



# MAQ<sup>®</sup>20

## Industrial Data Acquisition and Control System

### MA1039

## MAQ20 LabVIEW VI User Manual

Slot # 2	Model # MAQ20-VDN	# of Registers to Read 8	Local Start Address 1000 Ch 0 - Ch 7 Input Data	Range Selection Ch 0: 4, Ch 1: 4, Ch 2: 4, Ch 3: 4, Ch 4: 2, Ch 5: 1, Ch 6: 3, Ch 7: 2	Input Voltage 3.386, 3.383, 0.01743, 0.01494, 0.01494, 15.44, 2.55, -0.06972
Slot # 3	Model # MAQ20-VO	Local Start Address 1000 Ch 0 - Ch 7 Output Data	Output Voltage Ch 0: -3.5, Ch 1: -10, Ch 2: 2, Ch 3: -3.5, Ch 4: 6.5, Ch 5: 4.3, Ch 6: 5, Ch 7: 6		
Slot # 4	Model # MAQ20-DIOL	# of Registers to Read 5	Local Start Address 1000 Ch D00-D05 Output Data Local Start Address 1000 Ch DI0-DI5 Input Data	Discrete Output DO0: 1, DO1: 1, DO2: 0, DO3: 0, DO4: 1	Discrete Input 0, 1, 0, 1, 0

**MAQ20 LabVIEW VI User Manual**  
**MA1039 Rev. A – April 2015**  
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**ISO9001:2008-Registered QMS**

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## Errata Sheets

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

## 1.0 System Features

The MAQ20 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

- $\pm 0.035\%$  Accuracy
- Industry leading  $\pm 0.3\text{C}$  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  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- Wide Range 7-34VDC Power
- CE Compliant, UL/CUL Listing and ATEX Compliance pending

### Industry Leading Functionality

- The system is a Modbus Server and can be operated remotely with no local PC
- Up to 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

### 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
- Intuitive Graphical Control Software
  - ReDAQ Shape Graphical HMI Design & Runtime Solution
  - IPEmotion Multi-Vendor and Multi-Language Solution
  - Programming examples and LabVIEW VIs
  - OPC Server

## 2.0 System Description and Documentation

A MAQ20 Data Acquisition System must have as a minimum a Communications Module, a Backbone, and one I/O Module. Examples include:

[MAQ20-COMx](#) Communications Module with Ethernet, USB and RS-232 or RS-485 Interface

[MAQ20-DIOx](#) Discrete Input / Output Module

[MAQ20-xTC](#) Type x Thermocouple Input Module

[MAQ20-mVxN, -VxN](#) Voltage Input Module

[MAQ20-IxN](#) Process Current Input Module

[MAQ20-IO, -VO](#) Process Current Output and Process Voltage Output Module

[MAQ20-BKPLx](#) x Channel System Backbone

Refer to [www.dataforth.com/maq20.aspx](http://www.dataforth.com/maq20.aspx) 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 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 from module to module 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.

MAQ20 communications modules provide connection between a host computer and a MAQ20 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 MAQ20 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 MAQ20 I/O modules.

For details on hardware installation, configuration, and system operation, refer to the manuals and software available for download from [www.dataforth.com/maq20\\_download.aspx](http://www.dataforth.com/maq20_download.aspx). This includes, but is not limited to:

[MA1036](#) MAQ20 Quick Start Guide

[MA1040](#) MAQ20 Communications Module Hardware User Manual

[MA1041](#) MAQ20 milliVolt, Volt and Current Input Module Hardware User Manual

[MA1037](#) MAQ20 Configuration Software Tool User Manual

[MA1038](#) MAQ20 ReDAQ Shape for MAQ20 User Manual

[MAQ20-940/-941](#) ReDAQ Shape Software for MAQ20 – Developer Version/User Version

[MAQ20-945](#) MAQ20 Configuration Software Tool

[MAQ20-952](#) IPEMotion Software for MAQ20

### 3.0 General Description

The MAQ20 LabVIEW VIs provide a common interface to the MAQ20 Data Acquisition System usable by any SCADA, HMI or other application developed using LabVIEW. This simplifies communication with the MAQ20 and allows quick development of application specific, sophisticated data acquisition and control systems.

The VIs were developed using LabVIEW 2014 and use the standard National Instruments Modbus VIs. They are building blocks that show how to connect to a MAQ20 system and perform I/O module configuration and data input and output operations.

Dataforth provides the MAQ20DEMO-B Demonstration Suitcase and Process Simulator to show basic operation of the system. The MAQ20 system in this demonstration set is comprised of:

<a href="#">MAQ20-COM4</a>	Communications Module
<a href="#">MAQ20-JTC</a>	8-Channel J-Type Thermocouple Input Module
<a href="#">MAQ20-VDN</a>	8-Channel Differential Voltage Input Module
<a href="#">MAQ20-VO</a>	8 Isolated Channel Voltage Output Module
<a href="#">MAQ20-DIOL</a>	5 Discrete Output / 5 Discrete Input Module

The VI titled *MAQ20 IO Module Interface TCP Example* shows how to interface to each of these modules and is developed specifically to connect to the Demonstration Suitcase.

The techniques used are examples of how to interface to any MAQ20 Communications or I/O module and portions of the VI can be cut and pasted to develop other applications.

### 4.0 System Communications

The MAQ20 uses the Modbus TCP protocol for communication over Ethernet and the Modbus RTU protocol for communication over USB, RS-485 and RS-232. Refer to *MA1040 MAQ20 Communications Module Hardware User Manual* found at [www.dataforth.com/maq20\\_download.aspx](http://www.dataforth.com/maq20_download.aspx) for detailed information on communications setup. VIs are set up for communication over Ethernet. Serial communications are set up in a similar manner using the Modbus Serial Master VI.

The Modbus TCP Master and Close VIs provide the basic communications interface.



