MAQ®20

Industrial Data Acquisition and Control System

MA1063

MAQ20-DORLY20
Hardware User Manual

DATAFORTH®

MAQ20-DORLY20 Hardware User Manual
MA1063 Rev. C – March 2024

ISO9001:2015-Registered QMS

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About Dataforth Corporation

"Our passion at Dataforth Corporation is designing, manufacturing, and marketing the best possible signal conditioning, data acquisition, and data communication products. Our mission is to set new standards of product quality, performance, and customer service." Dataforth Corporation, with more than a quarter century of experience, is the worldwide leader in Instrument Class® Industrial Electronics – rugged, high performance signal conditioning, data acquisition, and data communication products that play a vital role in maintaining the integrity of industrial automation, data acquisition, and quality assurance systems. Our products directly connect to most industrial sensors and protect valuable measurement and control signals and equipment from the dangerous and degrading effects of noise, transient power surges, internal ground loops, and other hazards present in industrial environments.

Dataforth spans the globe with more than 50 International Distributors and US Representative Companies. Our customers benefit from a team of over 130 salespeople highly trained in the application of precision products for industrial markets. In addition, we have a team of application engineers in our Tucson factory ready to solve any in-depth application questions. Upon receipt of an RFQ or order, our Customer Service Department provides fast one-day delivery information turnaround. We maintain an ample inventory that allows small quantity orders to be shipped from stock.

Dataforth operates under an ISO9001:2015 quality management system.

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Errata Sheets

Refer to the Technical Support area of Dataforth's website (www.dataforth.com) for any errata information on this product.

1.0 System Features

The MAQ20 Data Acquisition System encompasses more than 30 years of design excellence in the process control industry. It is a family of high performance, DIN rail mounted, programmable, multi-channel, industrially rugged signal conditioning I/O and communications modules.

Instrument Class Performance

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

Industry Leading Functionality

- The system is a Modbus Server and can be operated remotely with no local PC
- Up to 4GB of logged data can be transferred via FTP during real-time acquisition
- Up to 24 I/O modules, 384 analog / 480 discrete channels, per system, per 19” rack width
- Per-channel configurable for range, alarms, and other functions
- Backbone mounts within DIN rail and distributes power and communications
- System firmware automatically registers the installation and removal of I/O modules
- I/O modules can be mounted remotely from the Communications Module
- Equal load sharing power supply modules allow for system expansion
- Hot Swappable I/O modules with Field-side pluggable terminal blocks on most models
- Sophisticated package enables high density mounting in 3U increments
- DIN Rail can be mounted on a continuous flat panel or plate

Distributed Processing Enables Even More Functionality

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

Multiple Software Options

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

2.0 System Description and Documentation

A MAQ®20 Data Acquisition System must have as a minimum a Communications Module, a Backbone, and one I/O Module. Examples include but are not limited to:

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

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

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-DORLY20 module has 20 isolated SPST latching relay output channels that switch between 2A at 30VDC and 0.4A at 150VDC. Contact state readback on each channel verifies the physical output state. Relays can be controlled individually or in blocks and have user configurable default output states which are set upon power up, power down/loss, and module reset. Advanced output functions SPDT, DPDT, 4x5 Cross Point Matrix, 10-Channel Differential Multiplexer, 20:1 Multiplexer and Null Mode are configured with external field terminal block wiring and controlled by module commands. Field connections are made through high density spring cage terminal blocks.

Output-to-Bus isolation is a robust 1500Vrms and each channel is protected up to 150Vrms continuous overload in the case of wiring faults or inadvertent wiring errors. 150Vrms channel-to-channel isolation gives the module the ability to control equipment with or without common signal grounds or different pieces of equipment with multiple reference potentials. The high channel count in the narrow module package gives exceptional functionality while preserving valuable mounting space and the high density minimizes cost per channel resulting in economical control solutions.

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

MA1036 MAQ®20 Quick Start Guide

MA1040 MAQ®20 Communications Module Hardware User Manual

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

MA1037 MAQ®20 Configuration Software Tool User Manual

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

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

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

MAQ20-945 MAQ®20 Configuration Software Tool

MAQ20-952 IPEMotion Software for MAQ®20

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

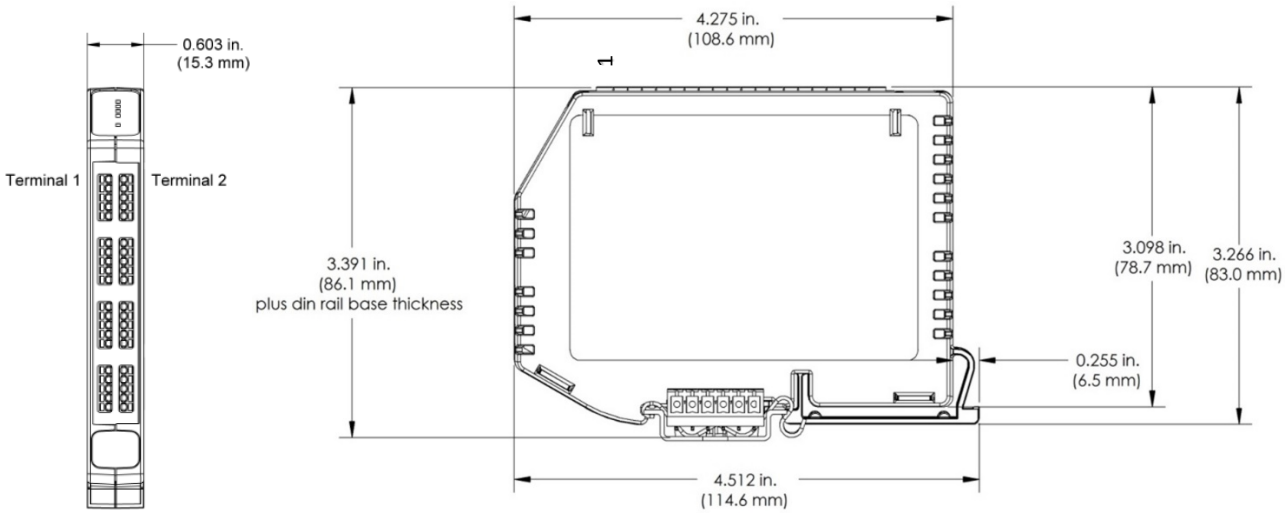
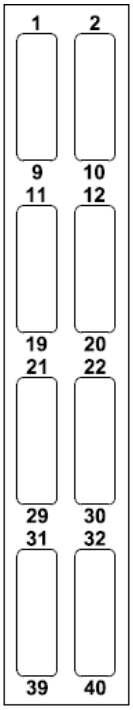


Figure 1: Module Dimensions

Table 1: MAQ20-DORLY20 I/O Terminal Block Connections



FIELD CONNECTION	TERMINAL	TERMINAL	FIELD CONNECTION
CH0 POLE	1	2	CH0 THROW
CH1 POLE	3	4	CH1 THROW
CH2 POLE	5	6	CH2 THROW
CH3 POLE	7	8	CH3 THROW
CH4 POLE	9	10	CH4 THROW
CH5 POLE	11	12	CH5 THROW
CH6 POLE	13	14	CH6 THROW
CH7 POLE	15	16	CH7 THROW
CH8 POLE	17	18	CH8 THROW
CH9 POLE	19	20	CH9 THROW
CH10 POLE	21	22	CH10 THROW
CH11 POLE	23	24	CH11 THROW
CH12 POLE	25	26	CH12 THROW
CH13 POLE	27	28	CH13 THROW
CH14 POLE	29	30	CH14 THROW
CH15 POLE	31	32	CH15 THROW
CH16 POLE	33	34	CH16 THROW
CH17 POLE	35	36	CH17 THROW
CH18 POLE	37	38	CH18 THROW
CH19 POLE	39	40	CH19 THROW

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

Solid Wire	AWG 25 to AWG 21
Stranded Wire	AWG 24 to AWG 21

5.0 Installation

The MAQ20 I/O module package has been designed for easy insertion into and removal from a system and can mate with DIN rails mounted flush on continuous panels or plates.

