded To clear a Latched alarm write a 0 to the corresponding channel bit. Default = 0.	0 to 15	INT16

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703	R/W	1	Alarm Status, High-High Bitwise	0 = No Alarm 1 = Alarm Limit Exceeded To clear a Latched alarm write a 0 to the corresponding channel bit. Default = 0.	0 to 15	INT16
704	R/W	1	Alarm Enable	1 = Enabled 0 = Disabled Default = 0	See Section 23.0	INT16
709	W	1	Save Alarm Parameters to Local Memory	Writing 1 will save the Alarm Configuration, High Limit, Low Limit, High-Low Deadband, High-High Limit, Low-Low Limit and High-High Low-Low Deadband.		
710	R/W	4	Alarm Configuration	Alarm Configuration Default = 0	See Section 23.0	INT16
730	R/W	8	High Limit	High Alarm Limit. 24-bit data LSB at 7xx, MSB at 7xx+1. 16-bit data at 7xx. Default = +f.s.	0 to 2^32-1	INT32
750	R/W	8	Low Limit	Low Alarm Limit. 24-bit data LSB at 7xx, MSB at 7xx+1. 16-bit data at 7xx. Default = -f.s.	0 to 2^32-1	INT32
770	R/W	8	High Low Deadband	Deadband for High Low Alarm. 24-bit data LSB at 7xx, MSB at 7xx+1. 16-bit data at 7xx. Default = 0.	0 to 2^32-1	INT32
790	R/W	8	High-High Limit	High-High Alarm Limit. 24-bit data LSB at xxx, MSB at xxx+1. 16-bit data at xxx. Default = +f.s.	0 to 2^32-1	INT32
810	R/W	8	Low-Low Limit	Low-Low Alarm Limit. 24-bit data LSB at 8xx, MSB at 8xx+1. 16-bit data at 8xx. Default = -f.s.	0 to 2^32-1	INT32
830	R/W	8	High-High Low-Low Deadband	Deadband for High-High Low-Low Alarm. 24-bit data LSB at 8xx, MSB at 8xx+1. 16-bit data at 8xx. Default = 0.	0 to 2^32-1	INT32

Address Range 1000 - 1699 : Module Data						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1016	R	1	Alarm Status, Low-Low Bitwise	Status of Low-Low Alarm 0 = No Alarm 1 = Alarm Limit Exceeded Default = 0	0 to 15	INT16
1017	R	1	Alarm Status, Low Bitwise	Status of Low Alarm 0 = No Alarm 1 = Alarm Limit Exceeded Default = 0	0 to 15	INT16
1018	R	1	Alarm Status, High Bitwise	Status of High Alarm 0 = No Alarm 1 = Alarm Limit Exceeded Default = 0	0 to 15	INT16
1019	R	1	Alarm Status, High-High Bitwise	Status of High-High Alarm 0 = No Alarm 1 = Alarm Limit Exceeded Default = 0	0 to 15	INT16

Once alarm configuration is complete it can be saved to local memory by writing a 1 to register 709. If the alarm configuration value is 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-BRDG1 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 4170000 counts, a Low limit of 200000 counts and a Deadband of 10000 counts.

The MAQ20-BRDG1 module with s/n 1234567-89 has an address offset of 2000 * 3 = 6000

Write to register address 6000 + 711 = 6711 a value of 2000 + 300 = 2300 to set a Latching Alarm with High Low limit on Channel 1
Write to register address 6000 + 731 = 6731 a value of 4170000 to set the High limit on Channel 1
Write to register address 6000 + 751 = 6751 a value of 200000 to set the Low limit on Channel 1
Write to register address 6000 + 771 = 6711 a data value of 10000 to set the Deadband for the High and Low limits on Channel 1
Write to register address 6000 + 704 = 6704 the equivalent of bit code 0000 0010 = 2 to enable the alarm on Channel 1
Write to register address 6000 + 709 = 6709 a data value of 1 to save the configuration to memory

When an alarm condition is reached as specified by the above parameters, the Alarm Status registers are updated 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 0010 = 3 is read, the low alarm limit plus deadband was exceeded on Channel 1

Write to register address 6000 + 701 = 6701 the equivalent of bit code 0000 0000 = 0 to clear the Channel 1 latched alarm. The red LED will be turned off.