Figure 1: Modbus TCP VIs

#### 4.1 Modbus TCP

The standard method of Ethernet connection to the MAQ20 is to use a static IP address. The factory default is:

**MAQ20 factory default static IP address: 192.168.128.100**

If desired, the IP address can be changed using the MAQ20 Configuration Software Tool or ReDAQ Shape Software for MAQ20.

Configure the Ethernet port on the host computer to also use a static IP address. In Windows 7, this is done by choosing Control Panel > Network and Sharing Center. Next select Change Adapter Settings, select the network adapter to be used for the Channel and select Properties, then select TCP/IPv4 and Properties.

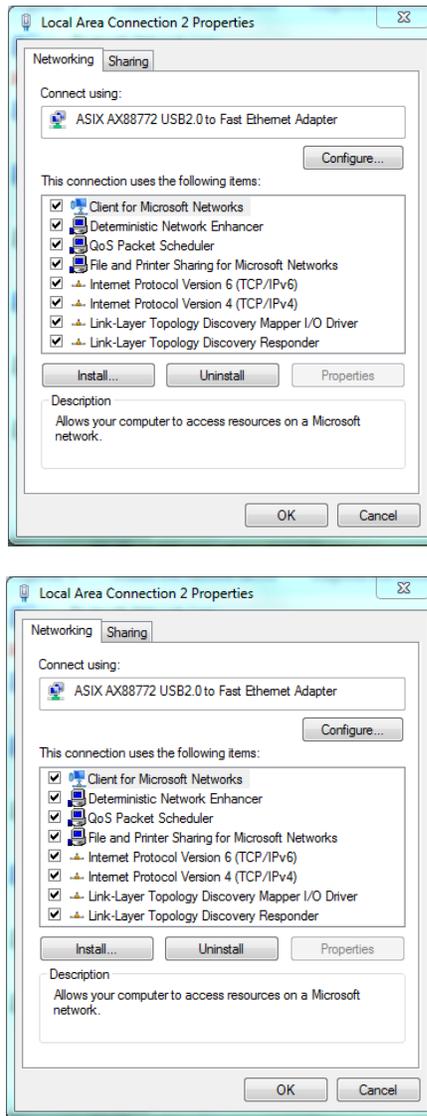


Figure 2: Host Computer Ethernet Port Configuration

Configure the port to use a static IP address.

**Host computer static IP Address: 192.168.xxx.xxx**

Choose any address that does not match the one set in the MAQ20. If the MAQ20 is set for 192.168.128.100, set the host computer to a lower address such as 192.168.128.095 for faster response.

**Host computer Subnet Mask: 255.255.0.0**

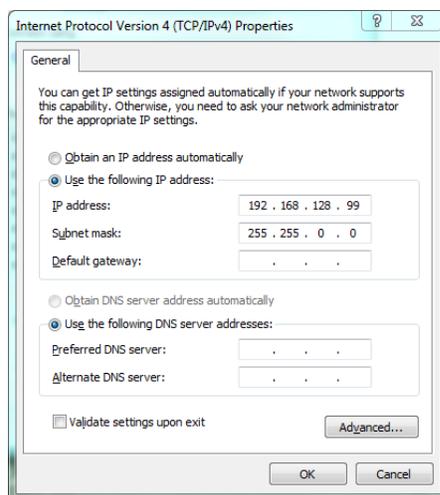


Figure 3: Host Computer IP Address &amp; Subnet Mask

## 5.0 MAQ20 Demonstration System and Addressing Overview

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. 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. Channel data for the MAQ20 Input and Output modules is stored starting at address 1000 within each module register space.

Address Maps for each module are found at the end of the individual MAQ20 I/O and Communication module hardware user manuals. A few of these are listed below.

- [MA1040](#) MAQ20 Communications Module Hardware User Manual
- [MA1041](#) MAQ20 milliVolt, Volt and Current Input Module Hardware User Manual
- [MA1042](#) MAQ20 Voltage & Current Output Module Hardware User Manual
- [MA1043](#) MAQ20-DIOL Discrete IO Module Hardware User Manual
- [MA1044](#) MAQ20 RTD-Potentiometer Input Module Hardware User Manual
- [MA1045](#) MAQ20-PWR3 Load-Share Power Supply Hardware User Manual
- [MA1046](#) MAQ20 Strain Gage Input Module Hardware User Manual
- [MA1047](#) MAQ20 TC Input Module Hardware User Manual
- [MA1048](#) MAQ20 Frequency Input Module Hardware User Manual

The *MAQ20 IO Module Interface TCP Example* VI is set up to interface to the MAQ20DEMO-B demonstration hardware. This system is comprised of a MAQ20-COM4 communications module and 4 I/O modules which connect to a Process Simulator to allow user input and output and give visual feedback.