To install a module:

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

To remove a module, reverse the steps in the installation process. If space is available, the clip at the bottom of the module can be squeezed by hand to release. For tight installations, insert a flat blade screwdriver into the recess in the clip (5), place the shaft of the screwdriver against the curved part of the clip and gently pry the clip to release (6) as shown in Figure 2 below.

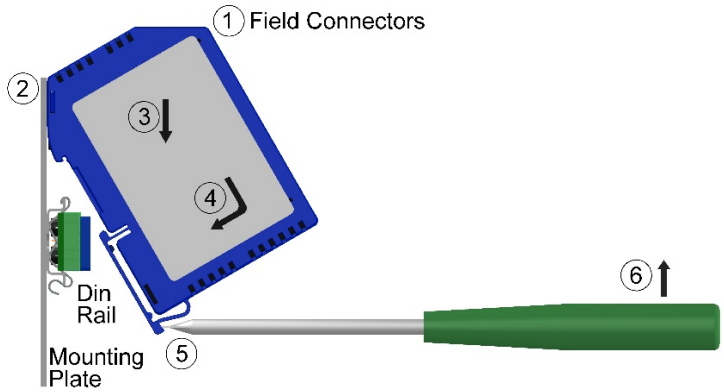


Figure 2: Installation and Removal

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

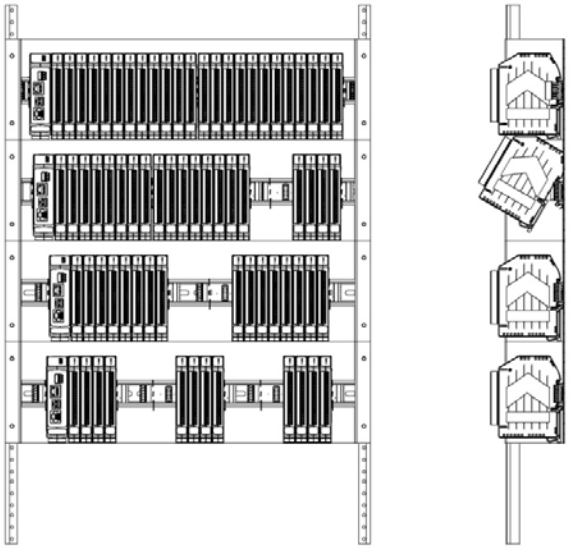


Figure 3: Possible System Configurations

6.0 Building a System

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

STANDARD SETUP PROCESS

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

2.) Install any MAQ20 I/O Module in any vacant local or remote backbone position. Observe that the green Power LED is on and communications activity is seen on the TX and RX LEDs. Allow 1 second for registration. This module has now been assigned Registration Number 1.

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

4.) Repeat Step 2 for all remaining MAQ20 I/O modules in the system. Subsequent modules installed are assigned Registration Number 2, 3, etc. The Registration Number sequence matches the physical sequence of module installation.

ALTERNATE SETUP PROCESS

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

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

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.

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

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

The system does not identify I/O modules by physical position on a backbone, only by registration sequence. MAQ20-940 ReDAQ Shape Software for MAQ20 provided by Dataforth shows a graphical representation of a system based on registration sequence and not by physical position. Tools within 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.

7.0 Maintaining a System

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

Standard system maintenance involves a simple three step process:

STANDARD MAINTENANCE PROCESS

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

2.) **CASE 1:** I/O module is replaced with one having a different model number or serial number: Remove a single MAQ20 I/O module from any local or remote backbone position. Replace the module with another having a different model number. This module can be installed in any vacant local or remote backbone position. Observe that the green Power LED is on and that there is 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.

CASE 2: I/O module is suspected faulty and is to be replaced with the same model number: Remove a single MAQ20 I/O module from any local or remote backbone position. Replace the module with another of the same model number. This module can be installed in any vacant local or remote backbone position. Observe that the green Power LED is on and communications activity is seen on the TX and RX LEDs. Allow 1 second for registration. This module now has the same Registration Number as the one removed.

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

3.) Repeat Step 2 for any remaining MAQ20 I/O modules in the system requiring maintenance.

ALTERNATE MAINTENANCE PROCESS

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

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

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

NOTES:

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

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

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.

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

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, Section 7.0, and Section 8.0.

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

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

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

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 *MAQ20-DORLY20 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 - 1299 : Module Data, Advanced Output Function Selection (TBD)						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1000	R/W	20	Relay States, Binary Representation, Addr 1000=LSB, Addr 1019=MSB	Relay States. Standard or Inverted Logic as defined in Register 1041.	DO0 - DO19 Standard Logic 0 = Relay Open 1 = Relay Closed DO0 - DO19 Inverted Logic 0 = Relay Closed 1 = Relay Open	INT16
1041	R/W	1	Logic Polarity	0 = Standard Logic (Default) 1 = Inverted Logic	0 or 1	INT16

Example: A MAQ20-DORLY20 module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 4. Write data to the discrete output channels to control the relays.

The MAQ20-DORLY20 module with s/n 1234567-89 has an address offset of 2000 * 4 = 8000

Assume the factory default setting of standard logic polarity.
Address 8000 + 1041 = 9041 is set to 0

Write to the DO channels DO0 – DO19 at addresses 8000 + 1000 to 1019 = 9000 to 9019

Write a 0 to these registers to open the relays.
Write a 1 to these registers to close the relays.

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*, *Section 7.0,* and *Section 8.0*.

ReDAQ Shape Software for MAQ20 presents a graphical representation of the system on the Acquire panel as shown in Figure 4. 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.

