MAQ®20

Industrial Data Acquisition and Control System

MA1040

MAQ20-COM2 & MAQ20-COM4 Hardware User Manual



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MAQ20-COM2 & MAQ20-COM4 Hardware User Manual
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Errata Sheets

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1.0 System Features

The MAQ®20 Data Acquisition System encompasses more than 25 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 Power Supply Range of 7-34VDC
- CE Compliant
- UL/cUL (Class I, Div 2, Groups A, B, C, D) Compliant, file E232858
- ATEX Compliance pending

Industry Leading Functionality

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

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Distributed Processing Enables Even More Functionality

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

Multiple Software Options

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

2.0 System Description and Documentation

A 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.

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

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

MAQ®20 communications modules provide connection between a host computer and a MAQ®20 Data Acquisition System over Ethernet, USB, RS-485 or RS-232. Ethernet communications use the Modbus TCP protocol, USB communications are based on the Modbus RTU protocol, and RS-485 and RS-232 communications use the Modbus RTU protocol. Serial communications over RS-485 can be either 2-wire or 4-wire. Each MAQ20-COMx module can interface to up to 24 MAQ®20 I/O modules in any combination allowing high channel counts and great flexibility in system configuration. A removable microSD card can be used by the MAQ20-COMx module to log data acquired from the MAQ®20 I/O modules.

The Communications Interface-to-Bus isolation is 50V and power input terminals are protected against overvoltage, transient, and reverse connections.

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

MA1036 MAQ®20 Quick Start Guide

MA1040 MAQ®20 Communications Module Hardware User Manual

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

MA1037 MAQ®20 Configuration Software Tool User Manual

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

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

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

MAQ20-945 MAQ®20 Configuration Software Tool

MAQ20-952 IPEMotion Software for MAQ®20

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3.0 Unpacking

Each MAQ®20 Data Acquisition System component is shipped in electro-static discharge (ESD) protective packaging. Use appropriate ESD protection measures while unpacking. Check visually for physical damage. If physical damage is noted, file a claim with the shipping carrier.

4.0 Module Dimensions and Input Connections

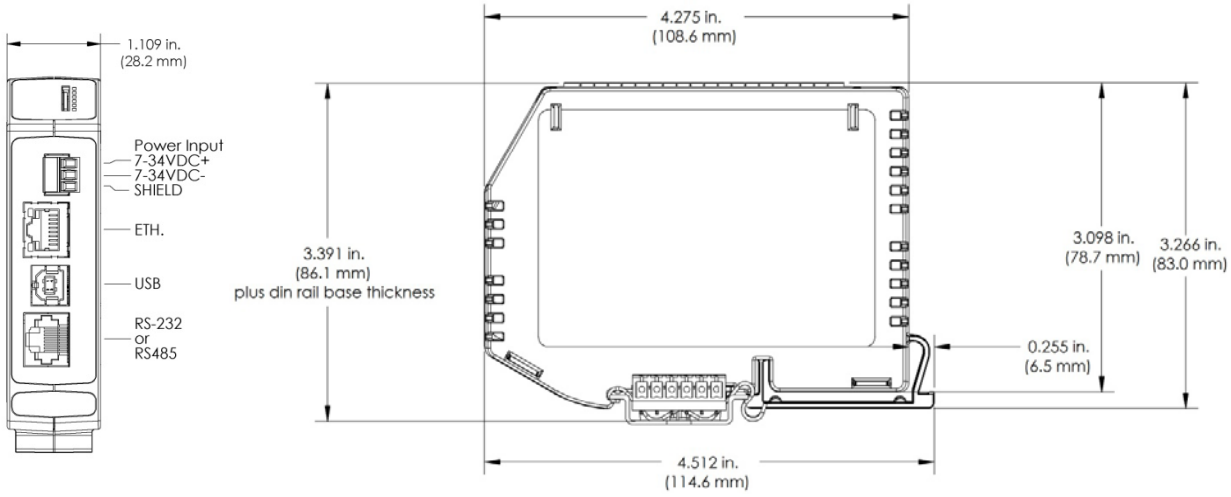


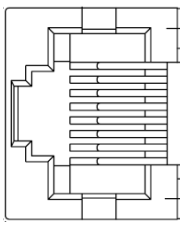
Figure 1: Module Dimensions

Table 1: Input Terminal Block Connections

POWER INPUT TERMINAL BLOCK POSITION (TOP TO BOTTOM)	INPUT CONNECTIONS	
1	7 – 34 VDC	+
2	7 – 34 VDC	-
3		SHIELD

The shield terminal is connected to the Communications Module common and Backbone common. This terminal can be used as system ground.

Table 2: RJ-45 Connections for RS-232 and RS-485

RJ-45 Terminal (top to bottom)	RS232	RS485 4W	RS485 2W	
1	NC	NC	NC	
2	NC	GND	GND	
3	NC	< RXD+	NC	
4	GND	TXD- >	TXD-	
5	< RX	TXD+ >	TXD+	
6	TX >	< RXD-	NC	
7	< CTS	NC	NC	
8	RTS >	NC	NC	

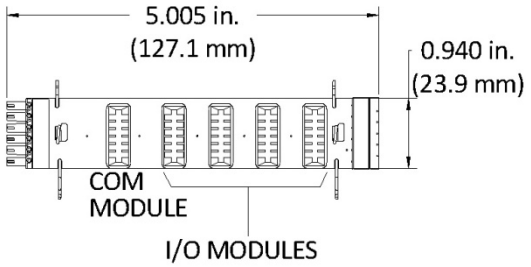
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5.0 System Backbones

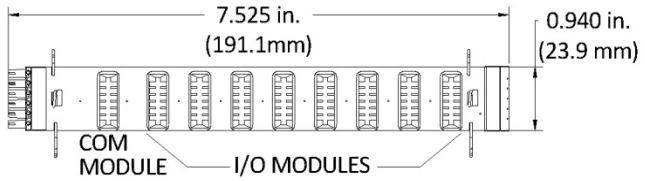
Four backbones models shown in Figure 2 below are offered for MAQ®20 Data Acquisition System. These mount within a 35 x 7.5mm standard DIN rail and distribute power and communications. Each model accommodates one Communications Module and a set number of I/O Modules. Spring clips on the backbone hold it in a DIN rail when no modules are present. When modules are installed, they secure the backbone in the DIN rail. Connectors on the ends of the backbones allow system expansion and allow I/O Modules to be installed remotely from the Communications Module.

The maximum system configuration is one Communications Module and 24 I/O Modules. Multiple Communications Modules cannot be installed in a single system.

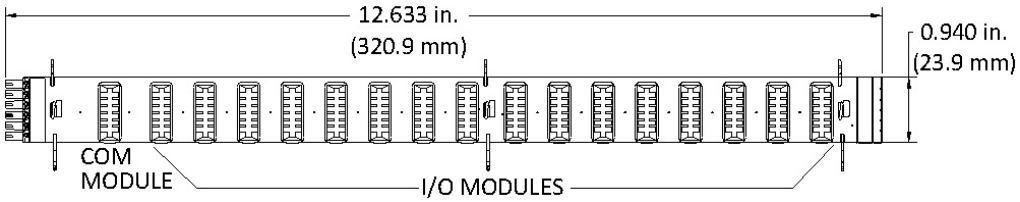
MAQ20-BKPL4 Use to mount 1 MAQ20-COMx Module and up to 4 MAQ®20 I/O Modules:



MAQ20-BKPL8 Use to mount 1 MAQ20-COMx Module and up to 8 MAQ®20 I/O Modules:



MAQ20-BKPL16 Use to mount MAQ20-COMx Module and up to 16 MAQ®20 I/O Modules:



MAQ20-BKPL24 Use to mount 1 MAQ20-COMx Module and up to 24 MAQ®20 I/O Modules:

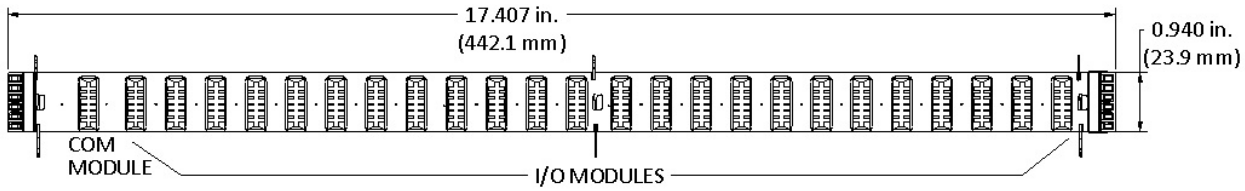


Figure 2: MAQ®20 Backbones

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6.0 Installation

Backbones must be mounted in the DIN rail with the MAQ20-COMx module socket on the left and the ‘UP’ arrow located on the left end of the backbone pointing to the top of the rail. The MAQ20-COMx module only mounts in the left-most position. MAQ®20 I/O modules can be mounted in any other position and in any order. When expansion backbones are used, I/O modules can reside in the MAQ20-COMx module position, but there must be only one MAQ20-COMx module per system. The MAQ®20 package design prevents reverse installation of modules when the backbone is mounted in a DIN rail.

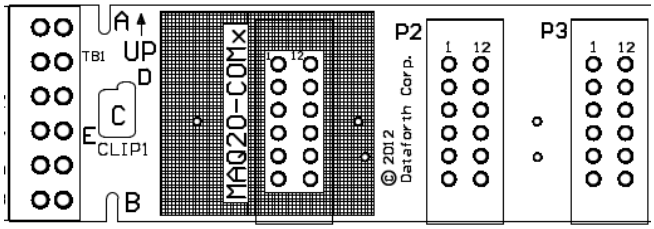


Figure 3: MAQ®20 Backbone Orientation

Male-Female connectors at the ends of the backbones allow them to be interconnected in any order for system expansion. Expansion backbones for mounting I/O Modules can be installed remotely from a backbone holding the system Communications Module. When this is done, expansion cables are used to connect the backbones. 1-meter and 2-meter expansion cables are offered as system accessories as shown in Figure 4.