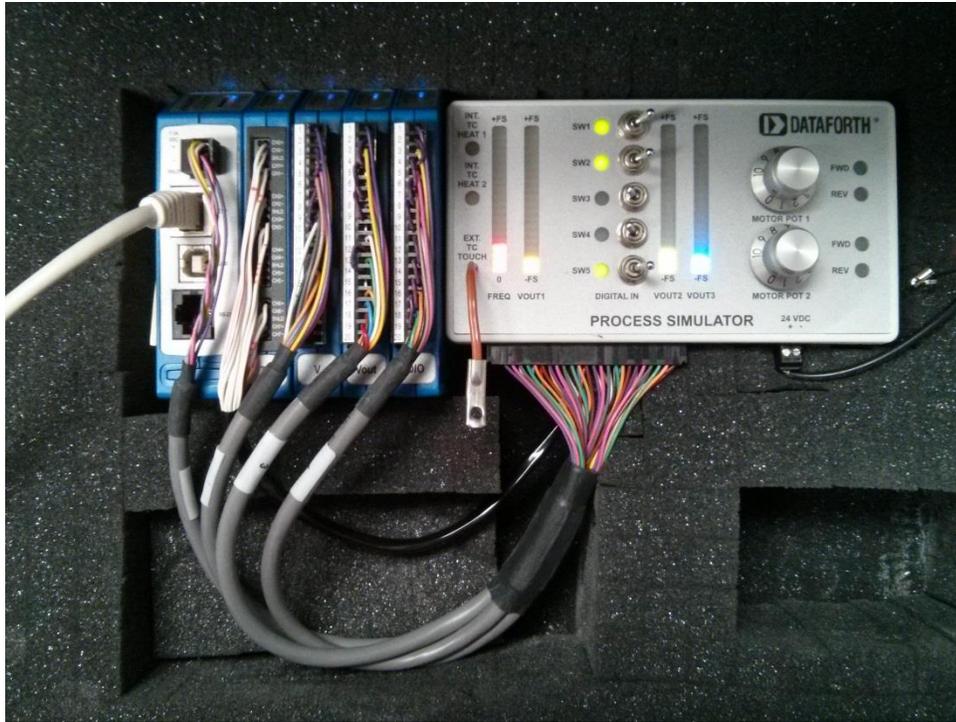


Figure 4: MAQ20DEMO-B Demonstration System with Process Simulator

The system details can be viewed using the MAQ20 Configuration Software Tool or ReDAQ Shape Software for MAQ20 available from the Dataforth website, [www.dataforth.com/maq20\\_download.aspx](http://www.dataforth.com/maq20_download.aspx).

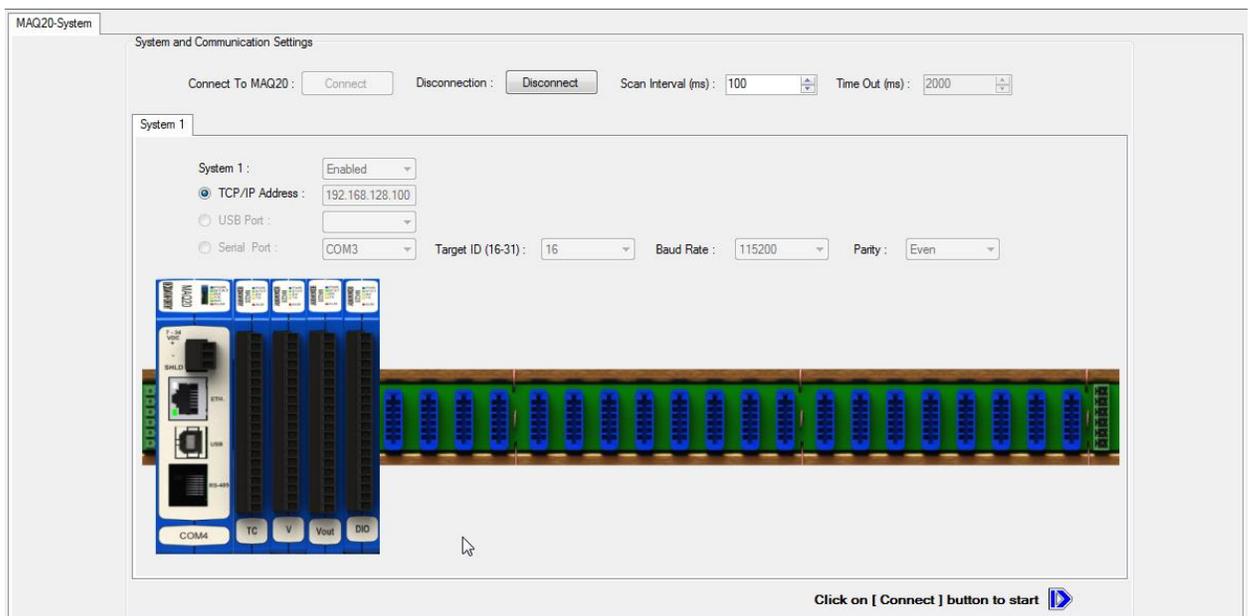


Figure 5: ReDAQ Shape System Display

For optimal VI operation, arrange the I/O modules in the system as follows using the MAQ20 Configuration Software Tool or ReDAQ Shape Software for MAQ20.

Slot 0	MAQ20-COM4	Start Address 0000
Slot 1	MAQ20-JTC	Start Address 2000
Slot 2	MAQ20-VDN	Start Address 4000
Slot 3	MAQ20-VO	Start Address 6000
Slot 4	MAQ20-DIOL	Start Address 8000

When using ReDAQ Shape Software for MAQ20, click on the communications module graphic to view system configuration. Highlight a module and use the Up and Down buttons to make the Slot Number match the physical position on the backbone.