Read register address 6000 + 702 = 6702 to view the status of the High Alarm.
If bit code 0000 0010 = 3 is read, the high alarm limit plus deadband was exceeded on Channel 1

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24.0   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 local memory. User parameters stored in local memory are not affected and will be reloaded upon power cycle. If the parameters listed below are to be changed and saved to local memory, make the changes then perform a Save to Local Memory operation.

Reset-to-Default reverts the module to the settings used at the factory during manufacture. It performs the standard reset actions plus resets non-volatile parameters to default settings. User parameters stored in local memory are not affected and will be reloaded upon power cycle. To return a module to original factory configuration, perform a Reset-to-Default followed by a Save to Local Memory operation.

The table below shows which parameters are affected for each reset.

Table 3: Parameters Affected by Standard Reset and Reset-to-Default

RESET TYPE	PARAMETERS
Standard Reset	Disables all Alarms, Clears Alarm Status Resets Min, Max and Average registers to 0 Resets Signal Gain, Average Weight, Excitation Voltage, Bridge Configuration, Shunt Calibration, Auto Zero, Sampling Rate, FIR Filter Enable, V/V Calculation Enable, Burst Sample Count, Burst Channel Enable to values set in Local Memory Clears all Status and Diagnostic registers
Reset-to-Default	All parameters listed under Standard Reset, plus: Resets Signal Gain, Average Weight, Excitation Voltage, Bridge Configuration, Shunt Calibration, Auto Zero, Sampling Rate, FIR Filter Enable, V/V Calculation Enable, Burst Sample Count, Burst Channel Enable to values to factory default values 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)
MAQ20 I/O modules utilize a watchdog timer to ensure reliable and predictable operation under all conditions. Upon power cycle or any extreme circumstance under which the watchdog timer expires, a Standard Reset is performed and parameters stored in local memory are loaded to the appropriate registers.

25.0   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-BRDG1, 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 (BRDG, 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.

26.0   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.

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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 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

27.0   Specifications

SPECIFICATIONS: STRAIN GAGE INPUT MODULE   Typical at Ta = +25°C and +24V system power

Model Number, Sensor Type & Input Range	
MAQ20-BRDG1	Full, Half, Quarter Bridge (with external bridge completion)
	4-wire or 6-wire connection
Number of Channels	4
Per Channel Setup	Individually configurable for range, alarms, averaging
Input Range	+/-100mV at 0.8mV/V to 40mV/V Sensitivity
Input Protection	
Continuous	30Vrms max
Transient	ANSI/IEEE C37.90.1
Excitation Voltage	2.5V, 3.3V, 5.0V, 10.0V @ 80mA max
Bridge Resistance	100ohm to 1kohm
Shunt Calibration	60kohm, 100kohm, 200kohm, External
Excitation Protection	
Continuous	30Vrms max
Transient	ANSI/IEEE C37.90.1
CMV	
Channel-to-Bus	1500Vrms, 1 min
Channel-to-Channel	±3V peak
Transient	ANSI/IEEE C37.90.1
CMR	100dB @ 50/60 Hz
NMR	60dB/decade
Accuracy(1)	±0.03% span
Linearity	±0.01% span
Resolution	0.0005% to 0.005% span
ADC Resolution	24-bit
Stability	
Zero	50ppm/C
Span	75ppm/C
Bandwidth	Programmable to 17kHz
Sampling Rate, Simultaneous	1kS/s to 32kS/s burst
Alarms	High / High-High / Low / Low-Low
Power Supply Current	400mA
Dimensions (h)(w)(d)	4.51" x 0.60" x 3.26" (114.6mm x 15.3mm x 8.28mm)
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, ATEX Pending
	UL/CUL Class I, Division 2, Groups A, B, C, D Pending

(1) Includes linearity/conformity, hysteresis and repeatability.