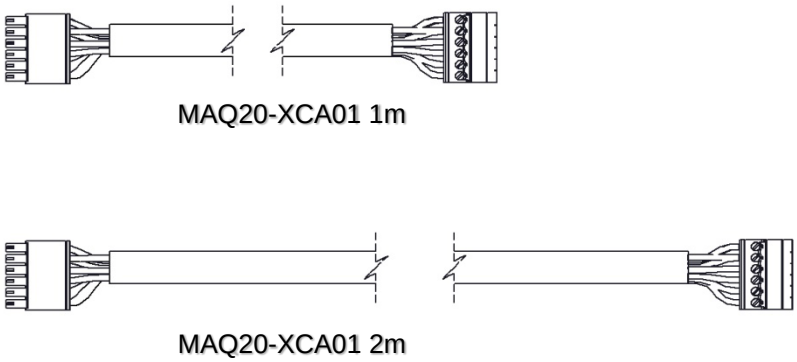


Figure 4: MAQ®20 Backbone Expansion Cables

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

To install a module:

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

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

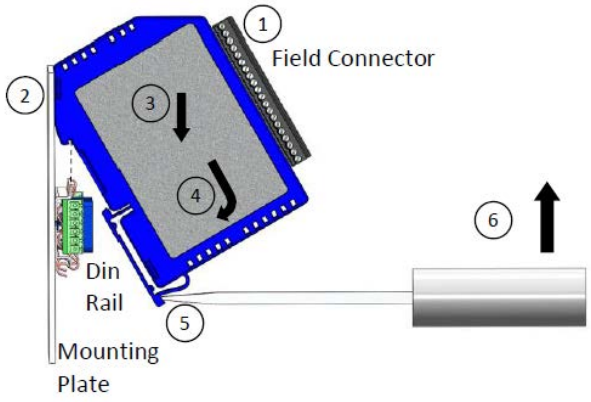


Figure 5: Installation and Removal

Multiple rows of MAQ®20 modules can be mounted at a 3U vertical spacing interval. Backbones can be combined to add I/O modules to a system. A system is only allowed to have one MAQ20-COMx module. Some possible configurations in a 19” rack are shown in Figure 6.

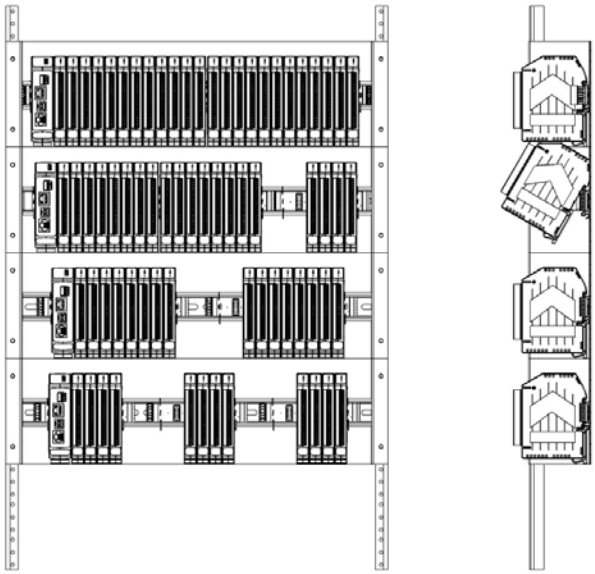


Figure 6: Possible System Configurations

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7.0 Building a System

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

STANDARD SETUP PROCESS

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

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

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

ALTERNATE SETUP PROCESS

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

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

NOTES:

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

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

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

The system does not identify I/O modules by physical position on a backbone, only by registration sequence. MAQ20-940 - ReDAQ Shape Software for MAQ®20 and MAQ20-945 - MAQ®20 Configuration Software Tool provided by Dataforth show a graphical representation of a system based on registration sequence and not by

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physical position. Tools within each software package allow the user to reassign Registration Numbers thereby making graphical representations match physical location for a single, local backbone. For further details, see Section 10.0.

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 Maintaining a System

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

Standard system maintenance involves a simple three step process:

STANDARD MAINTENANCE PROCESS

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

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

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

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

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

ALTERNATE MAINTENANCE PROCESS

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

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

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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 MAQ®20 and MAQ20-945 - MAQ®20 Configuration Software Tool allow the user to reassign Registration Numbers. For further details, see Section 10.0.

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 Expanding a System

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

Standard system expansion involves a simple three step process:

STANDARD EXPANSION PROCESS

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

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

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

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

ALTERNATE EXPANSION PROCESS

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

2.) Apply system power and observe that each module has the green Power LED on, and communications activity is seen on the TX and RX LEDs. Allow 5 seconds for full system

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registration. Added modules have now been assigned the next available sequential Registration Numbers, but in a random sequence not associated with the physical position on the backbone. Modules previously installed and registered in the system retain their assigned Registration Numbers.

NOTES:

Once the registration process is complete Registration Numbers are permanent as long as I/O modules are not removed from or added to a system. When system power is cycled or the system is reset, I/O module Registration Numbers will always remain the same. Tools within MAQ20-940 - ReDAQ Shape Software for MAQ®20 and MAQ20-945 - MAQ®20 Configuration Software Tool allow the user to reassign Registration Numbers. For further details, see Section 10.0.

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.

10.0 MAQ®20 I/O Module Registration

The MAQ®20 Data Acquisition System uses an automated registration process which periodically scans the system and will detect when MAQ®20 I/O modules are added and removed. Modules are assigned a sequential Registration Number based on the order in which they are detected. This order can be forced to occur in a given sequence by adding modules one at a time or it can be allowed to happen randomly. For further details, see Sections 7.0, 8.0 and 9.0.

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

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

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

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Address Maps for each module are found at the end of the individual MAQ®20 I/O module hardware manuals. An excerpt from the MAQ20-VSN module Address Map found in MA1041 MAQ20-mV-V-mA Input Module Hardware User Manual is shown below. Channel Data is stored starting at address 1000.

NOTES:

When a module is registered in a system, addresses are offset by 2000 * R, where R is the Registration Number. Refer to Section 10.0 for further details on Registration Number.

Address Range 1000 - 1699: Module Data						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1000	R	16	Channel Data	Data for all 8 Channels	-4096 to 4096	INT16

Example: A MAQ20-VSN module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 6. Read Current Data from Channels 0-16.

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

Read from register addresses 12000 + 1000 to 1016 = 12000 to 12016 the Current Data from Channels 0-16.

The MAQ20-940 - ReDAQ Shape Software for MAQ®20 and MAQ20-945 - MAQ®20 Configuration Software Tool both have a utility which allows the user to reassign Registration Numbers to I/O Modules in a system. This can be used to rearrange the way I/O modules are displayed in the software if the Alternate Registration Processes have been used instead of the Standard Registration Processes. These are both described in Sections 7.0, 8.0 and 9.0.

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

When using the Configuration Software Tool, the registration sequence is presented on the main screen as shown in Figure 7.

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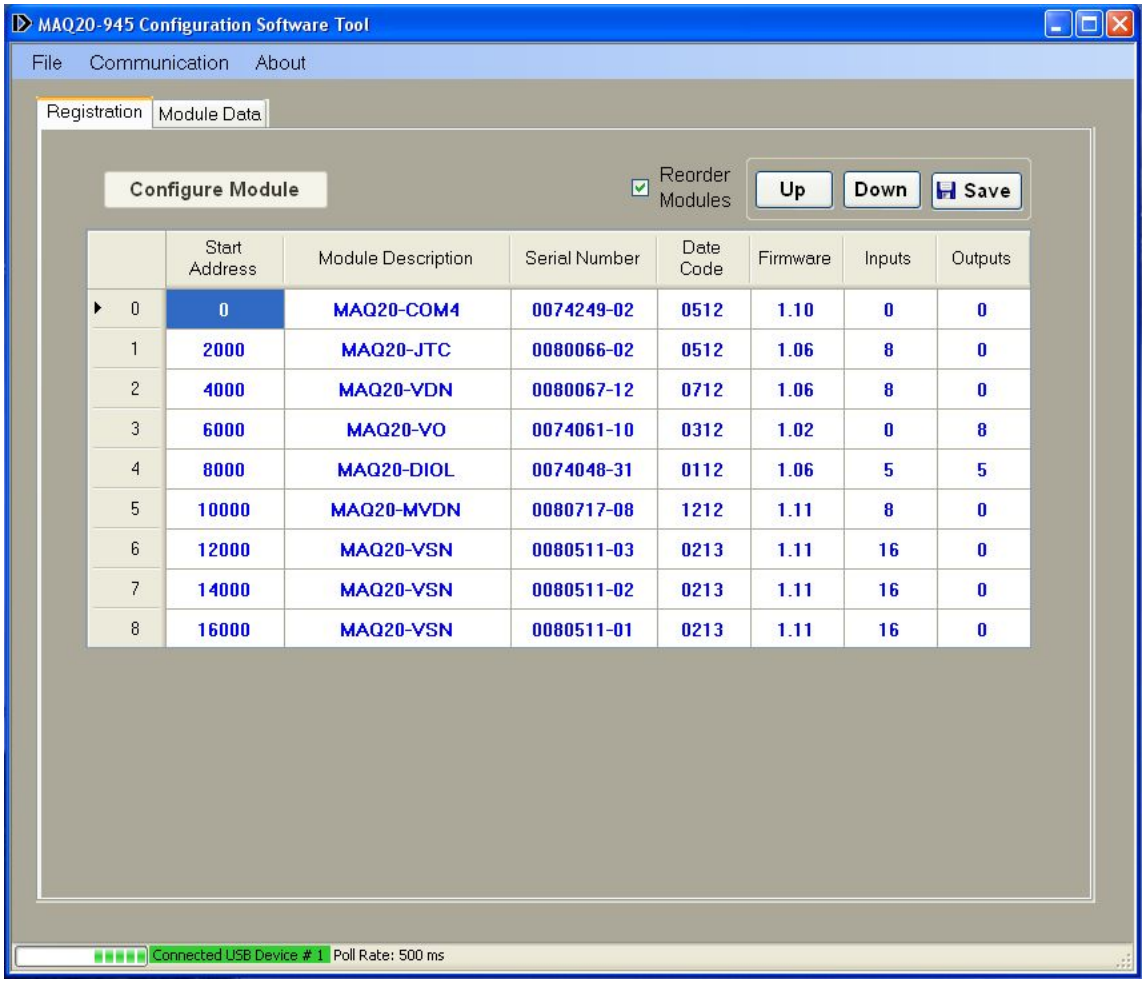


Figure 7: Module Registration using MAQ20-945 Configuration Software Tool

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

ReDAQ Shape Software for MAQ®20 presents a graphical representation of the system on the Acquire panel as shown in Figure 8.