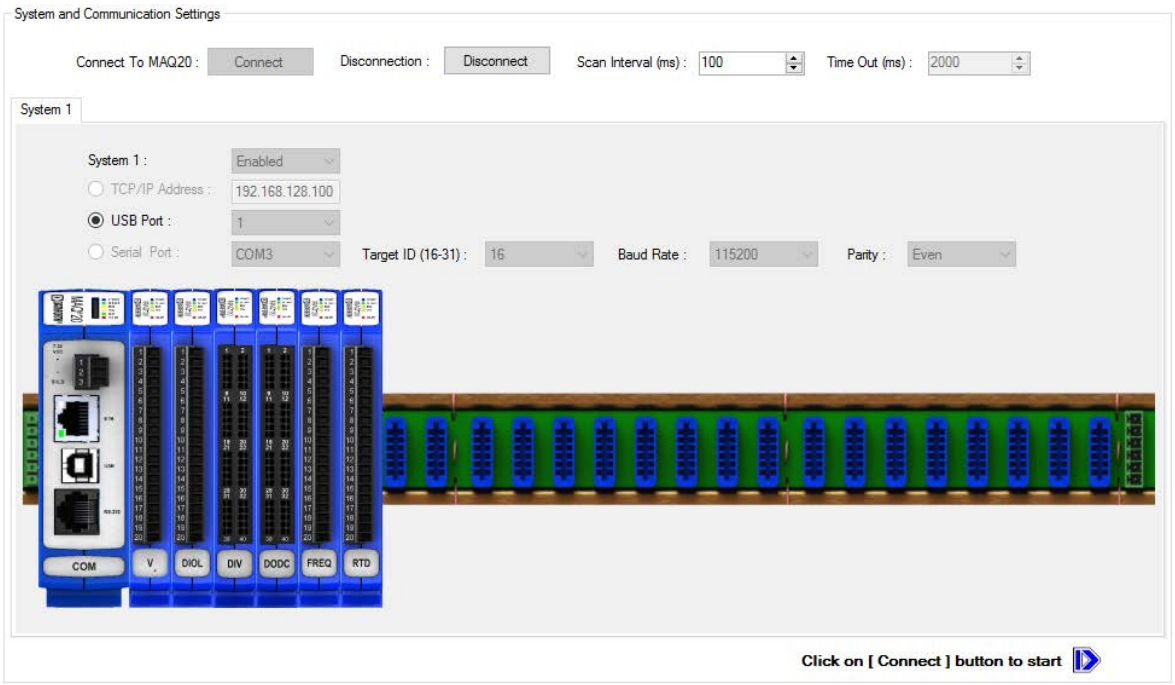
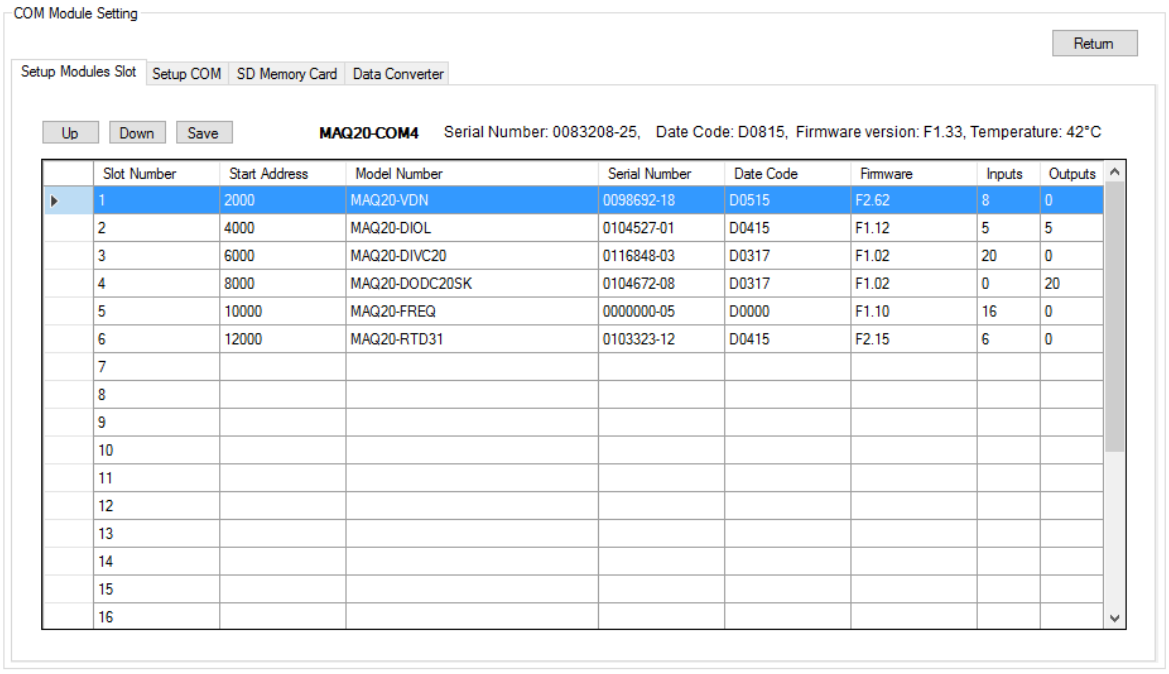


Figure 4: MAQ20-940 ReDAQ Shape for MAQ20 Main Configuration Screen

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



Slot Number	Start Address	Model Number	Serial Number	Date Code	Firmware	Inputs	Outputs
1	2000	MAQ20-VDN	0098692-18	D0515	F2.62	8	0
2	4000	MAQ20-DIOL	0104527-01	D0415	F1.12	5	5
3	6000	MAQ20-DIVC20	0116848-03	D0317	F1.02	20	0
4	8000	MAQ20-DODC20SK	0104672-08	D0317	F1.02	0	20
5	10000	MAQ20-FREQ	0000000-05	D0000	F1.10	16	0
6	12000	MAQ20-RTD31	0103323-12	D0415	F2.15	6	0
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

Figure 5: Module Registration using MAQ20-940 ReDAQ Shape for MAQ20

Registration Numbers are listed in the left column. The column title Slot Number is the same as the Registration Number and refers to the position where the software has registered the I/O module. Slot Number or 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 as long as I/O modules are not removed from or added to a system.

10.0 Writing Discrete Output Channels

The MAQ20-DORLY20 module presents to the field terminal blocks 20 isolated SPST latching relay output channels, each with a switching power of 60W, that can switch between 2A at 30VDC and 0.4A at 150VDC. Internal to the module, each relay has a DPST contact form. The second set of contacts is used for contact state readback to verify the physical output state. Relays can be controlled individually or in blocks.

Channel-to-Channel isolation is 150Vrms. Each channel has continuous overload protection up to 150Vrms in the case of inadvertent wiring errors. The basic circuit topology is shown in Figure 6 below.