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28.0 MAQ20-BRDG1 Address Map

The table in this section outlines the MAQ20-BRDG1 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.

Table 4: MAQ20-BRDG1 Address Map

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 0 - 99 : Module Information						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
0	R	15	Device Description	MAQ20-BRDG1	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	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	4	Input Range	0 = ±100mV (Default) 1 = ±50mV 2 = ±25mV 3 = ±12.5mV 4 = ±8.33mV	0 to 4	INT16
119	W	1	Save to Local Memory	Writing 0 will save Signal Gain, Average Weight, Vexc, Half Bridge, Shunt Calibration, Auto Zero, Sampling Rate.		INT16
120	R/W	8	Average Weight	Weight for Average Calculation. Default = 0.	0 to 15	INT16
600	R/W	1	Excitation Voltage	0 = 2.5V, 1 = 3.3V, 2 = 5V, 3 = 10V. Default = 0.	0 to 3	INT16
610	R/W	4	Half Bridge Configuration	0 = Half Bridge, 1 = Full Bridge. Default = 1.	0 or 1	INT16
620	R/W	4	Shunt Calibration Resistors	0 = 60kohm, 1 = 100kohm, 2 = 200kohm and 3 = External. Default = 0.	0 to 3	INT16
624	R/W	1	Shunt Calibration On/Off	0 = On, 1 = Off. Default = 1.	0 or 1	INT16
626	R/W	1	Auto Zero Ch 0 Enable	1 = Set new zero value, 0 = Clear zero. Default = 0.	0 or 1	INT16
627	R/W	1	Auto Zero Ch 1 Enable	1 = Set new zero value, 0 = Clear zero. Default = 0.	0 or 1	INT16
628	R/W	1	Auto Zero Ch 2 Enable	1 = Set new zero value, 0 = Clear zero. Default = 0.	0 or 1	INT16
629	R/W	1	Auto Zero Ch 3 Enable	1 = Set new zero value, 0 = Clear zero. Default = 0.	0 or 1	INT16
630	R/W	8	Auto Zero Values	4 channel Auto Zero values. 24-bit data LSB at 63x, MSB at 63x+1. 16-bit data at 63x.		INT32 / INT16
678	R/W	1	Sampling Rate & Resolution	0 = future use 1 = 16bit, 32kS/s 2 = 24bit, 16kS/s 3 = 24bit, 8kS/s 4 = 24bit, 4kS/s (Default) 5 = 24bit, 2kS/s 6 = 24bit, 1kS/s	1 to 6	INT16

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				Address Range 700 - 999 : Module Configuration		
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
700	R/W	1	Alarm Status, Low-Low Bitwise	0 = No Alarm 1 = Alarm Limit Exceeded To clear a Latched alarm write a 0 to the corresponding channel bit. Default = 0.	0 to 15	INT16
701	R/W	1	Alarm Status, Low Bitwise	0 = No Alarm 1 = Alarm Limit Exceeded To clear a Latched alarm write a 0 to the corresponding channel bit. Default = 0.	0 to 15	INT16
702	R/W	1	Alarm Status, High Bitwise	0 = No Alarm 1 = Alarm Limit Exceeded To clear a Latched alarm write a 0 to the corresponding channel bit. Default = 0.	0 to 15	INT16
703	R/W	1	Alarm Status, High-High Bitwise	0 = No Alarm 1 = Alarm Limit Exceeded To clear a Latched alarm write a 0 to the corresponding channel bit. Default = 0.	0 to 15	INT16
704	R/W	1	Alarm Enable	1 = Enabled 0 = Disabled Default = 0	See Section 23.0	INT16
709	W	1	Save Alarm Parameters to Local Memory	Writing 1 will save the Alarm Configuration, High Limit, Low Limit, High-Low Deadband, High-High Limit, Low-Low Limit and High-High Low-Low Deadband.		
710	R/W	4	Alarm Configuration	Alarm Configuration Default = 0	See Section 23.0	INT16
730	R/W	8	High Limit	High Alarm Limit. 24-bit data LSB at 7xx, MSB at 7xx+1. 16-bit data at 7xx. Default = +f.s.	0 to 2^32-1	INT32
750	R/W	8	Low Limit	Low Alarm Limit. 24-bit data LSB at 7xx, MSB at 7xx+1. 16-bit data at 7xx. Default = -f.s.	0 to 2^32-1	INT32
770	R/W	8	High Low Deadband	Deadband for High Low Alarm. 24-bit data LSB at 7xx, MSB at 7xx+1. 16-bit data at 7xx. Default = 0.	0 to 2^32-1	INT32
790	R/W	8	High-High Limit	High-High Alarm Limit. 24-bit data LSB at xxx, MSB at xxx+1. 16-bit data at xxx. Default = +f.s.	0 to 2^32-1	INT32