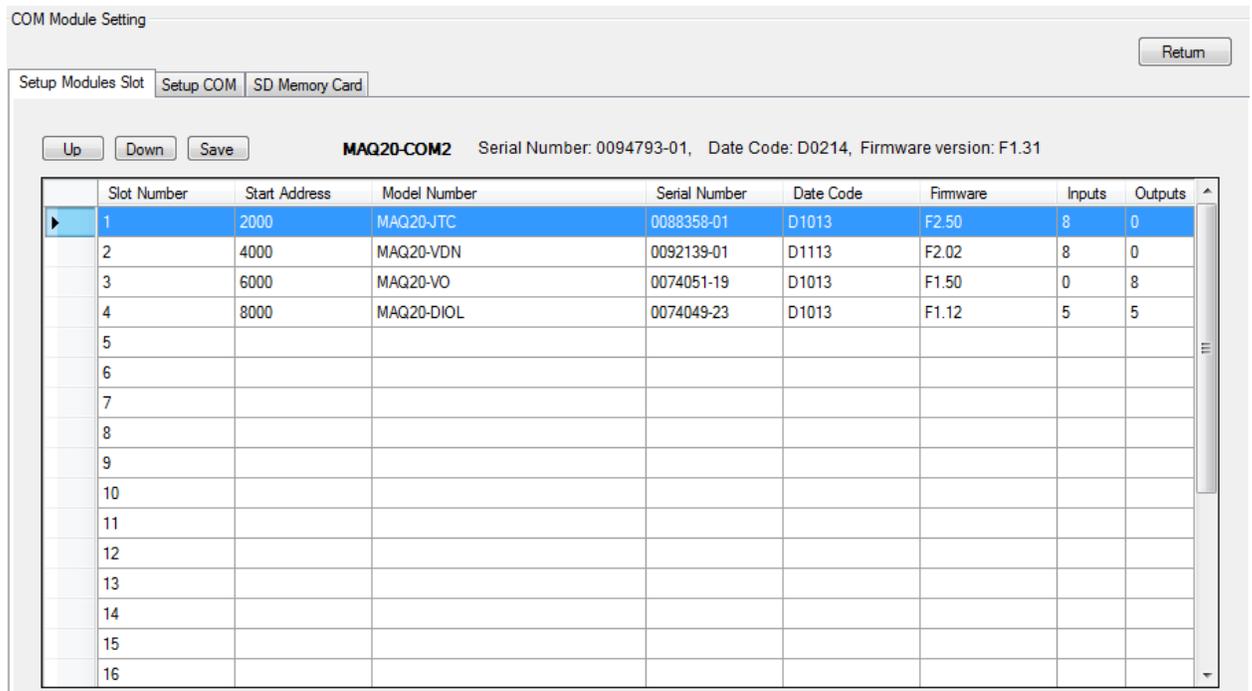


Figure 6: ReDAQ Shape Display of Modules by Slot Number

**Modbus Function Codes**

The MAQ20 Data Acquisition System supports the following Modbus function codes (commands):

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

### **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.

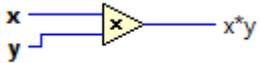
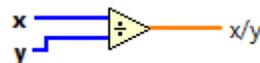
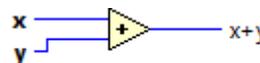
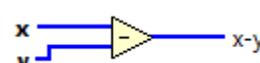
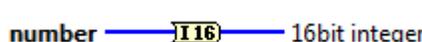
Modbus addresses are 0-based, meaning the first address is 0x0000 (0) and the last is 0xFFFF (65535). Address values map directly to address fields of all Modbus commands. Although only a small percentage of available Modbus addresses are mapped to data and/or control functions, the system allows access 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.

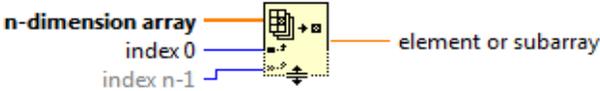
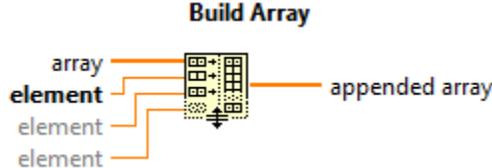
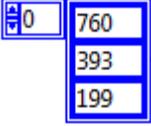
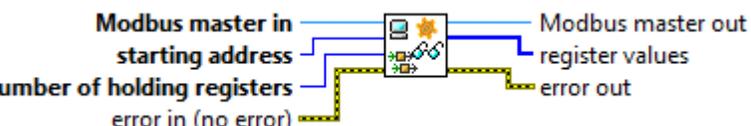
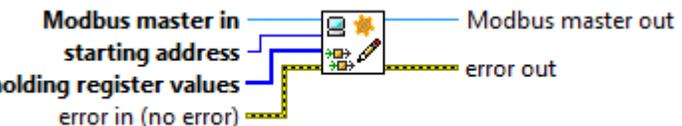
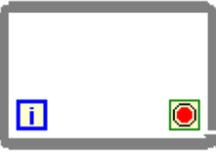
### **Modbus Exceptions**

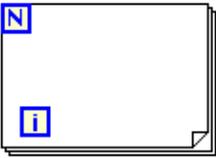
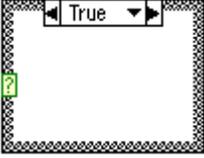
The system will return the following Modbus exception codes under the given conditions:

- 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 MAQ20 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.

## 6.0 LabVIEW Tools use in the VI Development

Controls	
Numeric Unsigned 16-bit	
String	
Double Precision	
Stop	
Indicators	
Numeric Unsigned 16-bit Array	
String	
Functions	
Wait	
Multiply	
Divide	
Add	
Subtract	
To Unsigned Byte Integer	
Byte Array to String	
To Word Integer	

Functions	
Index Array	 <p>The diagram shows the Index Array function with three inputs: 'n-dimension array' (orange), 'index 0' (blue), and 'index n-1' (blue). A single orange output line is labeled 'element or subarray'.</p>
Build Array	 <p>The diagram shows the Build Array function with four inputs: 'array' (orange), 'element' (orange), 'element' (orange), and 'element' (orange). A single orange output line is labeled 'appended array'.</p>
Constants	
Numeric Unsigned 16-bit Integer	 <p>A constant value of 1200 is shown in a blue-bordered box.</p>
Numeric Array	 <p>A constant array is shown in a blue-bordered box, containing the values 0, 760, 393, and 199 arranged in a 2x2 grid.</p>
Double Precision	 <p>A constant value of 4095 is shown in an orange-bordered box.</p>
VIs	
New TCP Master	 <p>The diagram shows the New TCP Master VI with three inputs: 'address' (magenta), 'port (502)' (blue), and 'error in (no error)' (yellow). It has two outputs: 'TCP master instance' (blue) and 'error out' (yellow).</p>
Read Holding Registers	 <p>The diagram shows the Read Holding Registers VI with four inputs: 'Modbus master in' (blue), 'starting address' (blue), 'number of holding registers' (blue), and 'error in (no error)' (yellow). It has two outputs: 'Modbus master out register values' (blue) and 'error out' (yellow).</p>
Write Multiple Holding Registers	 <p>The diagram shows the Write Multiple Holding Registers VI with four inputs: 'Modbus master in' (blue), 'starting address' (blue), 'holding register values' (blue), and 'error in (no error)' (yellow). It has two outputs: 'Modbus master out' (blue) and 'error out' (yellow).</p>
Close Modbus Master	 <p>The diagram shows the Close Modbus Master VI with two inputs: 'Modbus master in' (blue) and 'error in (no error)' (yellow). It has one output: 'error out' (yellow).</p>
Structures	
While Loop	 <p>The diagram shows a While Loop structure with a blue 'i' icon in the bottom-left corner and a red stop button in the bottom-right corner.</p>