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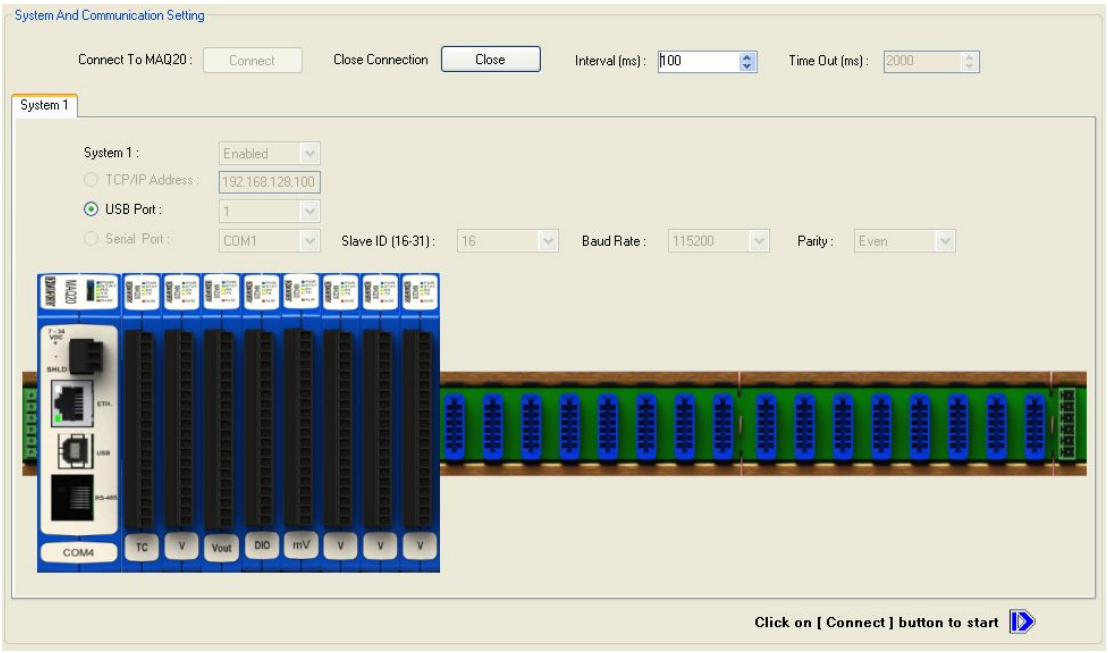
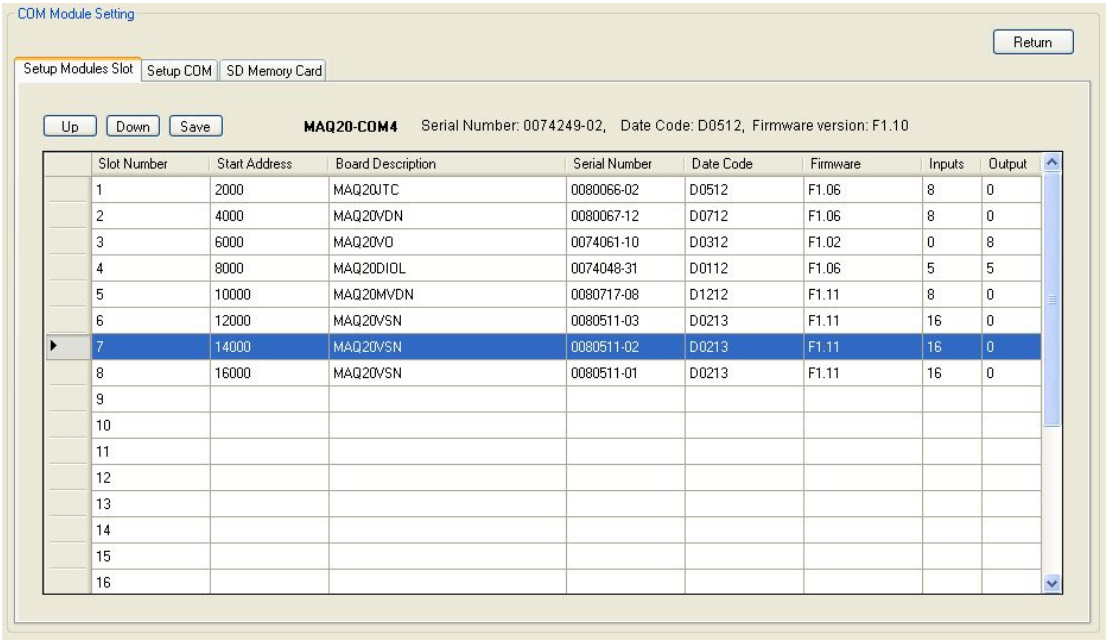


Figure 8: MAQ20-940 ReDAQ Shape for MAQ®20 Main Configuration Screen

To view the registration sequence, double-click on the MAQ20-COMx graphic as shown in Figure 9.



Slot Number	Start Address	Board Description	Serial Number	Date Code	Firmware	Inputs	Output
1	2000	MAQ20UTC	0080066-02	D0512	F1.06	8	0
2	4000	MAQ20VDN	0080067-12	D0712	F1.06	8	0
3	6000	MAQ20VO	0074061-10	D0312	F1.02	0	8
4	8000	MAQ20DIOL	0074048-31	D0112	F1.06	5	5
5	10000	MAQ20MVDN	0080717-08	D1212	F1.11	8	0
6	12000	MAQ20VSN	0080511-03	D0213	F1.11	16	0
7	14000	MAQ20VSN	0080511-02	D0213	F1.11	16	0
8	16000	MAQ20VSN	0080511-01	D0213	F1.11	16	0
9							
10							
11							
12							
13							
14							
15							
16							

Figure 9: Module Registration using MAQ20-940 ReDAQ Shape for MAQ20

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

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10.1 Manual I/O Module Registration

Modules presence in a system is shown in 24 registers starting at register 100. 1 indicates that a module is installed in that slot. Registration Number = register number +1 – 100.

Address Range 100 - 999: Module Configuration						
100	R/W	24	Module Status	0 = No Module 1 = Active Module	0 or 1	INT16

The address space for a module registered in a system starts at offset address 2000 * R, where R is the Registration Number. To determine the identity of a module registered in a given slot, read the model number and serial number starting from the offset address.

MAQ20-VDN 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-MVDN MAQ20-VDN	Characters, Numbers, "-" and Space	ASCII
19	R	11	Serial Number	S1234567-89	Characters, Numbers, "-" and Space	ASCII

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MAQ20 I/O module registration can be manually set using writes to the following registers:

Address Range 1000 - 1199: Registration and Data Logger						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1000	R/W	11	Manual Registration: Serial Number + Slot Number, Reset	Module serial number for which new registration (slot) number is to be assigned and the new registration (slot) number. New registration number (10 registers) is written to registers starting at address 1000 and the slot number (1 register) is appended to this number and is written to the register at address 1010. Write 11 registers in one operation. i.e. 1234567-89n, where n = slot number. Any write to the register at address 1000 resets the current registration.	Module Serial Number: Characters, Numbers, "-" and Space. New Slot Number: 1 to 24	INT16
1020	R/W	1	Auto Registration Enable	1 = Enabled, 0 = Disabled	0 or 1	INT16
1021	R/W	1	Registration Number Save	1 = Save the current registration numbers to EEPROM	1	INT16
1022	R/W	1	Registration Number Delete	The registration (slot) number written to this register will be deleted from the registration record.	1 to 24	INT16

Manually set MAQ20 I/O module registration using the following steps:

1.) Disable Auto Registration by writing 0 to register 1020.

2.) Write the serial number of the module to be registered to registers 1000-1009 and the slot number to register 1010. This data must be sent in one write operation. All MAQ20 I/O modules have a 10-digit serial number. Use leading zeros in the main number and the suffix as needed. The dash symbol '-' is written to register 1007.

NOTE: Do not register a module in a slot that already has a module registered.

3.) Vacate a slot or delete unused registration numbers by writing the registration number to register 1022.

4.) Repeat steps 2 and 3 until all modules are registered in the desired slots and all unoccupied slots have registration numbers deleted.

5.) Save the system configuration to the MAQ20-COMx module memory by writing 1 to register 1021.

6.) Enable Auto Registration by writing 1 to register 1020.

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11.0 Communications Configuration

The MAQ20-COMx Communication Module has three ports for communication with a host computer.

Module	Communication Ports
MAQ20-COM2	Ethernet, USB, RS-232
MAQ20-COM4	Ethernet, USB, RS-485

Communication to the system can occur over any one of the ports or through up to all three of the ports simultaneously. For multiple port operation, commands will be serviced in the order received.

Ethernet

The MAQ®20 Data Acquisition System uses the Modbus TCP protocol and has a 10/100 Base-T port. It is compatible with 10/100 or 1000 Base-T networks. Up to four simultaneous socket connections are supported. If all available sockets are used, new socket open requests will be denied. In such cases, a new socket can be opened only if one of the open sockets is closed by the client that opened the socket. In addition to the four simultaneous socket connections, each socket can process up to four simultaneous Modbus TCP transactions. A Server Busy Modbus exception response will be returned if this limit is exceeded.

Ethernet connections to the system are made using standard Category 5 cable with RJ-45 plugs on either end. Insert one end of the cable into the MAQ20-COMx module port and the other end into an Ethernet hub or host computer port. Ethernet cables offered as accessories for the system are:

SLX141-01, -02, -07	1, 2, 7-meter standard cable (i.e. connection to a switch)
SLX141-X01, -X02, -X07	1, 2, 7-meter crossover cable (i.e. connection to a PC)

The user must determine if straight through or crossover cables are required in each application.

MAQ20-COMx Default Settings

IP Address - 192.168.128.100
Subnet Mask - 255.255.0.0
Gateway - 127.0.0.1
TCP Port - 502

Changes to communications parameters take effect on the next power cycle.

Host Computer Port Settings

IP Address - 192.168.xxx.xx
*Any static IP address not matching the one used for the module.
Subnet Mask - 255.255.0.0

DHCP Mode

To operate the MAQ20-COMx module in DHCP mode, set the IP Address of the module as follows:
IP Address - 0.0.0.0

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USB

Communications over USB are based on the Modbus RTU protocol. The port is USB 2.0 compliant. To connect to a system using USB, a driver must first be installed. This driver is provided with the MAQ20-940 - ReDAQ Shape Software for MAQ®20 and MAQ20-945 - MAQ®20 Configuration Software Tool software packages. During the software installation process the user is asked whether the driver is to be installed. Prior installations are detected. The driver is available on the Dataforth website if Dataforth software is not being used.

The MAQ20-COMx module USB port uses a Type B connector. USB cables offered as accessories for the system are:

SLX147-01, -02, -05	1, 2, 5-meter, Type B to Type A

The maximum cable length to be used with the system is 5 meters.

RS-232 and RS-485

RS-232 and RS-485 communications use the Modbus RTU protocol. The MAQ20-COMx module serial port uses a standard RJ-45 connector. Cat 5 cables with RJ-45 plugs on both ends offered as accessories for the system are:

SLX141-01, -02, -07	1, 2, 7-meter standard cable

If the host computer has DB9 connectors, the following accessories are available:

SLX142	RJ-45 to DB-9 adapter, pre-wired
SLX143	RJ-45 to DB-9 adapter, customer configurable

RS-485 Terminations: In general, for RS-485 trunk line lengths over 100 ft (30.5m), the two devices at the extreme ends of the trunk line should be terminated and all other devices in between should not be terminated. The MAQ20-COMx module offers built-in terminations for 2-wire and 4-wire networks which can be enabled or disabled using a Modbus command. The default configuration is RS-485 Termination Disabled.