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Address Range 700 - 999 : Module Configuration						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
810	R/W	8	Low-Low Limit	Low-Low Alarm Limit. 24-bit data LSB at 8xx, MSB at 8xx+1. 16-bit data at 8xx. Default = -f.s.	0 to 2^32-1	INT32
830	R/W	8	High-High Low-Low Deadband	Deadband for High-High Low-Low Alarm. 24-bit data LSB at 8xx, MSB at 8xx+1. 16-bit data at 8xx. Default = 0.	0 to 2^32-1	INT32

Address Range 1000 - 1699 : Module Data						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1000	R	8	Channel Data	Data for 4 Signal Channels. 24-bit data LSB at 100x, MSB at 100x+1. 16-bit data at 100x, 100x+2.	0 to 2^32-1 or 0 to 2^16-1	INT32 / INT16
1008	R	8	EXC Data	Data for 4 Excitation Channels. 24-bit data LSB at 10xx, MSB at 10xx+1. 16-bit data at 10xx, 10xx+2.	0 to 2^32-1 or 0 to 2^16-1	INT32 / INT16
1016	R	1	Alarm Status, Low-Low Bitwise	Status of Low-Low Alarm 0 = No Alarm 1 = Alarm Limit Exceeded Default = 0	0 to 15	INT16
1017	R	1	Alarm Status, Low Bitwise	Status of Low Alarm 0 = No Alarm 1 = Alarm Limit Exceeded Default = 0	0 to 15	INT16
1018	R	1	Alarm Status, High Bitwise	Status of High Alarm 0 = No Alarm 1 = Alarm Limit Exceeded Default = 0	0 to 15	INT16
1019	R	1	Alarm Status, High-High Bitwise	Status of High-High Alarm 0 = No Alarm 1 = Alarm Limit Exceeded Default = 0	0 to 15	INT16
1020	R/W	8	V/V output	4 channels V/V reading. Integer part at 1xxx, fractional part at 1xxx+1.	-0.04 to +0.04	Float32