Structures	
For Loop	 <p>The icon for the For Loop structure, showing a square with a blue 'N' in the top-left corner and a blue 'I' in the bottom-left corner, representing the number of iterations and the iteration index, respectively.</p>
Case Structure	 <p>The icon for the Case Structure, showing a square with a dotted border, a green '2' in the bottom-left corner, and a 'True' label with a dropdown arrow at the top.</p>

## 7.0 MAQ20 Communications Module Interface

One Read Holding Registers VI is used to read the module Model #, and a second is used to read the registers containing the data for the Real Time Clock. Slot # is multiplied by 2000 to generate the address offset.

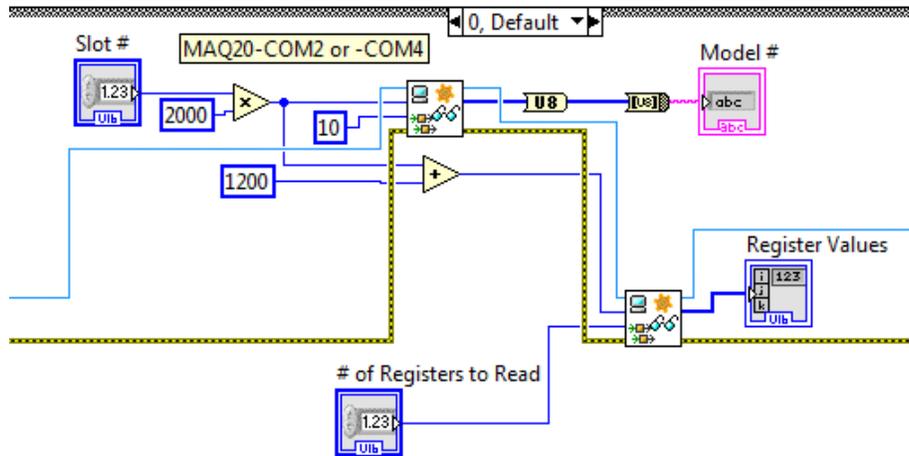


Figure 7: MAQ20-COM2 or -COM4 Basic VI Structure

To determine the address to read from, use the Address Map for the MAQ20-COM2 and MAQ20-COM4 modules found in the appendix of MA1040 MAQ20 Communications Module Hardware User Manual. An excerpt from the Address Map is shown below. Real Time Clock data is stored starting at address 1200.

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

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

The MAQ20-COM4 module in the demonstration system has a registration number of 0 and an address offset of  $2000 * 0 = 0$ .

The addresses to read from are 0 (address offset) + 1200 (RTC seconds) = 1200, through 0 (address offset) + 1206 (RTC year) = 1206.

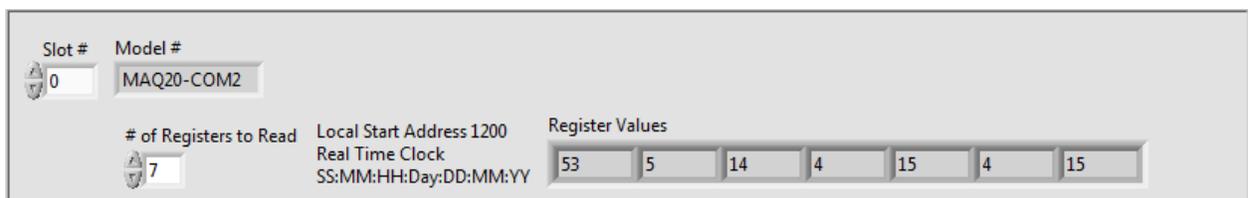


Figure 8: MAQ20-COM2 or -COM4 VI User Interface

## 8.0 MAQ20 Thermocouple Input Module Interface

One Read Holding Registers VI is used to read the module Model #, and a second is used to read the registers containing the data from the input channels. Slot # is multiplied by 2000 to generate the address offset.

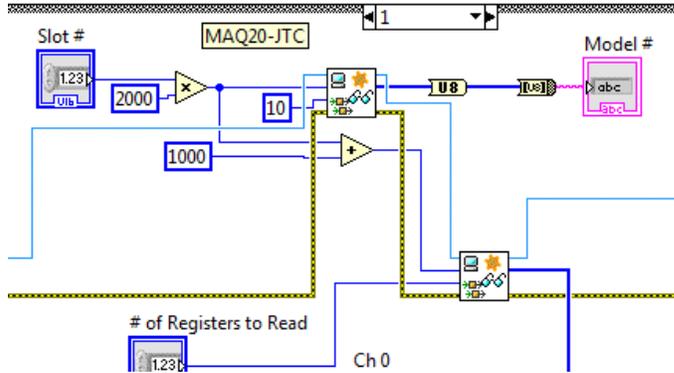


Figure 9: MAQ20-JTC Basic VI Structure

To determine the address to read from, use the Address Map for the MAQ20-xTC Types J, K, T, R and S Thermocouple Input Modules found in the appendix of MA1047 MAQ20 TC Input Module Hardware User Manual. An excerpt from the Address Map is shown below. Channel Data is stored starting at address 1000.

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

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

The MAQ20-JTC module in the demonstration system has a registration number of 1 and an address offset of  $2000 * 1 = 2000$ .

The addresses to read from are 2000 (address offset) + 1000 (MAQ20-JTC Ch 0) = 3000 through 2000 (address offset) + 1007 (MAQ20-JTC Ch 7) = 3007.