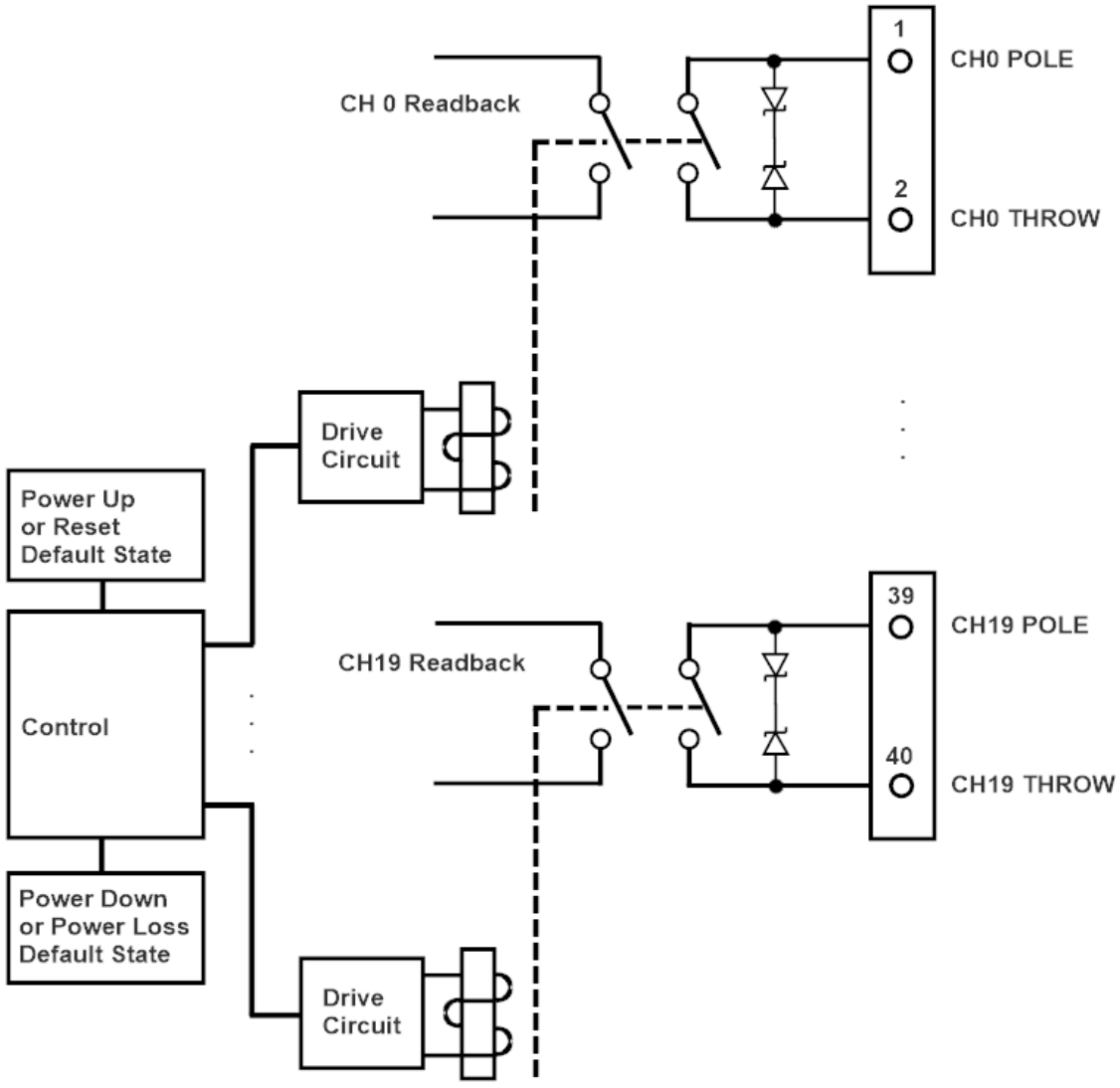


Figure 6: Relay Output Circuit Topology

The *MAQ20-DORLY20 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* for further details on Registration Number.

Address Range 1000 - 1299: Module Data, Advanced Output Function Selection (TBD)						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1000	R/W	20	Relay States, Binary Representation, Addr 1000=LSB, Addr 1019=MSB	Relay States. Standard or Inverted Logic as defined in Register 1041.	DO0 - DO19 Standard Logic 0 = Relay Open 1 = Relay Closed DO0 - DO19 Inverted Logic 0 = Relay Closed 1 = Relay Open	INT16
1035	R	1	Relay States, Block Read, MSB	Decimal Equivalent of Relay States, Data MSB (Channels 16-19)	0 to 15	INT16
1036	R	1	Relay States, Block Read, LSB	Decimal Equivalent of Relay States, Data LSB (Channels 0-15)	0 to 65,535	INT16
1038	W	1	Relay States, Block Write, MSB	Decimal Equivalent of Relay States, Data MSB (Channels 16-19)	0 to 15	INT16
1039	W	1	Relay States, Block Write, LSB	Decimal Equivalent of Relay States,Data LSB (Channels 0-15)	0 to 65,535	INT16
1041	R/W	1	Logic Polarity	0 = Standard Logic (Default) 1 = Inverted Logic	0 or 1	INT16

Output channel data is written and read using a series of 20 registers starting at reference address 1000. Relays can be opened and closed by bitwise manipulation of the data in these registers. In addition, data can be written and read in blocks. When block writing, the decimal equivalent of the 20-digit value representing channel states is written to registers 1039 (LSB) and 1038 (MSB). When block reading, the decimal equivalent of the 20-digit value representing current channel states is read from registers 1036 (LSB) and 1035 (MSB).

Control logic for the relays can be selected as standard, where writing a ‘1’ closes the relay and writing a ‘0’ opens the relay, or it can be selected as inverted, where writing a ‘0’ closes the relay and writing a ‘1’ opens the relay.

Example: A MAQ20-DORLY20 module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 4. Close the relay contacts on output channels 5, 16, 17, and 18 and then read back the states of the output channels using the block read decimal equivalent.

The MAQ20-DORLY20 module with s/n 1234567-89 has an address offset of 2000 * 4 = 8000

Note that channels are numbered starting at zero, so the 20 output channels are CH0 – CH19.
Assume the module is using the factory default Standard Logic.
Assume the module is in the factory default state of all channels open upon power up.

Write to register address 8000 + 1005 = 9005 a data value of 1 to close CH5 relay contacts
Write to register address 8000 + 1016 = 9016 a data value of 1 to close CH16 relay contacts
Write to register address 8000 + 1017 = 9017 a data value of 1 to close CH17 relay contacts
Write to register address 8000 + 1018 = 9018 a data value of 1 to close CH18 relay contacts

The data in registers 1000 – 1019, MSB in register 1019 to LSB in register 1000, is now:

xxxx xxxx xxxx 0111 0000 0000 0010 0000

Read from register address 8000 + 1036 = 9036 the decimal equivalent of relay states for CH0 through CH15. The value returned will be 32 (0000 0000 0010 0000).

Read from register address 8000 + 1035 = 9035 the decimal equivalent of relay states for CH16 through CH19. The value returned will be 7 (xxxx xxxx xxxx 0111).

11.0 Setting Default Outputs

The 20 output channels in the MAQ20-DORLY20 module have user configurable default output states which are set upon power up, power down or power loss, Standard Reset, and Reset-to-Default. These are used to put a system or application in a known safe state at standard startup, at standard shut down, upon power loss or other non-standard operating condition, or by using the reset commands.

Default Output channel data is written and read using a series of 20 registers. Registers starting at reference address 110 store default relay states upon module power up and upon issuing reset commands. Default Output states can be set by bitwise manipulation of the data in these registers or read bitwise from the registers. In addition, data can be written and read in blocks. When block writing or reading, the decimal equivalent of the 20-digit value representing channel states is written to or read from registers 109 (LSB) and 108 (MSB).

Registers starting at reference address 150 store default relay states upon module power down or power loss. Default Output states can be set by bitwise manipulation of the data in these registers or read bitwise from the registers. In addition, data can be written and read in blocks. When block

writing or reading, the decimal equivalent of the 20-digit value representing channel states is written to or read from registers 149 (LSB) and 148 (MSB).