Address Range 1000 - 1699 : Module Data						
Start Address	Read/Write	Number of Registers	Contents	Description	Data Range	Data type
1030	R/W	8	Signal Data Minimum	Minimum value for each of 4 signal channels. 24-bit data LSB at 10xx, MSB at 10xx+1. 16-bit data at 10xx. Default = -f.s.	0 to 2^32-1 or 0 to 2^16-1	INT32 / INT16
1050	R/W	8	Signal Data Maximum	Maximum value for each of 4 signal channels. 24-bit data LSB at 10xx, MSB at 10xx+1. 16-bit data at 10xx. Default = +f.s.	0 to 2^32-1 or 0 to 2^16-1	INT32 / INT16
1070	R/W	8	Signal Data Average	Average value for each of 4 signal channels. 24-bit data LSB at 10xx, MSB at 10xx+1. 16-bit data at 10xx. Default = 0.	0 to 2^32-1 or 0 to 2^16-1	INT32 / INT16
1078	R/W	8	Excitation Data Average	Average value for each of 4 excitation channels. 24-bit data LSB at 10xx, MSB at 10xx+1. 16-bit data at 10xx. Default = 0.	0 to 2^32-1 or 0 to 2^16-1	INT32 / INT16
1096	R/W	1	FIR filter Enable	Burst Scan Mode Only 1 = Enabled, 0 = Disabled Default = 0	0 or 1	INT16
1097	R/W	1	V/V Calculation Enable	Burst Scan Mode Only 1 = Enabled 0 = Disabled Default = 0	0 or 1	INT16
1098	R/W	2	Number of Samples to Read	Burst Scan Mode Only 24-bit data, 2M sample max. 16-bit data, 4M sample max. LSB at 1098, MSB at 1099. Default = 1000000	24-bit data 0 to 2000000, 16-bit data 0 to 4000000	INT32
1100	R/W	1	Scan Start	Burst Scan Mode Only 1 = Start, 0 = Stop Default = 0	0 or 1	INT16
1101	R/W	4	Channel Enable	Burst Scan Mode Only Channels to be included in Burst Scan 1 = Enable, 0 = Disable Default = 0	0 or 1	INT16
1105	R	2	Available Storage	Burst Scan Mode Only Storage space remaining, expressed in number of samples. 24-bit data, 2M sample max. 16-bit data 4M sample max. LSB at 1105, MSB at 1106. Default = 2000000	24-bit data 0 to 2000000, 16-bit data 0 to 4000000	INT32

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Address Range 1000 - 1699 : Module Data						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1107	R/W	2	Read Counter	Burst Scan Mode Only Sample read counter. 24-bit data, 2M sample max. 16-bit data 4M sample max. LSB at 1107, MSB at 1108. Default = 0	24-bit data 0 to 2000000, 16-bit data 0 to 4000000	INT32
1110	R	100	Read Data Buffer	Burst Scan Mode Only Used for data transfer from internal memory. INT32: 24-bit data LSB at 1xxx, MSB at 1xxx+1. INT16:16-bit data at 1xxx. Float32: Integer part at 1xxx, fractional part at 1xxx+1.	0 to 2^32-1 or 0 to 2^16-1 or -0.10 to +0.10	INT32 / INT16 / Float32

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 5**	**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

Start Address	Read/Write	Number of Registers	Contents	Description	Data Range	Data type
**Address Range 1700 - 1899 : Input Ranges**						
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

Address Range 1700 - 1899 : Input Ranges						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
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
1790	**R**	**1**	**Range 4**	**Engineering -fs.**	**-32,768 to 32,767**	**INT16**
1791	R	1	Range 4	Future Use	-32,768 to 32,767	INT16
1792	R	1	Range 4	Engineering +fs	-32,768 to 32,767	INT16
1793	R	1	Range 4	Future Use	-32,768 to 32,767	INT16
1794	R	1	Range 4	+fs & -fs multiplier Factor 10^X	-32,768 to 32,767	INT16
1795	R	1	Range 4	Engineering Units ("C", "V", etc)	A to Z	ASCII
1796	R	1	Range 4	Engineering Units ("C", "V", etc)	A to Z	ASCII
1797	R	1	Range 4	Future Use	-32,768 to 32,767	INT16
1798	R	1	Range 4	Count Value of -fs.	-32,768 to 32,767	INT16
1799	R	1	Range 4	Future Use	-32,768 to 32,767	INT16
1800	R	1	Range 4	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**	**Type**	**Example**	**Range**	**Data type**
1900	R/W	1	Watchdog Reset	0 = Normal 1 = Watchdog Reset Occurred	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. Default = 0.	0 to 65,535	INT16
1908	R/W	1	UART RX Error	UART RX Error Counter Command Too Short Default = 0	0 to 65,535	INT16
1909	R/W	1	UART RX Error	UART RX Error Counter Command Too Long Default = 0	0 to 65,535	INT16
1910	R/W	1	UART RX Error	UART RX Error Counter Command received in invalid state Default = 0	0 to 65,535	INT16