RS-485 Four-wire and Two-wire Networks: The factory default mode of operation is 4-wire. Two-wire mode uses only the TX+ and TX- pins of the RS-485 connector. This mode is selected using a Modbus command.

MAQ20-COMx Default Settings

Baud Rate	-	115.2kbps
Parity	-	Even
RS-485 Network	-	4-wire
RS-485 Termination	-	Disabled
Slave ID	-	16

Changes to communications parameters take effect on the next power cycle.

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The Address Map for the MAQ20-COMx Communication Module is found at the end of this manual. Excerpts from the Address Map are shown below. Communications configuration information is stored at addresses 50 to 69 and ports configuration on a given module can be read from addresses 130 to 133.

NOTES:

MAQ20-COMx Communication Module addresses always start at zero and are not offset by the Registration Number. Refer to Section 10.0 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**
50	R/W	4	Ethernet IP Address	192.168.128.100	0 to 255	INT16
55	R/W	4	Ethernet Subnet Mask	255.255.0.0	0 to 255	INT16
60	R/W	1	Serial Port Baud Rate	0 = 1200 1 = 2400 2 = 4800 3 = 9600 4 = 19200 5 = 38400 6 = 57600 7 = 115200 8 = 230400 9 = 460800 10 = 921600	1 to 10	INT16
65	R/W	1	Serial Port Parity	0 = None 1 = Odd 2 = Even	0 to 2	INT16
66	R/W	1	RS485 Type	0 = 4-wire 1 = 2-wire	0 or 1	INT16
67	R/W	1	Termination	0 = Disabled 1 = Enabled	0 or 1	INT16
68	R/W	1	Slave ID	16 Default Slave ID	0 to 31	INT16

Address Range 100 - 999: Module Configuration						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
130	R	1	Ethernet port	0 = None, 1 = Present	0 or 1	INT16
131	R	1	USB port	0 = None, 1 = Present	0 or 1	INT16
132	R	1	RS485 port	0 = None, 1 = Present	0 or 1	INT16
133	R	1	RS232 port	0 = None, 1 = Present	0 or 1	INT16

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

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Example: **Change the MAQ20-COM4 module serial port parameters to 57600bps, no parity and RS-485 2-wire operation.**

1.) A Read from register address 132 will return a data value of 1 indicating that the module has an RS-485 port.

2.) Write to register address 60 a data value of 6 to set the baud rate to 57600bps.

3.) Write to register address 65 a data value of 0 to set no parity.

4.) Write to register address 66 a data value of 1 to set 2-wire mode.

5.) Cycle system power and connect with the new parameters.

Multiple MAQ®20 Data Acquisition Systems can be connected to a single host computer. Ethernet connected systems are uniquely identified by IP address and RS-232 and RS-485 connected systems are uniquely identified by port number. When multiple systems are connected using USB, the host computer assigns a number to each USB port. This assignment should persist across host computer boot cycles but may reassign in a different sequence if the systems are disconnected and reconnected. Refer to the host computer hardware and operating system manuals to determine operation.

Resetting Communication Parameters to Factory Default Values

The MAQ20-COMx module communication parameters can be reset to the factory default settings by issuing a Reset to Default command over an operational port. If communications cannot be established with the module, communication parameters can be reset to factory default settings by executing the following steps:

MAQ20-COM2
Short pins 3 and 4 on the RJ-45 connector, cycle power, remove the short, reconnect the serial cable.

MAQ20-COM4
Short pins 2 and 8 on the RJ-45 connector, cycle power, remove the short, reconnect the serial cable.

12.0 Modbus Protocol

Modbus Function Codes

The MAQ®20 Data Acquisition System supports the following Modbus function codes (commands):

- 3, Read Holding Registers
- 4, Read Input Registers
- 6, Write Single Register
- 16, Write Multiple Registers

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Modbus Addresses

The system makes no distinction between Modbus Input registers and Modbus Holding registers. Read Input Registers will return the same data as Read Holding Registers as long as both commands use the same address and quantity.

Modbus addresses are 0-based, meaning the first address is 0x0000 (0) and the last is 0xFFFF (65535). Address values map directly to address fields of all Modbus commands. Although only a small percentage of available Modbus addresses are mapped to data and/or control functions, the system allows access to the entire range of Modbus addresses. If a Read command accesses an address that the system does not map, 0x0000 will be returned. If a Write command accesses an address that the system does not map, the write will have no effect.

The Address Maps in this manual and in all MAQ®20 I/O module hardware manuals list all Modbus addresses that the MAQ®20 Data Acquisition System maps.

Modbus Exceptions

The system will return the following Modbus exception codes under the given conditions:

- 1, Illegal Function: The received function code is unknown or not supported.
- 2, Illegal Address: The received address and quantity would access data beyond address 0xFFFF.
- 3, Illegal Data: The number of bytes in the request does not match that expected or one or more fields of the command contains an invalid value (i.e., a quantity field is zero or too large, a byte count field is zero or does not agree with the quantity field, etc.).
- 6, Server Busy: This exception only occurs with Modbus TCP and indicates that the MAQ®20 Data Acquisition System is already processing its maximum number of simultaneous transactions and cannot accept more. The request should be re-issued after a response is received from one of the four active transactions.

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13.0 SD Card Operation

The MAQ20-COMx module accepts a micro-SD memory card with up to 4GB capacity for storing data and settings from system I/O modules. Larger capacity cards are not recognized by the system. Examples of logged parameters include Current, Min, Max, and Average data from input modules, Alarm Status, analog output module channel settings, Discrete I/O module data, and the contents of any register in the Modbus Address space.

A filename with a maximum of 7 characters must be chosen before logging is started. After a specified log task is complete, a new filename must be chosen before a new log task is started or the previous data will be overwritten. The filename must always have a '.txt' extension and be compatible with standard MS Windows file naming convention. The default filename is 'File1.txt'.

Two parameters must be specified to log data; Start Addresses and Number of Registers. Data can be logged from up to 400 Registers specified by up to 4 Start Addresses and up to 100 sequential Registers beginning from each Start Address. If the Number of Registers is set to zero, no data will be logged.

Log Interval defines the elapsed time in milliseconds between log events from the specified Start Addresses and Number of Registers. Minimum interval is 100ms and maximum interval is 4,294,967,296ms (49.7 days). Log Interval is stored as a 32-bit number.

Number of Samples specifies how many samples are to be logged from each Start Address. Minimum value is 1 and maximum value is 4,294,967,296.

Every set of logged parameters is time stamped with the current reading from the system Real Time Clock.

Logging can be started and stopped, and SD card presence, card size, and estimated free space can be determined. SD card size and estimated free space in bytes are stored as a 32-bit number.

Removing the card from the module while logging is active can result in loss of data.

The Address Map for the MAQ20-COMx Communication Module is found at the end of this manual. Excerpts from the Address Map are shown below. Parameters used for data logging operations are stored at addresses 1100 to 1141.

NOTES:

MAQ20-COMx Communication Module addresses always start at zero and are not offset by the Registration Number. Refer to Section 10.0 for further details on Registration Number.

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Address Range 1000 - 1199: Registration and Data Logger						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1100	R/W	11	Log File Name	FILE1.TXT	Characters, Numbers and "."	ASCII
1120	R/W	1	Log Start Address 1	Default = 2000 (Start Address of I/O Module in Slot 1. Data for this module is at Start Address 3000)	0 to 49999	INT16
1121	R/W	1	Number of Registers to Log 1	Number of Registers to Log starting at Log Start Address 1. Maximum = 100, Default = 8	0 to 100	INT16
1122	R/W	1	Log Start Address 2	Default = 4000 (Start Address of I/O Module in Slot 2. Data for this module is at Start Address 5000)	0 to 49999	INT16
1123	R/W	1	Number of Registers to Log 2	Number of Registers to Log starting at Log Start Address 2. Maximum = 100, Default = 0	0 to 100	INT16
1130	R/W	2	Log Interval	Log Interval in ms. Min = 100, Default = 100. MSB at Address 1130, LSB at Address 1131.	100 to 2^{32}-1	INT32
1132	R/W	2	Log number of Samples	Log Number of Samples. Default = 100. MSB at Address 1132, LSB at Address 1133.	0 to 2^{32}-1	INT32
1140	R/W	1	Log Enable	1 = Enabled, 0 = Disabled (Default)	0 or 1	INT16

Data can be logged from any register in any MAQ®20 module in a system. Address Maps for each module detailing register location and contents are found at the end of the individual MAQ®20 module hardware manuals. Excerpts from the MAQ20-VDN module Address Map found in MA1041 MAQ20-mV-V-mA Input Module Hardware User Manual are shown below. Module identification information is stored at addresses 0 to 30 and Channel Data and Alarms are stored at addresses 1000 to 1078.

NOTES:

When a module is registered in a system, addresses are offset by 2000 * R, where R is the Registration Number. Refer to Section 10.0 for further details on Registration Number.

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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-MVDN MAQ20-VDN	Characters, Numbers, "-" and Space	ASCII
19	R	11	Serial Number	S1234567-89	Characters, Numbers, "-" and Space	ASCII
30	R	5	Date Code	D1510	Characters, Numbers	ASCII

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 all 8 Channels	-4096 to 4096	INT16
1016	R	1	Alarm Status	Status of Low-Low Alarm	0 to 65,535	INT16
1017	R	1	Alarm Status	Status of Low Alarm	0 to 65,535	INT16
1018	R	1	Alarm Status	Status of High Alarm	0 to 65,535	INT16
1019	R	1	Alarm Status	Status of High-High Alarm	0 to 65,535	INT16
1030	R/W	8	Data Minimum	Minimum value for each of 8 Channels	-4096 to 4096	INT16
1050	R/W	8	Data Maximum	Maximum value for each of 8 Channels	-4096 to 4096	INT16
1070	R/W	8	Data Average	Average for each of 8 Channels	-4096 to 4096	INT16

Example: **A MAQ20-VDN module with serial number 1234567-89 is installed in a system and has been assigned a Registration Number of 2. Log the following parameters: Device Description, Serial Number, Current Data from Channels 0-5, Min Data from Channel 0-5, Low Alarm Status.**

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

1.) Write to register address 1120 a value of 4000 to set Start Address 1 from which data will be logged.

2.) Write to register address 1121 a value of 26 to set the number of sequential registers from Start Address 1 to be logged. This will log the Device Description and Serial Number.

3.) Write to register address 1122 a value of 4000 + 1000 = 5000 to set Start Address 2 from which data will be logged.

4.) Write to register address 1123 a value of 6 to set the number of sequential registers from Start Address 2 to be logged. This will log Current Data from Channels 0-5.

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5.) Write to register address 1124 a value of 4000 + 1030 = 5030 to set Start Address 3 from which data will be logged.