The *MAQ20-DORLY20 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* 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**
108	R/W	1	Default Relay States at Power Up, Block Read/Write, MSB	Decimal Equivalent of Relay Default States at Power Up, Data MSB (Channels 16-19)	0 to 15	INT16
109	R/W	1	Default Relay States at Power Up, Block Read/Write, LSB	Decimal Equivalent of Relay Default States at Power Up, Data LSB (Channels 0-15)	0 to 65,535	INT16
110	R/W	20	Default Relay Configuration at Power Up	Relay State at Power Up. Default = 0.	DO0 - DO19 Standard Logic 0 = Relay Open 1 = Relay Closed DO0 - DO19 Inverted Logic 0 = Relay Closed 1 = Relay Open	INT16
148	R/W	1	Default Relay States at Power Down or Power Loss, Block Read/Write, MSB	Decimal Equivalent of Relay Default States at Power Down or Power Loss, Data MSB (Channels 16-19)	0 to 15	INT16
149	R/W	1	Default Relay States at Power Down or Power Loss, Block Read/Write, LSB	Decimal Equivalent of Relay Default States at Power Down or Power Loss, Data LSB (Channels 0-15)	0 to 65,535	INT16
150	R/W	20	Default Relay Configuration at Power Down or Power Loss	Relay State at Power Down or Power Loss. Default = 0.	DO0 - DO19 Standard Logic 0 = Relay Open 1 = Relay Closed DO0 - DO19 Inverted Logic 0 = Relay Closed 1 = Relay Open	INT16
190	W	1	Save to EEPROM	0 = Save Default Out, Logic Polarity	0	INT16

Example: A MAQ20-DORLY20 module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 4.

Set the Default Output state on power up for channel 0, 1, and 2 relay contacts to closed and for channel 3, 4, and 5 relay contacts to open using bitwise data manipulation.

Set the Default Output state on power down for channel 0 through channel 9 relay contacts to closed and for channel 10 through channel 19 relay contacts to open using block write.

The MAQ20-DORLY20 module with s/n 1234567-89 has an address offset of 2000 * 4 = 8000

Note that channels are numbered starting at zero, so the 20 output channels are CH0 – CH19. Assume the module is using the factory default Standard Logic.

Write to register address 8000 + 110 = 8110 a data value of 1 to set CH0 default state to closed
Write to register address 8000 + 111 = 8111 a data value of 1 to set CH1 default state to closed
Write to register address 8000 + 112 = 8112 a data value of 1 to set CH2 default state to closed

Write to register address 8000 + 123 = 8123 a data value of 0 to set CH13 default state to open
Write to register address 8000 + 124 = 8124 a data value of 0 to set CH14 default state to open
Write to register address 8000 + 125 = 8125 a data value of 0 to set CH15 default state to open

The desired data in registers 150 – 169, MSB in register 169 to LSB in register 150, is:

xxxx xxxx xxxx 0000 0000 0011 1111 1111

Write to register address 8000 + 149 = 8149 the decimal equivalent of signed 16-bit data for CH0 – CH15 relay states. This is the LSB of the 32-bit channel data and the value is 1023.

Write to register address 8000 + 148 = 8148 the decimal equivalent of signed 16-bit data for CH16 – CH19 relay states. This is the MSB of the 32-bit channel data and the value is 0.

12.0 Alternate Output Mode Description and Configuration (Preliminary)

The standard output contact form presented at the field terminal blocks is 20 channels of SPST. The following advanced output functions can be configured with external field terminal block wiring and controlled by writing to designated registers in the module address map. Although mode control by writing to designated registers is not currently implemented, all of the modes below except Null Mode can be realized by making the field terminal block wiring connections shown using crimp wire splices or printed circuit panels and then writing the appropriate data to the standard relay control registers.

12.1 SPDT Mode - (Preliminary. Not Currently Implemented)

This mode operates the 20 relays as if they were 10 SPDT relays. Even numbered terminals are normally open (NO) and odd numbered terminals are normally closed (NC). The relays have three states – NO, NC, and Off. Off means both contacts are open. Switching action is break-before-make by default and can be configured make-before-break by writing to a designated register in the address map.

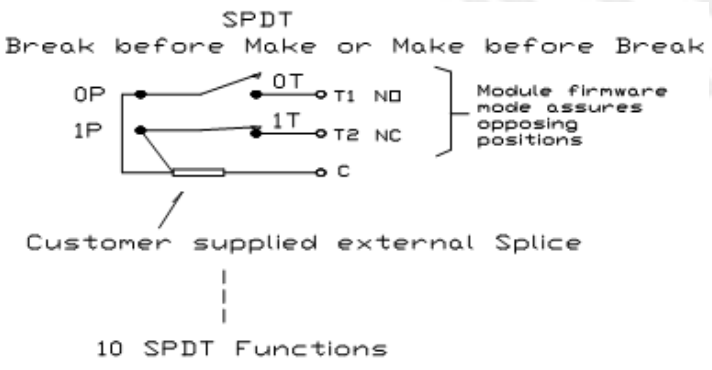


Figure 7: SPDT Mode Field Terminal and Wiring

12.2 DPDT Mode – (Preliminary. Not Currently Implemented)

This mode operates the 20 relays as if they were 5 DPDT relays. Even numbered terminals are normally open (NO) and odd numbered terminals are normally closed (NC). The relays have three states – NO, NC, and Off. Off means both contacts are open. Switching action is break-before-make.

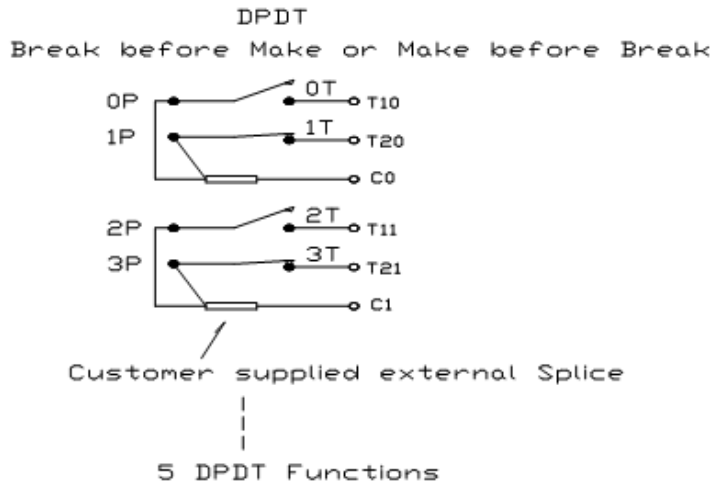


Figure 8: DPDT Mode Field Terminals and Wiring

12.3 Cross Point Matrix Mode – (Preliminary. Not Currently Implemented)

This mode operates the 20 relays as a 4 by 5 cross point switch.