Table 5: MAQ20-BRDG1 Range Table

Sampling Rate = 1kS/s, 2kS/s, 4kS/s, 8kS/s, 16kS/s

	Signal Gain Code	Signal Gain	Standard Input Voltage	Equivalent Counts	Over/Under Range	Equivalent Counts
	0 (Default)	1	-100mV to +100mV	-8197767 to 8197767	-102.328mV to +102.328mV	-8388608 to 8388607
	1	2	-50mV to +50mV	-8197767 to 8197767	-51.164mV to +51.164mV	-8388608 to 8388607
	2	4	-25mV to +25mV	-8197767 to 8197767	-25.582mV to +25.582mV	-8388608 to 8388607
	3	8	-12.5mV to +12.5mV	-8197767 to 8197767	-12.791mV to +12.791mV	-8388608 to 8388607
	4	12	-8.33mV to +8.33mV	-8197767 to 8197767	-8.527mV to +8.527mV	-8388608 to 8388607

	Exc Code	Vexc	Standard Input Voltage	Equivalent Counts	Over/Under Range	Equivalent Counts
BRDG1	0 (Default)	2.5	2.5	1310720		
	1	3.333	3.333	1747452		
	2	5	5	2621440		
	3	10	10	5242880		

Sampling Rate = 32kS/s

	Signal Gain Code	Signal Gain	Standard Input Voltage	Equivalent Counts	Over/Under Range	Equivalent Counts
	0 (Default)	1	-100mV to +100mV	-32023 to 32023	-102.328mV to +102.328mV	-32768 to 32767
	1	2	-50mV to +50mV	-32023 to 32023	-51.164mV to +51.164mV	-32768 to 32767
	2	4	-25mV to +25mV	-32023 to 32023	-25.582mV to +25.582mV	-32768 to 32767
	3	8	-12.5mV to +12.5mV	-32023 to 32023	-12.791mV to +12.791mV	-32768 to 32767
	4	12	-8.33mV to +8.33mV	-32023 to 32023	-8.527mV to +8.527mV	-32768 to 32767

	Exc Code	Vexc	Standard Input Voltage	Equivalent Counts	Over/Under Range	Equivalent Counts
BRDG1	0 (Default)	2.5	2.5	5120		
	1	3.333	3.333	6826		
	2	5	5	10240		
	3	10	10	20480		

DATAFORTH®

DATAFORTH WARRANTY
Applying to Products Sold by Dataforth Corporation

a. **General**. Dataforth Corporation ("Dataforth") warrants that its products furnished under this Agreement will, at the time of delivery, be free from defects in material and workmanship and will conform to Dataforth's applicable specifications or, if appropriate, to buyer's specifications accepted in writing by Dataforth. DATAFORTH'S OBLIGATION OR LIABILITY TO BUYER FOR PRODUCTS WHICH DO NOT CONFORM TO THE ABOVE STATED WARRANTY SHALL BE LIMITED TO DATAFORTH, AT DATAFORTH'S SOLE DISCRETION, EITHER REPAIRING, REPLACING, OR REFUNDING THE PURCHASE PRICE OF THE DEFECTIVE PRODUCT(S) PROVIDED THAT WRITTEN NOTICE OF SAID DEFECT IS RECEIVED BY DATAFORTH WITHIN THE TIME PERIODS SET FORTH BELOW:

i. for all software products including licensed programs, thirty (30) days from date of initial delivery;

ii. for all hardware products including complete systems, one (1) year from date of initial delivery;

iii. for all special products, sixty (60) days from date of initial delivery; and

further, all products warranted hereunder for which Dataforth has received timely notice of nonconformance must be returned FOB to Dataforth's plant in Tucson, Arizona USA within thirty (30) days after the expiration of the warranty periods set forth above.