6.) Write to register address 1125 a value of 6 to set the number of sequential registers from Start Address 3 to be logged. This will log Min Data from Channels 0-5.

7.) Write to register address 1126 a value of 4000 + 1017 = 5017 to set Start Address 4 from which data will be logged.

8.) Write to register address 1127 a value of 1 to set the number of sequential registers from Start Address 3 to be logged. This will log the Low Alarm Status for Channels 0-8. The bit code xxxx xxxx in this register represents alarm status for each channel with either 0 (normal) or 1 (tripped).

If no writes to registers 1130 and 1132 are made, the Log Interval will be 100ms (default) and the Log Number of Samples will be 100 (default).

Write to register address 1140 a value of 1 to enable logging.

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14.0 Retrieving Data from the SD Card – Manual or FTP Server

A 4GB microSD card and USB Adapter are provided with each MAQ20-COMx module. Press in the memory card to release it. Once removed the USB adapter can be used to read the card from any computer.

Alternately, the card can be read in-system during system idle or system operation using the MAQ®20 built in FTP Server. This File Transfer Protocol server is a useful remote data acquisition tool for listing, reading, saving, and deleting SD card data files over Ethernet connections to the MAQ®20 Data Acquisition System. It can be used with any web browser such as Internet Explorer, Mozilla Firefox, PC command prompt, or FTP client software such as FileZilla.

The FTP server in each MAQ20-COMx module supports passive and active connections with limited FTP commands. It also supports anonymous, username, and password login. These login parameters are stored in the module registers and can be changed by the user.

MAQ®20 FTP server supported commands:

- **Anonymous:** The anonymous login can be set to enabled/disabled and is stored in Modbus Address 91. 1 = enable, 0 = disable. The default state is enabled.
- **Username:** 10 characters max. The default username is “maq20” and is stored in Modbus Addresses 71-80.
- **Password:** 10 characters max. The default password is “1234” and is stored in Modbus Addresses 81-90.
- ** To save login parameters to EEPROM, write a 1 to Modbus Address 70
- **Dir:** Lists all of the file names on the microSD card.
- **Get:** Remotely Read/Save a file from the microSD card over the Ethernet.
- **Del:** Delete a file from the microSD card.
- **Quit:** Quit FTP.

Before using the MAQ®20 FTP server:

- Verify that the SD card is plugged in.
- Configure the host computer firewall to allow FTP operation on ports 20 and 21.
- Navigate to the host computer file directory where the SD card file is to be saved. The File Save command executes the file transfer operation.

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To use a web browser to log in to the MAQ®20 FTP server:

- If anonymous login is enabled, enter; ftp://192.168.128.100. This is the default IP address of the MAQ®20.

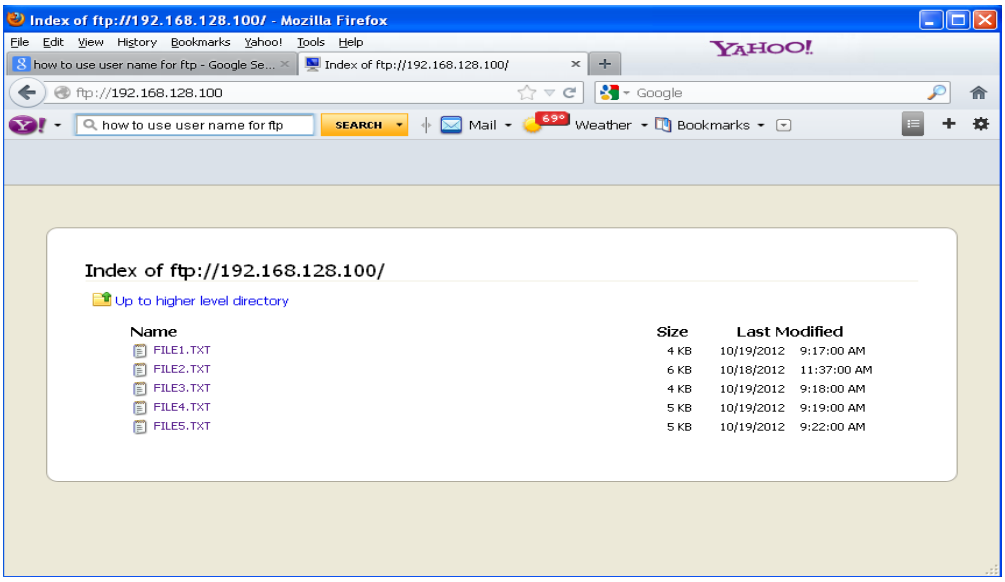


Figure 10: Logging in Using a Web Browser and Anonymous Login Enabled

- If anonymous login is disabled, enter username and password. ftp://maq20:1234@192.168.128.100

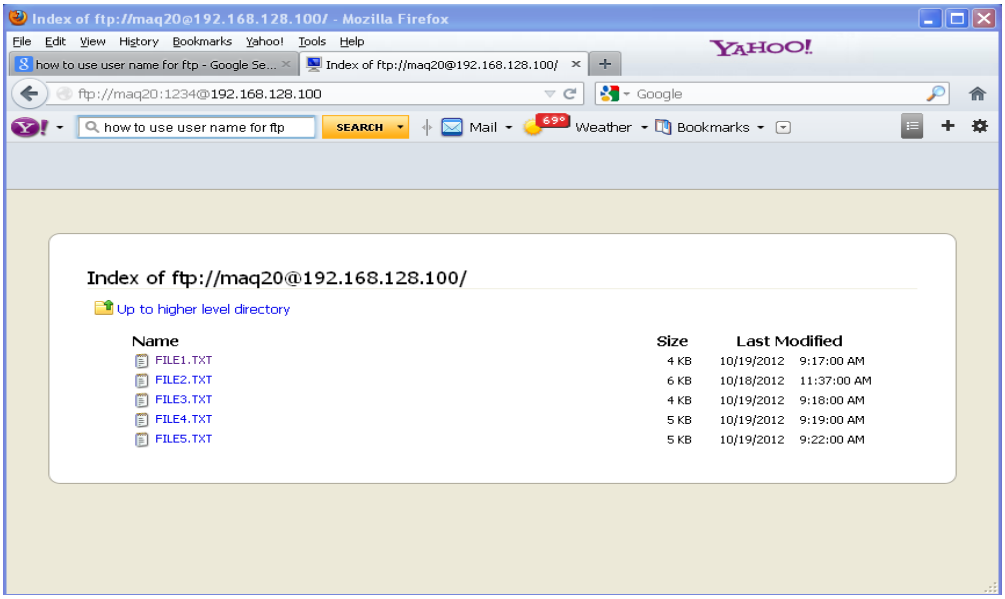


Figure 11: Logging in Using a Web Browser and Anonymous Login Disabled

- Click on the file name to read the file.

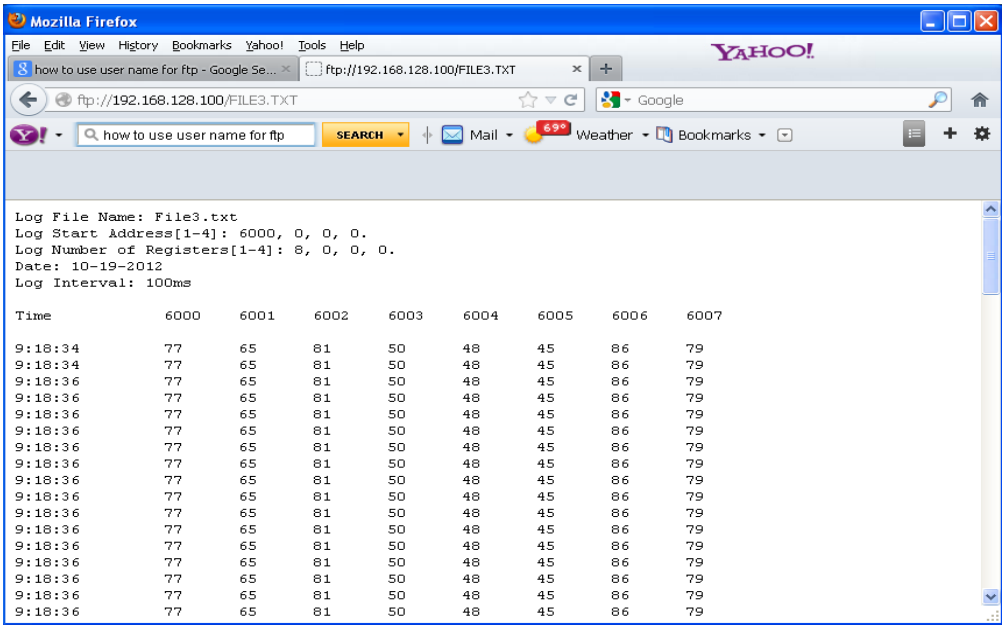


Figure 12: Reading a File through a Web Browser

- Use File Save As to save the file.

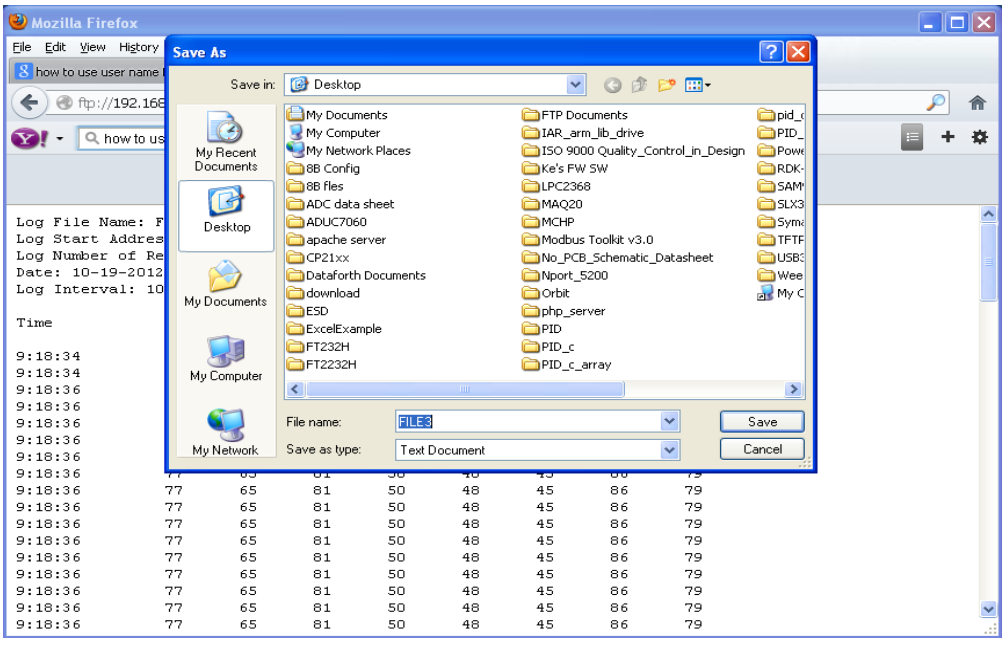


Figure 13: Saving a File through a Web Browser

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To use the Command Prompt to log in to the MAQ®20 FTP server:

- If anonymous login is enabled, enter; ftp://192.168.128.100. This is the default IP address of the MAQ®20.