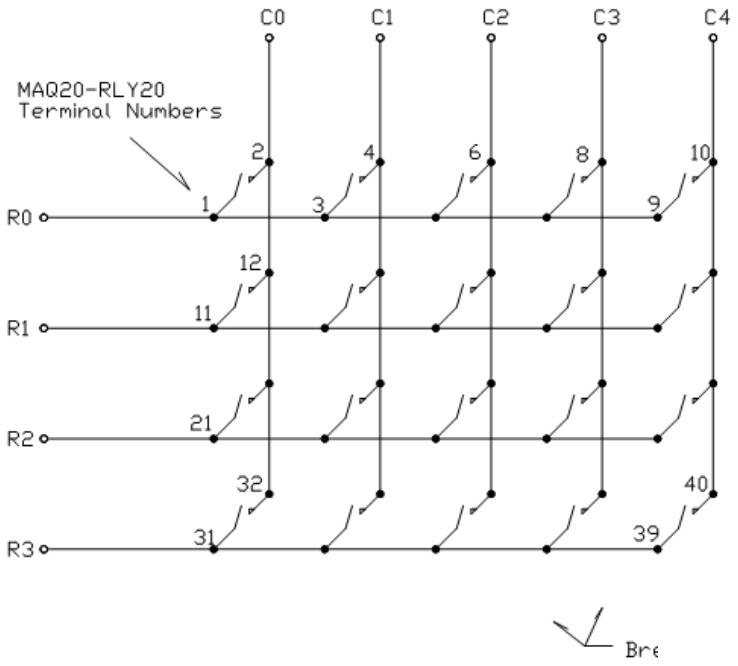


Figure 9: Cross Point Matrix Field Terminals and Wiring

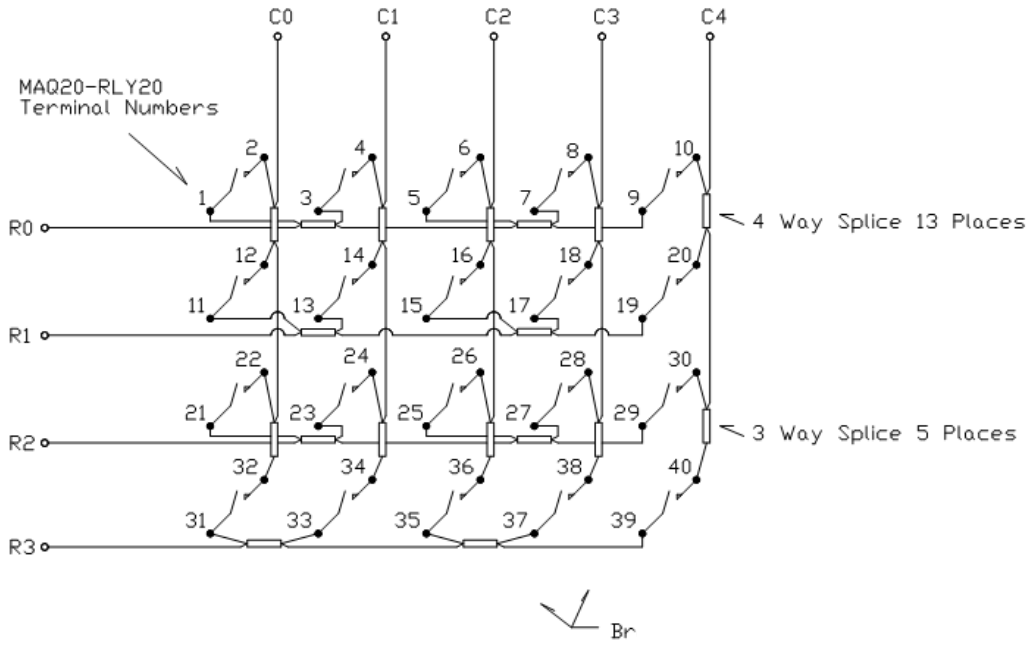


Figure 10: Cross Point Matrix Field Terminals and Wiring with Splice Connections

12.4 Differential Multiplexer Mode – (Preliminary. Not Currently Implemented)

Differential multiplexing is useful for precision measurements. This mode operates the 20 relays as a multiplexer with 10 differential inputs and 1 differential output. Switching action is break-before-make. Multiplexer control allows any combination of switches to be closed or open.

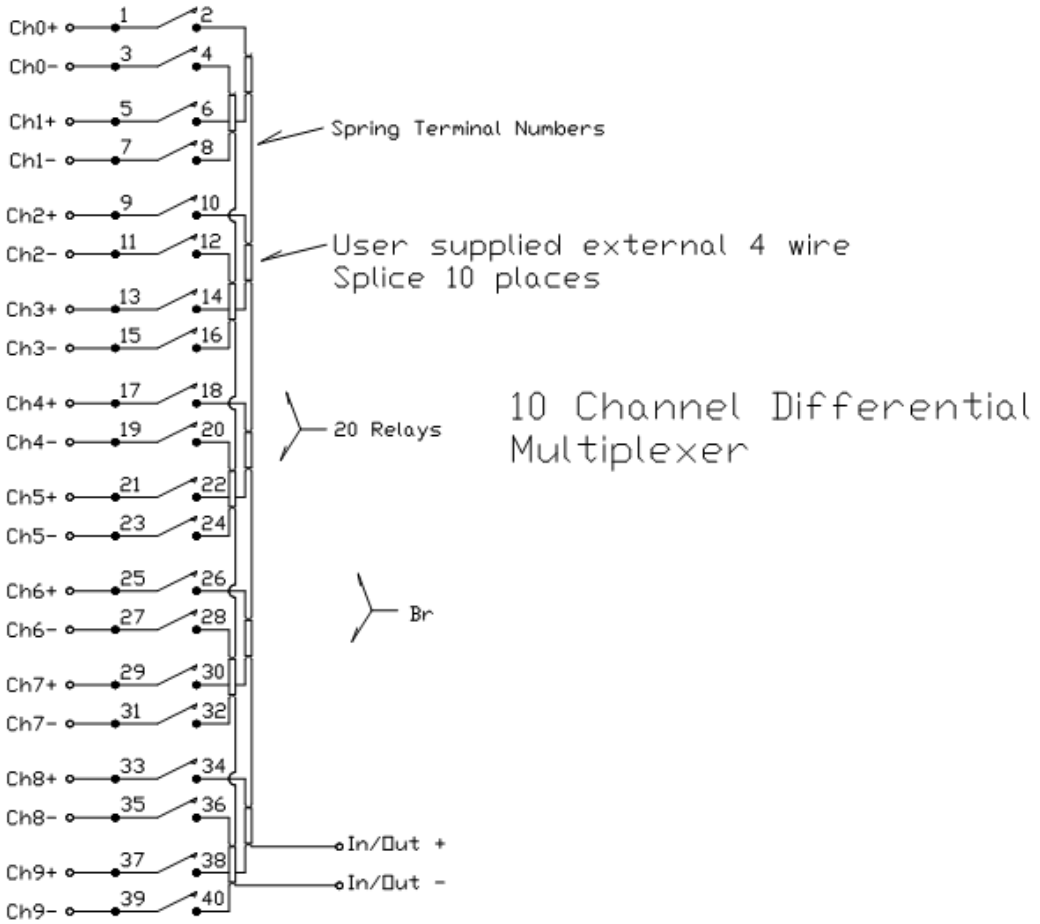


Figure 11: Differential Multiplexer Field Terminals and Wiring

12.5 Multiplexer Mode – (Preliminary. Not Currently Implemented)

This mode operates the 20 relays as a 20:1 multiplexer. Switching action is break-before-make. Multiplexer control allows any combination of switches to be closed or open.