MAQ20 input module input ranges can be configured on a per-channel basis. These can be set or checked using the MAQ20 Configuration Software Tool or ReDAQ Shape Software for MAQ20 to obtain the optimum range and resolution for given measurements. The following screen shot is from the ReDAQ Shape for MAQ20 software.

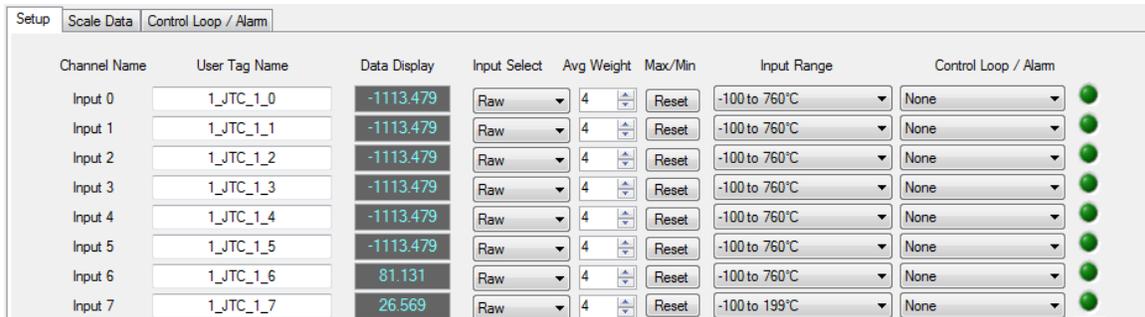


Figure 10: ReDAQ Shape Interface to MAQ20-JTC

Data stored in the MAQ20 registers is in counts. To convert this to engineering units, use the count mapping tables in the appendix of the specific MAQ20 Hardware User Manual.

Table 1: MAQ20-JTC Range Assignment

JTC	Range	Standard Input Temperature	Equivalent Counts	Over/Under Range	Equivalent Counts	Deg C per Count
JTC	0	-100°C to +760°C (Default)	-539 to 4095	-102°C to +775°C	-550 to 4177	0.1855
	1	-100°C to +393°C	-1078 to 4236	-102°C to +401°C	-1100 to 4321	0.0928
	2	-100°C to +199°C	-2156 to 4290	-102°C to +203°C	-2199 to 4376	0.0464

The VI does not have the ability to configure the input ranges, but this could be added to the VI by adding a Write Multiple Holding Registers VI and writing to the appropriate registers.

To display the data read from the module in engineering units, the user must select the input range for each channel to match the actual module configuration. Count mapping for the MAQ20-JTC module has been built into the VI. Range and count mapping are applied to the measured data and then the resulting measured temperature is displayed.