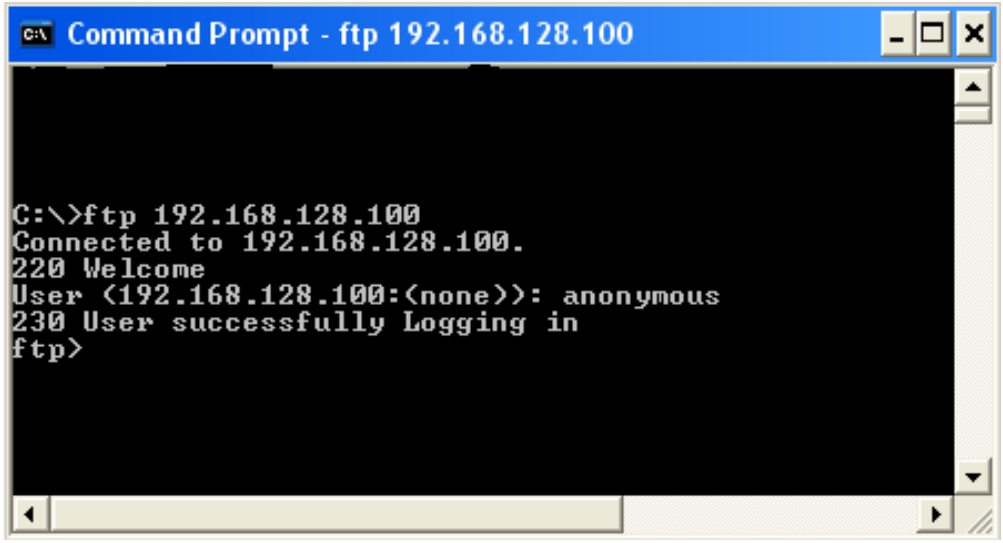


Figure 14: Logging in Using Command Prompt and Anonymous Login Enabled

- If anonymous login is disabled, enter username and password. ftp://maq20:1234@192.168.128.100

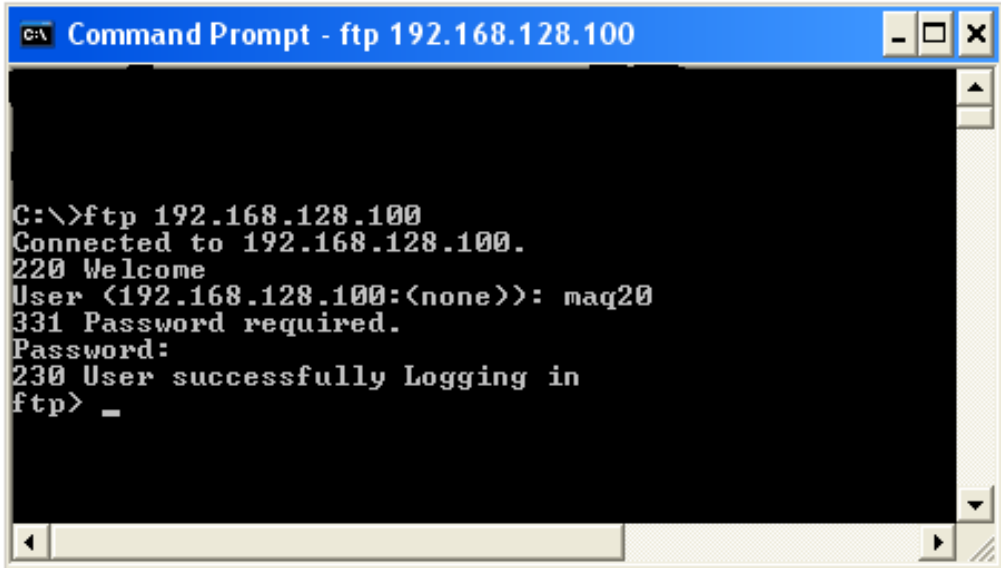


Figure 15: Logging in Using Command Prompt and Anonymous Login Disabled

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- Use the “dir” command to list all of the files stored on the MAQ®20 SD card.

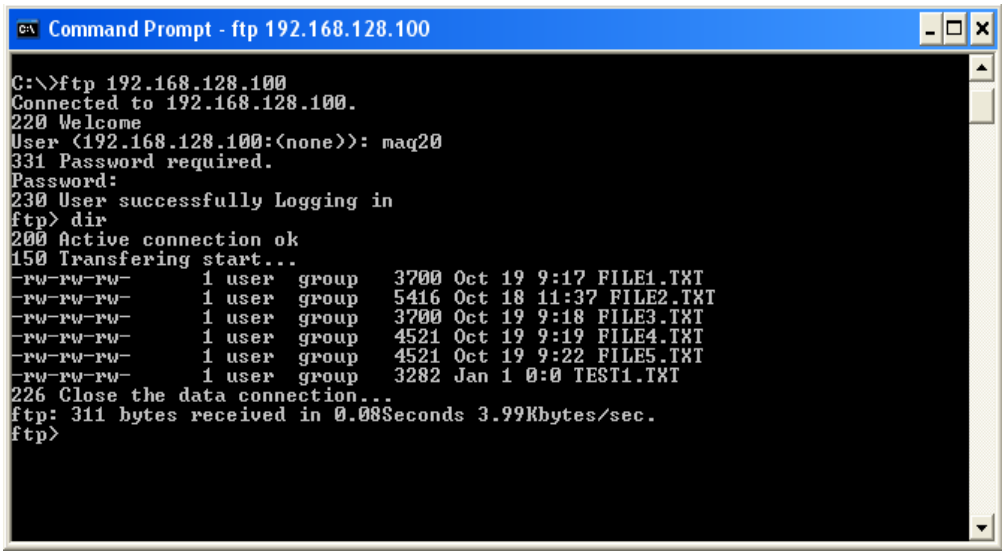


Figure 16: Listing Files Using Command Prompt

- Use the “get” command to download a file from the MAQ®20 SD card.

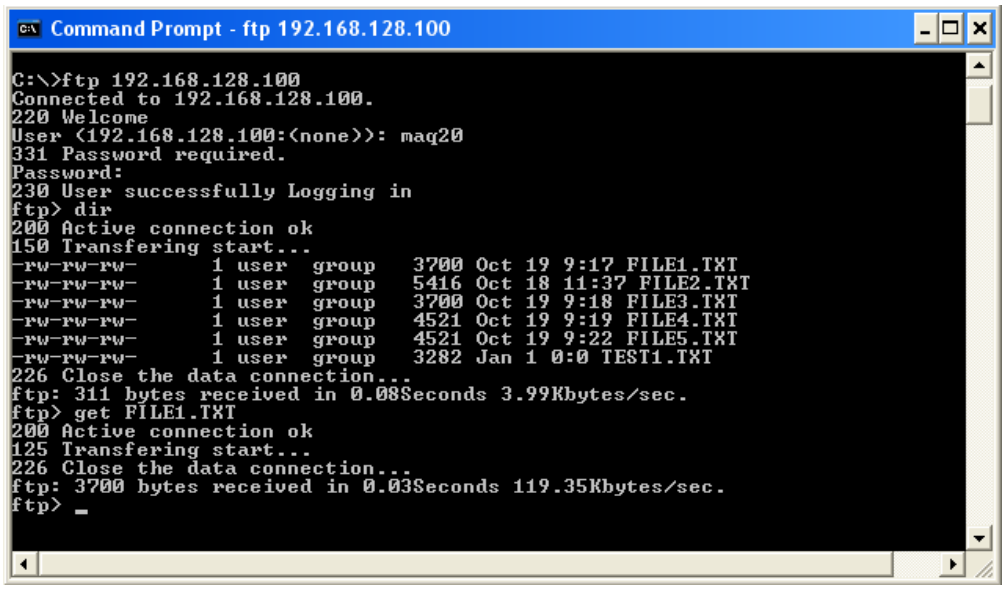


Figure 17: Downloading Files Using Command Prompt

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- Use the “del” command to delete a file from the MAQ®20 SD card.

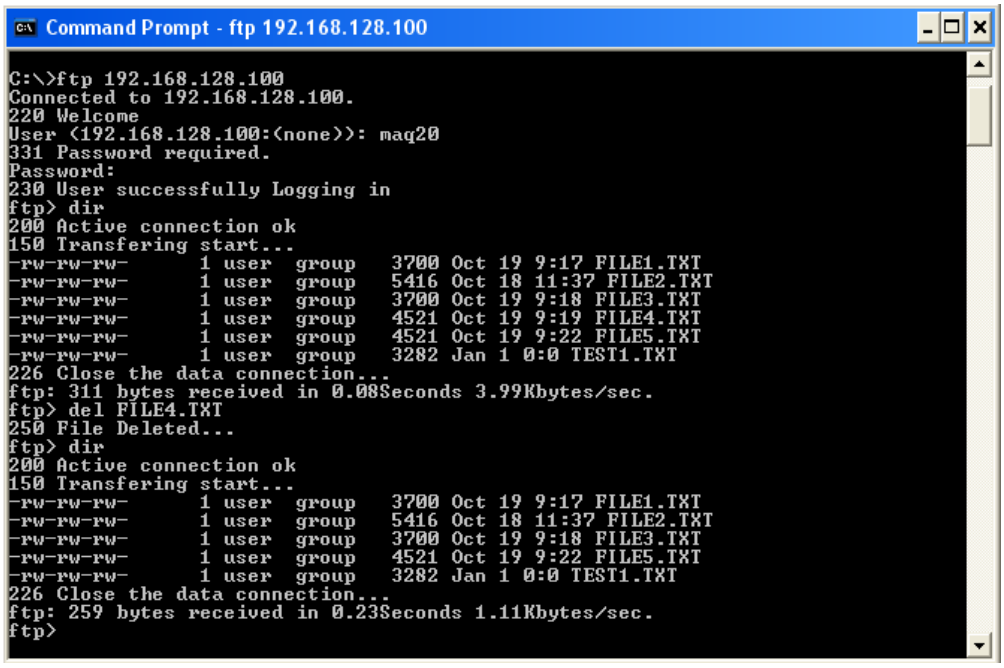


Figure 18: Deleting Files Using Command Prompt

- Use the “quit” command to terminate the FTP server session.