The foregoing warranties shall not apply to any products which Dataforth determines have, by buyer or otherwise, been subjected to operating and/or environmental conditions in excess of the maximum value established therefore in the applicable specifications, or any products that have been the subject of mishandling, misuse, misapplication, neglect, improper testing, repair, alteration or damage. THE PROVISIONS OF THE FOREGOING WARRANTIES EXTEND TO BUYER ONLY AND NOT TO BUYER'S CUSTOMERS OR USERS OF BUYER'S PRODUCTS. THE DATAFORTH STANDARD WARRANTY IS IN LIEU OF ALL WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE OR USE AND ALL OTHER WARRANTIES WHETHER EXPRESS, IMPLIED OR STATUTORY, EXCEPT AS TO TITLE. THE DATAFORTH STANDARD WARRANTY MAY BE CHANGED BY DATAFORTH WITHOUT NOTICE.

b. **Buyer Indemnity**. Buyer agrees to indemnify and hold Dataforth harmless from and against any and all claims, damages and liabilities whatsoever asserted by any person, entity, industry organization, government, or governmental agency of any country resulting directly or indirectly (i) from any acts not authorized by Dataforth in writing or any statements regarding the products inconsistent with Dataforth's product documentation or standard warranty, or (ii) from any breach or threatened breach by buyer, or by any of its employees or agents, of any term, condition or provision of this Warranty or (iii) from any warranty, representation, covenant or obligation given by buyer to any third party and not expressly provided for in this Warranty or (iv) for any non-compliance (in any form) of the products with any necessary or mandatory applicable laws, regulations, procedures, government or industry policies or requirements related to the use, sale or importation of the products. Such indemnification shall include the payment of all reasonable attorneys' fees and other costs incurred by Dataforth in defending such claim.

c. **Limitation on Damages**.

(1) IN NO EVENT SHALL DATAFORTH, ITS SUPPLIERS, LICENSORS, SERVICE PROVIDERS, EMPLOYEES, AGENTS, OFFICERS, AND DIRECTORS BE LIABLE FOR INDIRECT, SPECIAL, INCIDENTAL, COVER, ECONOMIC, PUNITIVE, ACTUAL, EXEMPLARY, CONSEQUENTIAL OR OTHER DAMAGES OF ANY NATURE INCLUDING, WITHOUT LIMITATION, LOST PROFITS OR REVENUES, COSTS OF REPLACEMENT PRODUCTS, LOSS OR DAMAGE TO DATA ARISING OUT OF THE USE OR INABILITY TO USE ANY DATAFORTH PRODUCT.

(2) IN NO EVENT SHALL DATAFORTH BE LIABLE FOR DIRECT, SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY NATURE RESULTING FROM BUYER'S NONCOMPLIANCE (IN ANY FORM) WITH ALL NECESSARY OR MANDATORY APPLICABLE LAWS, REGULATIONS, PROCEDURES, GOVERNMENT POLICIES OR REQUIREMENTS RELATED TO THE USE, SALE OR IMPORTATION OF PRODUCTS.

(3) IN NO EVENT WILL THE COLLECTIVE LIABILITY OF DATAFORTH AND ITS SUPPLIERS, LICENSORS, SERVICE PROVIDERS, EMPLOYEES, AGENTS, OFFICERS, AND DIRECTORS TO ANY PARTY (REGARDLESS OF THE FORM OF ACTION, WHETHER BASED UPON WARRANTY, CONTRACT, TORT, OR OTHERWISE) EXCEED THE GREATER OF EITHER US$1000.00 (ONE THOUSAND DOLLARS U.S.A. CURRENCY) OR THE AMOUNT PAID TO DATAFORTH FOR THE APPLICABLE PRODUCT OR SERVICE OUT OF WHICH LIABILITY AROSE.

(4) DATAFORTH'S LIABILITY ARISING OUT OF THE PRODUCTION, SALE OR SUPPLY OF PRODUCTS OR THEIR USE OR DISPOSITION, WHETHER

BASED UPON WARRANTY, CONTRACT, TORT OR OTHERWISE, SHALL NOT EXCEED THE GREATER OF EITHER US$1000.00 (ONE THOUSAND DOLLARS U.S.A. CURRENCY) OR THE ACTUAL PURCHASE PRICE PAID BY BUYER FOR DATAFORTH'S PRODUCTS. DATAFORTH'S LIABILITY FOR ANY CLAIM OF ANY KIND SHALL IN NO CASE EXCEED THE OBLIGATION OR LIABILITY SPECIFIED IN THIS WARRANTY.