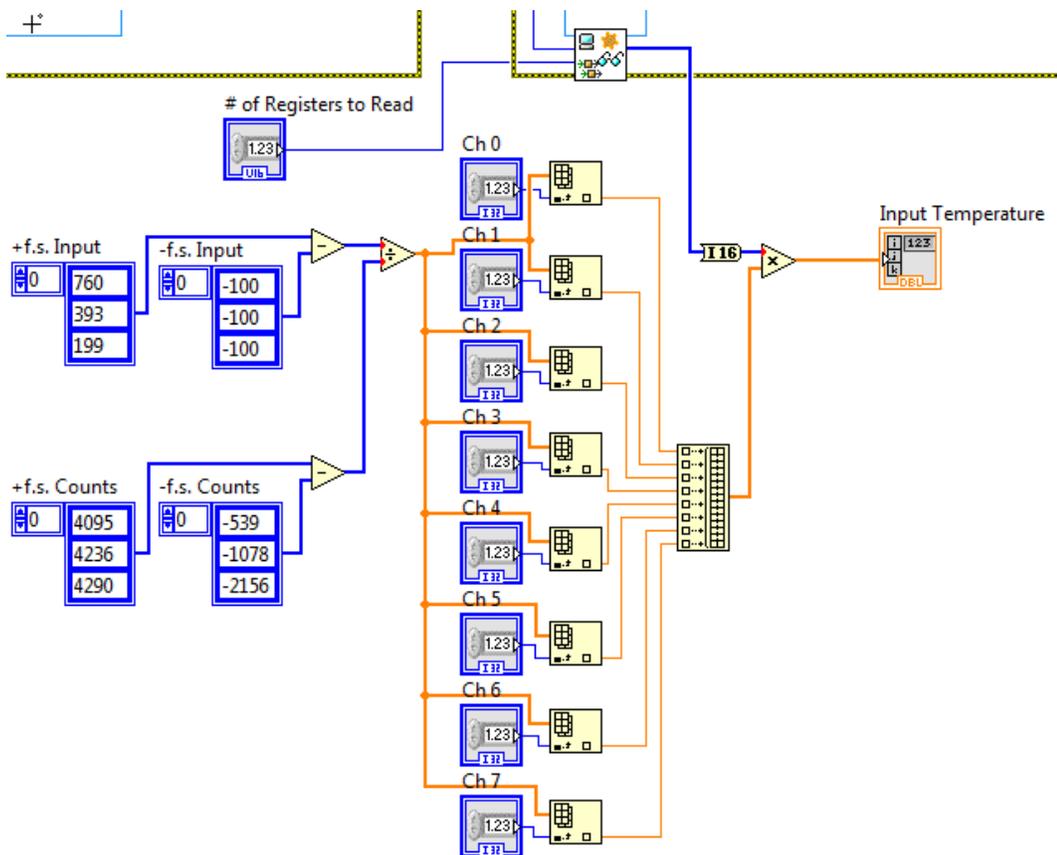


Figure 11: Converting MAQ20-JTC Data to Engineering Units

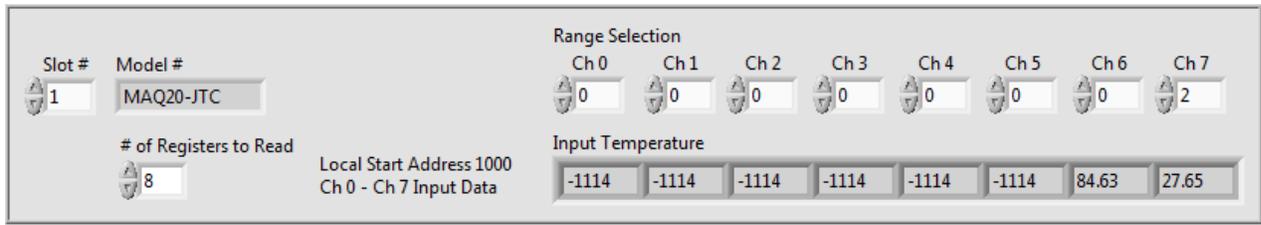


Figure 12: MAQ20-JTC VI User Interface

## 9.0 MAQ20 Millivolt, Voltage & Current Input Module Interface

One Read Holding Registers VI is used to read the module Model #, and a second is used to read the registers containing the data from the input channels. Slot # is multiplied by 2000 to generate the address offset.

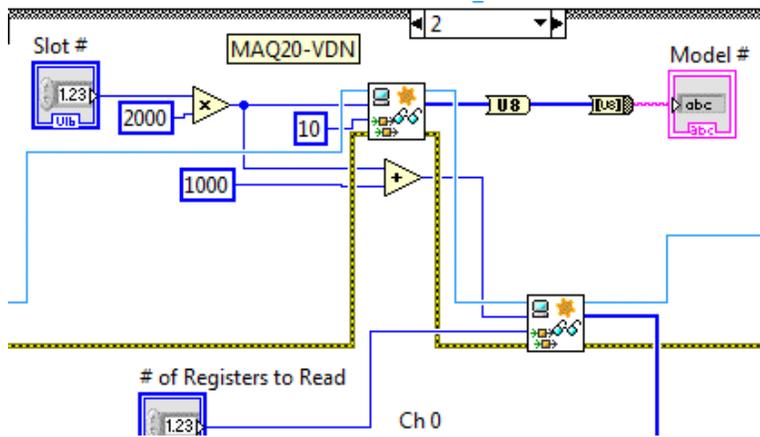


Figure 13: MAQ20-VDN Basic VI Structure

To determine the address to read from, use the Address Map for the MAQ20-MVDN, -VDN, -VSN, -IDN or -ISN Input Modules found in the appendix of MA1041 MAQ20 mV-V-mA Input Module Hardware User Manual. An excerpt from the MAQ20-VDN Address Map is shown below. Channel Data is stored starting at address 1000.

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

Address Range 1000 - 1699 : Module Data						
Start Address	Read/Write	Number of Registers	Contents	Description	Data Range	Data type
1000	R	16	Channel Data	Data for all 8 Channels	-4096 to 4095	INT16

The MAQ20-VDN module in the demonstration system has a registration number of 2 and an address offset of  $2000 * 2 = 4000$ .

The addresses to read from are 4000 (address offset) + 1000 (MAQ20-VDN Ch 0) = 5000 through 4000 (address offset) + 1005 (MAQ20-VDN Ch 5) = 5005.

MAQ20 input module input ranges can be configured on a per-channel basis. These can be set or checked using the MAQ20 Configuration Software Tool or ReDAQ Shape Software for MAQ20 to obtain the optimum range and resolution for given measurements. The following screen shot is from the ReDAQ Shape for MAQ20 software.

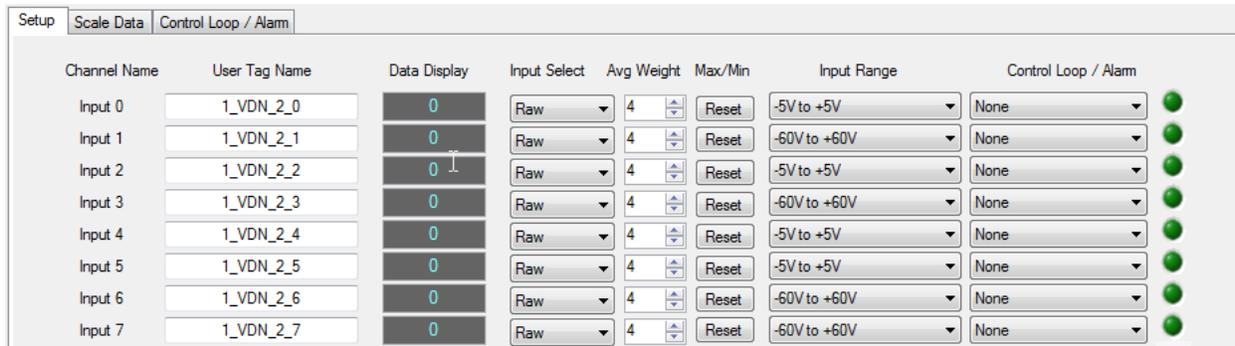


Figure 14: ReDAQ Shape Interface to MAQ20-VDN

Data stored in the MAQ20 registers is in counts. To convert this to engineering units, use the count mapping tables in the appendix of the specific MAQ20 Hardware User Manual.

Table 2: MAQ20-VDN Range Assignment

	Range	Standard Input Voltage	Equivalent Counts	Over/Under Range	Equivalent Counts	Volts per Count
<b>MAQ20-VDN</b>	0	-60V to +60V	-4016 to 4016	-61.2V to +61.2V	-4096 to 4095	0.01494
	1	-40V to +40V	-4016 to 4016	-40.8V to +40.8V	-4096 to 4095	0.009961
	2	-20V to +20V	-4016 to 4016	-20.4V to +20.4V	-4096 to 4095	0.004980
	3	-10V to +10V	-4016 to 4016	-10.2V to +10.2V	-4096 to 4095	0.002490
	4	-5V to +5V (Default)	-4016 to 4016	-5.1V to +5.1V	-4096 to 4095	0.001245

The VI does not have the ability to configure the input ranges, but this could be added to the VI by adding a Write Multiple Holding Registers VI and writing to the appropriate registers.