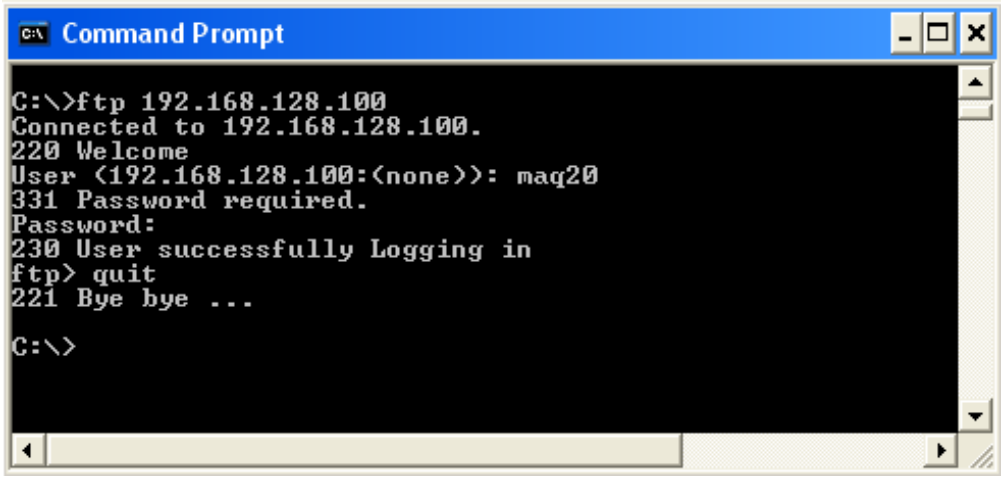


Figure 19: Terminating an FTP Session Using Command Prompt

15.0 Real Time Clock

A real time clock on the MAQ20-COMx module can be used to obtain time stamps for acquired data. The clock is set at the factory and can be accessed by the user. RTC registers are found at Modbus Addresses 1200 – 1206.

When data is logged to the microSD card, each set of logged parameters is time stamped with a reading from the RTC. This is the most accurate method for time stamping acquired data because it is not dependent upon host computer system load or communications data rate.

Functions within MAQ20-940 - ReDAQ Shape Software for MAQ®20 display acquired data from I/O modules in tabular or graphical form. Time stamps for this data are determined from the host computer system clock and are not as accurate.

16.0 Remote Operation via Direct Internet Connection

A powerful feature of the MAQ®20 Data Acquisition System is the ability to operate it remotely over the internet without the requirement of a local computer.

The MAQ®20 Data Acquisition System has a built-in Modbus server and an FTP server. The Modbus server is used for remote system operation and the FTP server is used for remote access to the MAQ20-COMx module SD card. Connect the system to the internet through a wired router or wireless router by using Modbus port number 502 or FTP server port numbers 20 and 21. The client computer (internet access point) then operates the system remotely using Modbus client software such as ReDAQ Shape for MAQ®20 from Dataforth, MAQ®20 Configuration Software Tool from Dataforth, Modbus poll, or even custom Modbus client software written in C++, C#, VB or LabVIEW. FTP server operation is outlined in Section 14.0.

To connect the MAQ®20 Data Acquisition System to the internet for remote operation:

- Obtain a wired or wireless router from sources such as D-Link, Netgear, Linksys, etc.
- Obtain a static public IP address from an internet server provider.
- Do not connect the router to the MAQ20. Use the router setup software to configure the router to use the static IP address.
- Connect the MAQ®20 directly to a client PC. Use the MAQ®20 Configuration Software Tool or other Modbus client software to set the MAQ®20 system IP address to 0.0.0.0. This puts the system in DHCP mode.
- Disconnect the MAQ®20 from the client PC and connect it to the router. Restart the MAQ®20 system by cycling the power. Use the router setup software to detect the MAQ®20 system. The name “TARGET” and an assigned IP address will be found.
- Set the IP address of “TARGET” to permanent (never expire).
- Forward the assigned IP address of “TARGET” and Modbus port number 502 or FTP port numbers 20 and 21 to the static public IP address.

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To perform remote data acquisition and control from the client computer:

- Install the Modbus client software such as ReDAQ Shape for MAQ®20 from Dataforth, MAQ®20 Configuration Software Tool from Dataforth, Modbus Poll, or other client software.
- Connect the client computer to the internet.
- Configure the MAQ®20 system for Ethernet communications and set the Ethernet address to the static public IP address obtained from the internet server provider.
- The MAQ®20 Data Acquisition System will now operate the same as through a direct local connection.

17.0 Reset Functions

Two types of firmware reset are supported in the MAQ20-COMx modules:

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

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

Table 3 shows what parameters are affected for each reset.

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

RESET TYPE	PARAMETERS
Standard Reset	Log File Name = 'FILE1.TXT' Log Start Address 1 = 2000 Log Number of Registers 1 = 8 Log Start Address 2 = 4000 Log Number of Registers 1 = 0 Log Start Address 3 = 6000 Log Number of Registers 1 = 0 Log Start Address 4 = 8000 Log Number of Registers 1 = 0 Log Interval = 100ms Log Number of Samples = 100 Log Enable = 0 Clears all Status and Diagnostic registers
Reset-to-Default	All parameters listed under Standard Reset, plus: Ethernet IP Address = 192.168.128.100 Ethernet Subnet Mask = 255.255.0.0 Serial Port Baud Rate = 115.2kbps Serial Port Parity = Even RS-485 Type = 4-wire RS-485 Terminations = Disabled Slave ID = 16 FTP Username = 'maq20' FTP Password = '1234' FTP Anonymous Login = Enabled

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Reset Registers

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

NOTE: The MAQ20-COMx 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.

If communications cannot be established with the module, communication parameters can be reset to factory default settings by executing the following steps:

MAQ20-COM2

Short pins 3 and 4 on the RJ-45 connector, cycle power, remove the short, reconnect the serial cable.

MAQ20-COM4

Short pins 2 and 8 on the RJ-45 connector, cycle power, remove the short, reconnect the serial cable.

Power-On-Reset (POR) and Brownout

MAQ20-COMx 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.

18.0 LED Indicators

A set of 5 LEDs on the top panel of the MAQ20-COMx modules indicate module power, operation, communication, SD card access, and alarm status.

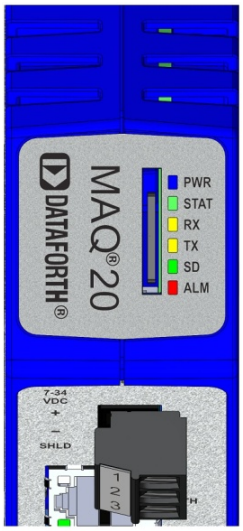


Figure 20: MAQ®20 Faceplate

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LED Function and Troubleshooting Tips:

PWR

Normal operation: BLUE, solid lit

LED Off: Abnormal power situation

- Verify that 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.

LED Constant On or Constant Off: Abnormal operation

- Remove and reapply power to force a reset.
- Determine if the module is communicating by observing the TX and RX LEDs.

RX, TX

Normal Operation – YELLOW, rapid blinking during communication with MAQ®20 I/O modules

LED Constant Off: Abnormal operation or no communications to MAQ®20 I/O modules

- 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.

SD

Normal operation: Off

SD Card Access: GREEN, 1 Hz blinking

ALM

Normal operation: Off

Alarm Condition Detected: RED, solid lit.

- Reserved for future use. No MAQ20-COMx alarm conditions are defined at this time.

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

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

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19.0 Specifications

MAQ®20 COMMUNICATIONS MODULE

Model Number	Description
MAQ20-COM4	Ethernet, USB, RS-485
MAQ20-COM2	Ethernet, USB, RS-232
Communications	
Ethernet	10/100 Base-T (1000 Base-T compatible) RJ-45, Modbus TCP
USB	USB 2.0, Type B, Proprietary Modbus over USB
RS-485	2-wire or 4-wire, up to 921.6kbps, up to 4000 ft, RJ-45, Modbus RTU
RS-232	Up to 921.6kbps, RJ-45, Modbus RTU
CMV	
Power-to-Bus	50V
Comms-to-Bus	50V
Transient	ANSI/IEEE C37.90.1
Power Supply	
Input Power	7-34VDC @ 2A max
Power to Bus	5VDC @ 3A max
Dimensions (h)(w)(d)	4.51” x 1.11” x 3.26” (114.6mm x 28.2mm 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

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20.0 MAQ20-COM2 and MAQ20-COM4 Address Map

Tables in this section outline the MAQ20-COMx 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.

NOTES:

When a module is registered in a system, addresses are offset by 2000 * R, where R is the Registration Number. MAQ20-COMx Communication Module addresses always start at zero and are not offset by the Registration Number. Refer to Section 10.0 for further details on Registration Number.

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Table 4: MAQ20-COM2 and MAQ20-COM4 Address Map

Address Range 0 - 99: Module Information						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
0	R	10	Device Description	MAQ20-COMx	Characters, Numbers, "-" and Space	ASCII
19	R	11	Serial Number	S1234567-89	Characters, Numbers, "-" and Space	ASCII
30	R	5	Date Code	D1510	Characters, Numbers	ASCII
35	R	5	Firmware Rev	F1.00	Characters, Numbers and "."	ASCII
50	R/W	4	Ethernet IP Address	192.168.128.100	0 to 255	INT16
55	R/W	4	Ethernet Subnet Mask	255.255.0.0	0 to 255	INT16
60	R/W	1	Serial Port Baud Rate	0 = 1200 1 = 2400 2 = 4800 3 = 9600 4 = 19200 5 = 38400 6 = 57600 7 = 115200 8 = 230400 9 = 460800 10 = 921600	1 to 10	INT16
65	R/W	1	Serial Port Parity	0 = None 1 = Odd 2 = Even	0 to 2	INT16
66	R/W	1	RS485 Type	0 = 4-wire 1 = 2-wire	0 or 1	INT16
67	R/W	1	Termination	0 = Disabled 1 = Enabled	0 or 1	INT16
68	R/W	1	Slave ID	16 Default Slave ID	0 to 31	INT16
70	W	1	Save Com Port and File Server Info to EEPROM.	Writing a 1 to this address saves register contents from addresses 50-91 to EEPROM	1	INT16
71	R/W	10	File Server Username	Default = maq20 10 characters max	Characters and Numbers	ASCII
81	R/W	10	File Server Password	Default = 1234 10 characters max	Characters and Numbers	ASCII
91	R/W	1	File Server Anonymous Login	0 = Disabled, 1 = Enabled (Default)	0 or 1	INT16
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

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Table 4: MAQ20-COM2 and MAQ20-COM4 Address Map

Address Range 100 - 999: Module Configuration						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
100	R/W	24	Module Status	0 = No Module, 1 = Active Module	0 or 1	INT16
130	R	1	Ethernet port	0 = None, 1 = Present	0 or 1	INT16
131	R	1	USB port	0 = None, 1 = Present	0 or 1	INT16
132	R	1	RS485 port	0 = None, 1 = Present	0 or 1	INT16
133	R	1	RS232 port	0 = None, 1 = Present	0 or 1	INT16
134	R	1	CAN port	0 = None, 1 = Present	0 or 1	INT16