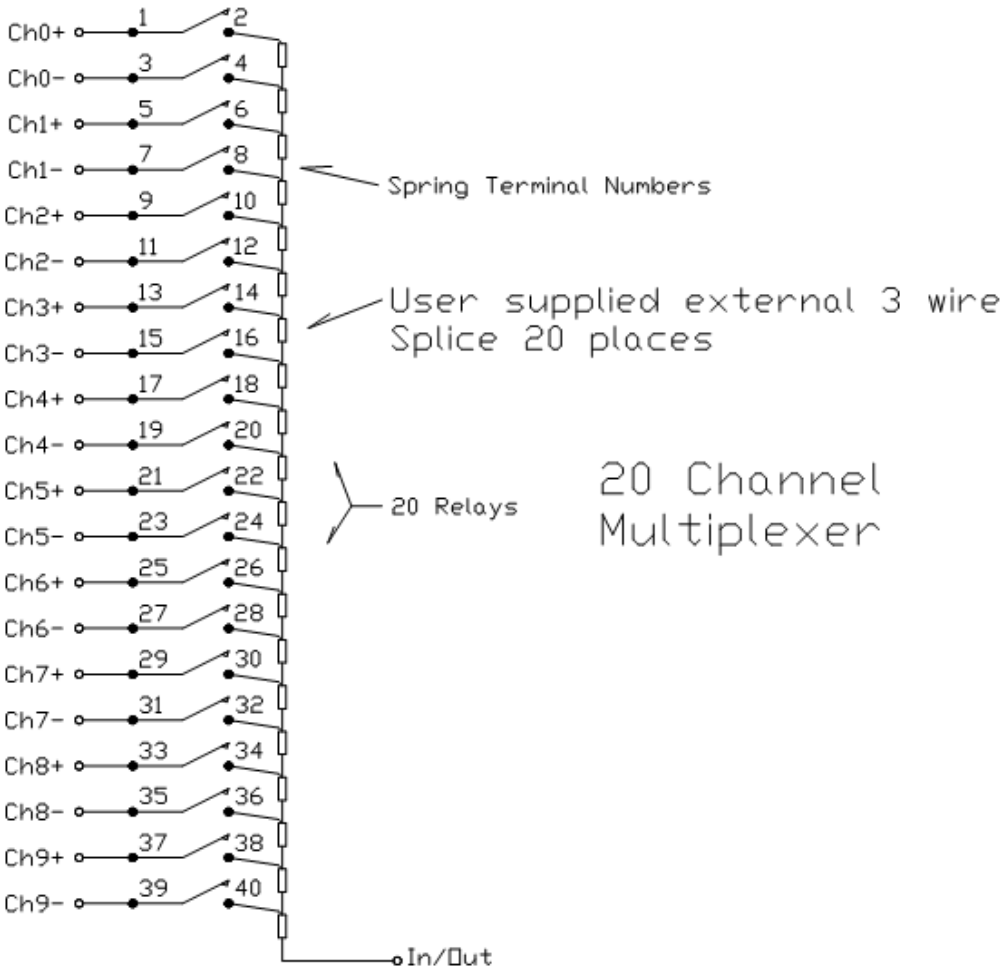


Figure 12: Multiplexer Field Terminals and Wiring

12.6 Null Mode – (Preliminary. Not Currently Implemented)

In Null Mode no change is ever made to the latching relay states except by host command. The current user state is stored in nonvolatile memory. Relay states are not changed at power down or power loss. After subsequent power up, relay states remain in the last state set by the user. Switching action is break-before-make.

12.7 Other Multiplexer Modes – (Preliminary. Not Currently Implemented)

Utilizing the 20 SPST relays presented at the field terminal blocks and relay control by either bitwise manipulation or block writing, many different functions can be realized to suit specific application needs. Two examples of other multiplexer modes are shown.

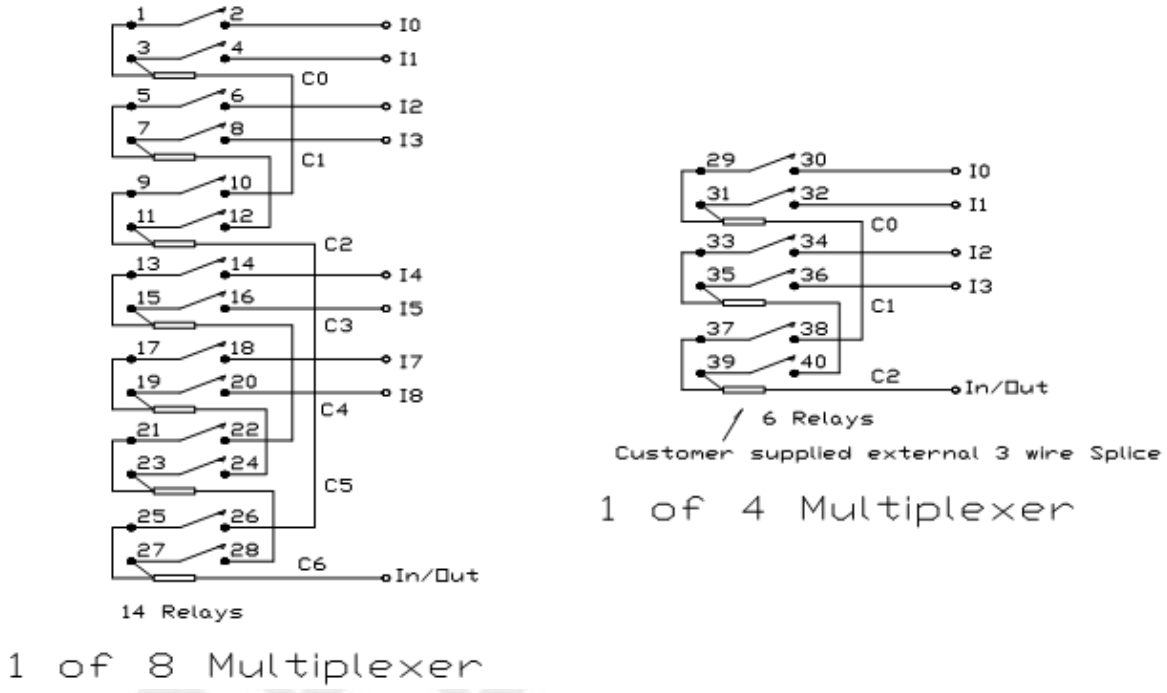


Figure 13: Other Multiplexer Modes Field Terminals and Wiring

13.0 Reset Functions

Two types of firmware reset are supported in the MAQ20 I/O modules:

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

Reset-to-Default reverts the module to the settings used at the factory during manufacture. It performs the standard reset actions plus resets the stated non-volatile parameters to default settings.

Refer to the *MAQ20-DORLY20 Address Map* for further details on what parameters are affected by resets and what default values are.

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

RESET TYPE	PARAMETERS
Standard Reset	Sets Output Channel relays to user defined Power Up/Reset states Sets Logic Polarity to user defined state Clears all Status and Diagnostic registers
Reset-to-Default	All parameters listed under Standard Reset, plus: Sets Output Channel relays to state 0 (open) Sets Default Relay Power Up/Reset states to 0 (open) Sets Default Relay Power Down/Power Loss states to 0 (open) Sets Logic Polarity to 0 (Standard)

Reset Registers

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

NOTE:

The MAQ20 I/O modules send a response to the reset register write before carrying out the reset. This means the module will be unresponsive to commands for approximately 3 seconds.