d. **Technical Assistance**. Dataforth 's Warranty as hereinabove set forth shall not be enlarged, diminished or affected by, and no obligation or liability shall arise or grow out of, Dataforth's rendering of technical advice, facilities or service in connection with buyer's order of the products furnished hereunder.

e. **Warranty Procedures**. Buyer shall notify Dataforth of any products which it believes to be defective during the applicable warranty period and which are covered by the Warranty set forth above. Buyer shall not return any products for any reason without the prior authorization of Dataforth and issuance of a Return Material Authorization ("RMA") number. After issuance of a RMA number, such products shall be promptly returned by buyer (and in no event later than thirty (30) days after the Warranty expiration date), transportation and insurance prepaid, to Dataforth's designated facility for examination and testing. Dataforth shall either repair or replace any such products found to be so defective and promptly return such products to buyer, transportation and insurance prepaid. Should Dataforth's examination and testing not disclose any defect covered by the foregoing Warranty, Dataforth shall so advise buyer and dispose of or return the products in accordance with buyer's instructions and at buyer's sole expense,

and buyer shall reimburse Dataforth for testing expenses incurred at Dataforth's then current repair rates.

f. **Repair Warranty**. Dataforth warrants its repair work and/or replacement parts for a period of ninety (90) days from receipt by buyer of the repaired or replaced products or for the remainder of the warranty period for the initial delivery of such order as set forth in paragraph a above, whichever is greater.

g. **Critical Applications**. Certain applications using Dataforth's products may involve potential risks of death, personal injury, or severe property or environmental damage ("Critical Applications"). DATAFORTH'S PRODUCTS ARE NOT DESIGNED, INTENDED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS, SAFETY EQUIPMENT, NUCLEAR FACILITY APPLICATIONS OR OTHER CRITICAL APPLICATIONS WHERE MALFUNCTION OF THE PRODUCT CAN BE EXPECTED TO RESULT IN PERSONAL INJURY, DEATH OR SEVERE PROPERTY DAMAGE. BUYER USES OR SELLS SUCH PRODUCTS FOR USE IN SUCH CRITICAL APPLICATIONS AT BUYER'S OWN RISK AND AGREES TO DEFEND, INDEMNIFY AND HOLD HARMLESS DATAFORTH FROM ANY AND ALL DAMAGES, CLAIMS, PROCEEDINGS, SUITS OR EXPENSE RESULTING FROM SUCH USE.

h. **Static Sensitive**. Dataforth ships all product in anti-static packages. Dataforth's Warranty as hereinabove set forth shall not cover warranty repair, replacement, or refund on product or devices damaged by static due to buyer's failure to properly ground.

Application Support

Dataforth provides timely, high-quality product support. Call 1**-800-444-7644 TOLL-FREE**.

Returns/Repair Policy

All warranty and repair requests should be directed to the Dataforth Customer Service Department at (520) 741-1404. If a product return is required, request a Return Material Authorization (RMA) number. You should be ready to provide the following information:

1. Complete product model number.
2. Product serial number.
3. Name, address, and telephone number of person returning product.
4. Special repair instructions.
5. Purchase order number for out-of-warranty repairs.

The product should be carefully packaged, making sure the RMA number appears on the outside of the package, and ship prepaid to:

Dataforth Corporation
6230 S. Country Club
Tucson, AZ 85706 USA

An RMA Request Form and instructions for processing are also found at www.dataforth.com.

The information provided herein is believed to be reliable; however, DATAFORTH assumes no responsibility for inaccuracies or omissions. DATAFORTH assumes no responsibility for the use of this information, and all use of such information shall be entirely at the user's own risk. Application information is intended as suggestions for possible use of the products and not as explicit performance in a specific application. Prices and specifications are subject to change without notice. No patent rights or licenses to any of the circuits described herein are implied or granted to any third party. DATAFORTH does not authorize or warrant any DATAFORTH product for use in life support devices and/or systems.