Address Range 1000 - 1199: Registration and Data Logger						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1020	R/W	1	Auto Registration Enable	1 = Enabled, 0 = Disabled	0 or 1	INT16
1100	R/W	11	Log File Name	FILE1.TXT	Characters, Numbers and "."	ASCII
1120	R/W	1	Log Start Address 1	Default = 2000 (Start Address of I/O Module in Slot 1. Data for this module is at Start Address 3000)	0 to 49999	INT16
1121	R/W	1	Number of Registers to Log 1	Number of Registers to Log starting at Log Start Address 1. Maximum = 100, Default = 8	0 to 100	INT16
1122	R/W	1	Log Start Address 2	Default = 4000 (Start Address of I/O Module in Slot 2. Data for this module is at Start Address 5000)	0 to 49999	INT16
1123	R/W	1	Number of Registers to Log 2	Number of Registers to Log starting at Log Start Address 2. Maximum = 100, Default = 0	0 to 100	INT16
1124	R/W	1	Log Start Address 3	Default = 6000 (Start Address of I/O Module in Slot 3. Data for this module is at Start Address 7000)	0 to 49999	INT16
1125	R/W	1	Number of Registers to Log 3	Number of Registers to Log starting at Log Start Address 3. Maximum = 100, Default = 0	0 to 100	INT16
1126	R/W	1	Log Start Address 4	Default = 8000 (Start Address of I/O Module in Slot 4. Data for this module is at Start Address 9000)	0 to 49999	INT16
1127	R/W	1	Number of Registers to Log 4	Number of Registers to Log starting at Log Start Address 4. Maximum = 100, Default = 0	0 to 100	INT16
1130	R/W	2	Log Interval	Log Interval in ms. Min = 100, Default = 100. MSB at Address 1130, LSB at Address 1131.	100 to 2^{32}-1	INT32

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Table 4: MAQ20-COM2 and MAQ20-COM4 Address Map

Address Range 1000 - 1199: Registration and Data Logger						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1132	R/W	2	Log number of Samples	Log Number of Samples. Default = 100. MSB at Address 1132, LSB at Address 1133.	0 to 2^{32}-1	INT32
1140	R/W	1	Log Enable	1 = Enabled, 0 = Disabled (Default)	0 or 1	INT16
1150	R	1	Card available	1 = available	0 or 1	INT16
1151	R/W	2	Total space	4MB max. MSB at Address 1151, LSB at Address 1152.	0 to 2^{32}-1	INT32
1153	R/W	2	Free space	MSB at Address 1153, LSB at Address 1154.	0 to 2^{32}-1	INT32

Address Range 1200 - 1299: Module RTC and Temperature						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1200	R/W	1	Second	0-59	0-59	INT16
1201	R/W	1	Minute	0-59	0-59	INT16
1202	R/W	1	Hour	0-23	0-23	INT16
1203	R/W	1	Day	(1-7), 1 = Sunday	1 to 7	INT16
1204	R/W	1	Date	(1-31)	1 to 31	INT16
1205	R/W	1	Month	(1-12)	1 to 12	INT16
1206	R/W	1	Year	(0-99)	0 to 99	INT16
1210	R	1	Internal Temperature Sensor	Degree C	-45 to 130	INT16

Address Range 1300 - 1499: PID Loop Controllers						
Start Address	**Read/Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1300				See MA1056 - MAQ®20 PID Loop Control User Manual		
…						
1499						

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	1 = Reset, 0 = No Reset	0 or 1	INT16
1901	R/W	1	Brownout Reset	1 = Reset, 0 = No Reset	0 or 1	INT16
1902	R/W	1	I2C TX Error	Increments on I2C TX Error	0 to 65,535	INT16
1903	R/W	1	I2C RX Error	Increments on I2C RX Error	0 to 65,535	INT16
1906	R/W	1	Numeric Error	Increments when a value received is outside of the allowed range	0 to 65,535	INT16

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Table 4: MAQ20-COM2 and MAQ20-COM4 Address Map

Address Range 1900 - 1999: Status Registers						
Start Address	**Read/ Write**	**Number of Registers**	**Contents**	**Description**	**Data Range**	**Data type**
1907	R/W	1	Alpha Data Error	Increments when a Alpha Data 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
1911	R/W	1	Log File Open Error	Increments when reading from a Log File has an error	0 to 65,535	INT16
1912	R/W	1	Log File Write Error	Increments when writing to a Log File has an error	0 to 65,535	INT16
1913	R/W	1	SD Card Error	Increments when SD Card has an error	0 to 65,535	INT16

21.0 Throughput

Test Networks and Test Setup

Modbus RTU throughput was measured using a point-to-point RS-485 connection or point-to-point USB connection between a MAQ®20 Data Acquisition System and a host computer. Serial communication was performed at 921.6kbps, with 8 data bits, 1 stop bit and even parity.

Modbus TCP throughput was measured using an Ethernet switch with 10/100 Base-T connection between a MAQ®20 Data Acquisition System and a host computer.

Calculated data is based on command processing time in the system firmware and Modbus communication requirements. Measured performance was determined by executing the appropriate command 1000 times and assuming equal command processing time for each execution. Commands were looped using a Windows application.

The specific computer hardware and operating system used can affect performance and should be carefully evaluated in applications where throughput is critical.

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Two systems were used for measuring performance:

System 1

Computer:	Standard PC
Operating System:	Windows XP, SP3
RS-485 Interface:	PC Card
USB Interface:	PC USB Port
Ethernet Interface:	PC Fast Ethernet Card

System 2

Computer:	Standard PC
Operating System:	Windows 7
RS-485 Interface:	PC Card
USB Interface:	PC USB Port
Ethernet Interface:	PC Fast Ethernet Card

Throughput Terminology

Command Time: Time required to process a command including the MAQ®20 command processing time and communication overhead.

Command Rate: Rate at which a command can be sent the MAQ®20 and new data is returned. Expressed in commands per second (Hz). This value is the inverse of the Command Time. Note that commands can be sent to the I/O modules faster, but new data is not guaranteed to be returned.

Throughput: The number of channel reads or writes per second (Hz) sending commands at the Command Rate. This value is dependent on the number of channels processed by the command and is calculated by multiplying the Command Rate by the number of channels processed by the command.

Table 5: I/O Module Fixed Internal Continuous Scan Rate

I/O Module	Scan Rate (ms) vs Channels Enabled					
	1	4	5	8	10	16
MAQ20-xDN, MAQ20-xTC	5	20	25	40		
MAQ20-xSN	5	20	25	40	60	80
MAQ20-xO	0.2	0.8	1	1.6		
MAQ20-DIOL	0.01	0.04	0.05	0.08	0.1	
MAQ20-DIOL	0.01	0.04	0.05			

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Table 6: Command Time for New Data

Communications Type	Command Time (ms) vs Channels Enabled							
	1	4	5	8	10	16		
Modbus RTU (RS485)								
Read Analog Data		24.04		44.07			MAQ20-xDN	MAQ20-xTC
Read Analog Data				44.1		85.1	MAQ20-xSN	
Write Analog Data	4.05	4.07		4.23			MAQ20-xO	
Read Discrete Data		3.58			4.1		MAQ20-DIOL	
Write Discrete Data	3.23		4.04				MAQ20-DIOL	
Modbus RTU (USB)								
Read Analog Data		23.25		44.15			MAQ20-xDN	MAQ20-xTC
Read Analog Data				44.19		85.21	MAQ20-xSN	
Write Analog Data	3.24	4.14		4.2			MAQ20-xO	
Read Discrete Data		3.24			4.15		MAQ20-DIOL	
Write Discrete Data	3.21		3.82				MAQ20-DIOL	
Modbus TCP								
Read Analog Data		22.59		42.85			MAQ20-xDN	MAQ20-xTC
Read Analog Data				42.92		83.55	MAQ20-xSN	
Write Analog Data	2.59	2.8		3.1			MAQ20-xO	
Read Discrete Data		2.5			2.85		MAQ20-DIOL	
Write Discrete Data	2.46		2.71				MAQ20-DIOL	

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Table 7: Command Rate for New Data

Communications Type	Commands per second vs Channels Enabled							
	1	4	5	8	10	16		
Modbus RTU (RS485)								
Read Analog Data		42		23			MAQ20-xDN	MAQ20-xTC
Read Analog Data				23		12	MAQ20-xSN	
Write Analog Data	247	246		236			MAQ20-xO	
Read Discrete Data		279			244		MAQ20-DIOL	
Write Discrete Data	310		248				MAQ20-DIOL	
Modbus RTU (USB)								
Read Analog Data		43		23			MAQ20-xDN	MAQ20-xTC
Read Analog Data				23		12	MAQ20-xSN	
Write Analog Data	309	242		238			MAQ20-xO	
Read Discrete Data		309			241		MAQ20-DIOL	
Write Discrete Data	312		262				MAQ20-DIOL	
Modbus TCP								
Read Analog Data		44		23			MAQ20-xDN	MAQ20-xTC
Read Analog Data				23		12	MAQ20-xSN	
Write Analog Data	386	357		323			MAQ20-xO	
Read Discrete Data		400			351		MAQ20-DIOL	
Write Discrete Data	407		369				MAQ20-DIOL	

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Table 8: Throughput vs Channels Enabled

Communications Type	Throughput (Ch/s) vs Channels Enabled							
	1	4	5	8	10	16		
Modbus RTU (RS232)								
Read Analog Data		166		182			MAQ20-xDN	MAQ20-xTC
Read Analog Data				181		188	MAQ20-xSN	
Write Analog Data	247	983		1891			MAQ20-xO	
Read Discrete Data		1117			2439		MAQ20-DIOL	
Write Discrete Data	310		1238				MAQ20-DIOL	
Modbus RTU (USB)								
Read Analog Data		172		181			MAQ20-xDN	MAQ20-xTC
Read Analog Data				181		188	MAQ20-xSN	
Write Analog Data	309	966		1905			MAQ20-xO	
Read Discrete Data		1235			2410		MAQ20-DIOL	
Write Discrete Data	312		1309				MAQ20-DIOL	
Modbus TCP								
Read Analog Data		177		187			MAQ20-xDN	MAQ20-xTC
Read Analog Data				186		192	MAQ20-xSN	
Write Analog Data	386	1429		2581			MAQ20-xO	
Read Discrete Data		1600			3509		MAQ20-DIOL	
Write Discrete Data	407		1845				MAQ20-DIOL	

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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.

https://www.dataforth.com/terms-and-conditions-sale

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MAQ20-COM2 & MAQ20-COM4 Hardware User Manual
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