Power-On-Reset (POR) and Brownout

MAQ20 I/O modules utilize a brown-out detect circuit and watchdog timer to ensure reliable and predictable operation under all conditions. Upon power cycle, brown-out detect or any extreme circumstance under which the watchdog timer expires, a Standard Reset is performed, and parameters stored in EEPROM are loaded to the appropriate registers.

14.0 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-DORLY20, 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 (RLY, 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.

15.0 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.

Figure 14: MAQ®20 Faceplate

LED Function and Troubleshooting Tips:

PWR

Normal operation: BLUE, solid lit

LED Off: Abnormal power situation

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

STAT

Normal operation: GREEN, 1 Hz blinking

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

- This function is not implemented in the MAQ20-DORLY20 module

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.

16.0 Specifications

MAQ20-DORLY20 RELAY OUTPUT MODULE Typical at T_A = +25°C and +24V system power

Model Number, Input / Output MAQ20-DORLY20	60W per channel (2A at 30V to 0.4A at 150V)
Number of Channels	20
Output Configuration	SPST Latchng Relay with Contact State Readback
Switching Characteristics	
Turn-On / Turn-Off Time	1ms / 1ms
Output Load	
Ta = +25°C	60W per channel max (2A at 30V to 0.4A at 150V)
Ta = +85°C	40W per channel max (1.3A at 30V to 0.27A at 150V)
Output Protection	
Continuous	±150V peak max
Transient	ANSI/IEEE C37.90.1
CMV	
Channel-to-Bus	1500Vrms, 1 min
Channel-to-Channel	150Vrms, 212V peak
Transient	ANSI/IEEE C37.90.1
Standard Output Functions	
Logic Selection	Standard / Inverted
Block Write	20 Channel
Default Relay State on Power Up	User Configurable
Default Relay State on Power Down or Power Loss	User Configurable
Default Relay State on Reset	User Configurable
Alternate Output Modes	
Configure with External Wiring	SPDT, DPDT, 4x5 Crosspoint Matrix 10-Channel Differential Multiplexer 20:1 Multiplexer, Null Mode
Update Rate	1300 Ch/s net, 65 Ch/s at 20-Ch Simultaneous
Power Supply Current	30mA
Dimensions (h)(w)(d)	4.51” x 0.60” x 3.26” (114.6mm x 15.3mm x 82.8mm)
Environmental	
Operating Temperature	-40°C to +85°C
Storage Temperature	-40°C to +85°C
Relative Humidity	0 to 95%, non-condensing
Emissions, EN61000-6-4	ISM Group 1
Radiated, Conducted	Class A
Immunity EN61000-6-2	ISM Group 1
RF	Performance A
ESD, EFT	Performance B
Certifications	Heavy Industrial CE UL/cUL (Class I, Div 2, Groups A, B, C, D) file E232858 ATEX Pending

17.0 MAQ20-DORLY20 Address Map

The table in this section outlines the MAQ20-DORLY20 address space. Data in these registers contains all permanent and user settable information for module configuration, status, operation of all functions, data read/write, and data storage. Table columns list the following information:

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

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

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

Contents: Parameter stored at the specified address.

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

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

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

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

NOTE:

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

Table 4: MAQ20-DORLY20 Address Map

Address Range 0 - 99: Module Information						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
0	R	15	Device Description	MAQ20-DORLY20	Characters, Numbers, "-" and Space	ASCII
19	R	11	Serial Number	S1234567-89	Characters, Numbers, "-" and Space	ASCII
30	R	5	Date Code	D0317 (D<month><year>)	Characters, Numbers	ASCII
35	R	5	Firmware Rev	Fx.xx	Characters, Numbers and "."	ASCII
40	R	1	Input Channels	0 Input Channels	0	ASCII
41	R	1	Output Channels	20 Output Channels	20	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**
108	R/W	1	Default Relay States at Power Up, Block Read/Write, MSB	Decimal Equivalent of Relay Default States at Power Up, Data MSB (Channels 16-19)	0 to 15	INT16
109	R/W	1	Default Relay States at Power Up, Block Read/Write, LSB	Decimal Equivalent of Relay Default States at Power Up, Data LSB (Channels 0-15)	0 to 65,535	INT16
110	R/W	20	Default Relay Configuration at Power Up	Relay State at Power Up. Default = 0.	DO0 - DO19 Standard Logic 0 = Relay Open 1 = Relay Closed DO0 - DO19 Inverted Logic 0 = Relay Closed 1 = Relay Open	INT16
148	R/W	1	Default Relay States at Power Down or Power Loss, Block Read/Write, MSB	Decimal Equivalent of Relay Default States at Power Down or Power Loss, Data MSB (Channels 16-19)	0 to 15	INT16
149	R/W	1	Default Relay States at Power Down or Power Loss, Block Read/Write, LSB	Decimal Equivalent of Relay Default States at Power Down or Power Loss, Data LSB (Channels 0-15)	0 to 65,535	INT16
150	R/W	20	Default Relay Configuration at Power Down or Power Loss	Relay State at Power Down or Power Loss. Default = 0.	DO0 - DO19 Standard Logic 0 = Relay Open 1 = Relay Closed DO0 - DO19 Inverted Logic 0 = Relay Closed 1 = Relay Open	INT16
190	W	1	Save to EEPROM	0 = Save Default Out, Logic Polarity	0	INT16

Address Range 1000 - 1299: Module Data, Advanced Output Function Selection (TBD)						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1000	R/W	20	Relay States, Binary Representation, Addr 1000=LSB, Addr 1019=MSB	Relay States. Standard or Inverted Logic as defined in Register 1041.	DO0 - DO19 Standard Logic 0 = Relay Open 1 = Relay Closed DO0 - DO19 Inverted Logic 0 = Relay Closed 1 = Relay Open	INT16
1035	R	1	Relay States, Block Read, MSB	Decimal Equivalent of Relay States, Data MSB (Channels 16-19)	0 to 15	INT16
1036	R	1	Relay States, Block Read, LSB	Decimal Equivalent of Relay States, Data LSB (Channels 0-15)	0 to 65,535	INT16
1037	R	1	Read	Reserved for Future	TBD	INT16
1038	W	1	Relay States, Block Write, MSB	Decimal Equivalent of Relay States, Data MSB (Channels 16-19)	0 to 15	INT16
1039	W	1	Relay States, Block Write, LSB	Decimal Equivalent of Relay States,Data LSB (Channels 0-15)	0 to 65,535	INT16
1040	W	1	Write	Reserved for Future	TBD	INT16
1041	R/W	1	Logic Polarity	0 = Standard Logic (Default) 1 = Inverted Logic	0 or 1	INT16

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

DATAFORTH WARRANTY

To view the current Dataforth Corporation Warranty, please click on the link below for the Dataforth Standard Terms and Conditions of Sale Applying to Products Sold by Dataforth Corporation. The Warranty in its entirety is Section 3. Please check this link periodically for updates.

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MA1063 Rev. C – March 2024

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