To display the data read from the module in engineering units, the user must select the input range for each channel to match the actual module configuration. Count mapping for the MAQ20-VDN module has been built into the VI. Range and count mapping are applied to the measured data and then the resulting measured voltage is displayed.

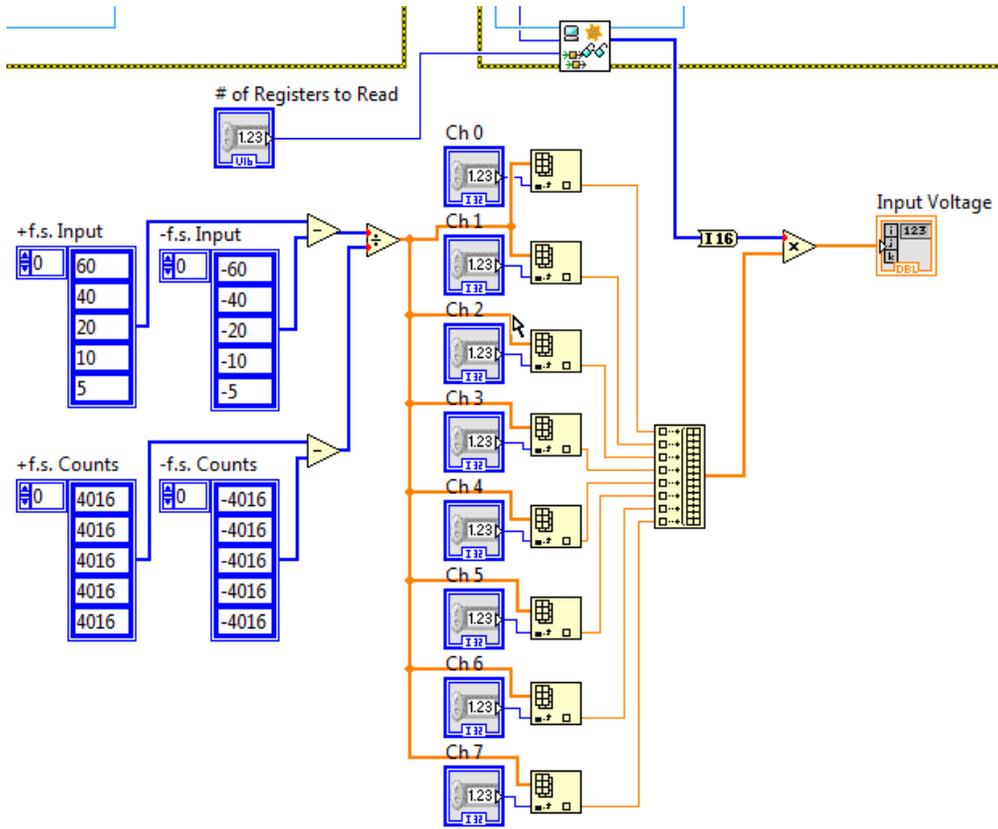


Figure 15: Converting MAQ20-VDN Data to Engineering Units

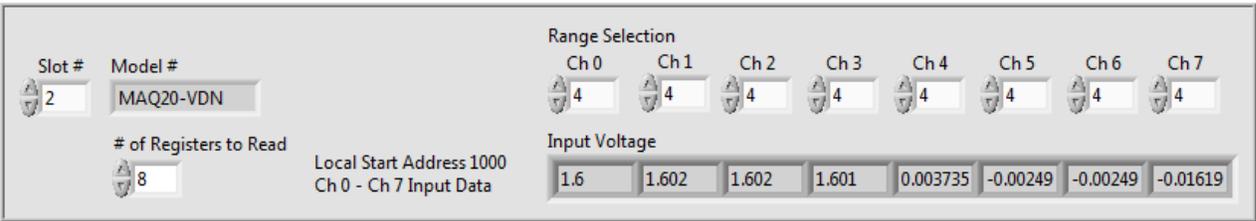


Figure 16: MAQ20-VDN VI User Interface

## 10.0 MAQ20 Voltage & Current Output Module Interface

A Read Holding Registers VI is used to read the module Model #. Slot # is multiplied by 2000 to generate the address offset.

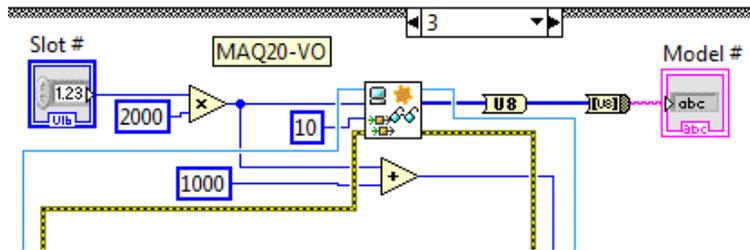


Figure 17: MAQ20-VO Basic VI Structure

To determine the address to write to, use the Address Map for the MAQ20-VO or -IO Output Modules found in the appendix of MA1042 MAQ20 Voltage & Current Output Module Hardware User Manual. An excerpt from the MAQ20-VO Address Map is shown below. Channel Data is stored starting at address 1000.

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

Address Range 1000 - 1699 : Module Data						
Start Address	R/W	Number of Registers	Contents	Description	Data Range	Data type
1000	R/W	8	Channel Data	Data for each of 8 channels Default = 2048	See Table	INT16

The addresses to write to are  $6000$  (address offset) +  $1000$  (MAQ20-VO Ch 0) =  $7000$  through  $6000$  (address offset) +  $1007$  (MAQ20-VO Ch 7) =  $7007$ .

MAQ20 output module output ranges can be configured on a per-channel basis. These can be set or checked using the MAQ20 Configuration Software Tool or ReDAQ Shape Software for MAQ20 to obtain the optimum range and resolution for given control signals. The following screen shot is from the ReDAQ Shape for MAQ20 software.

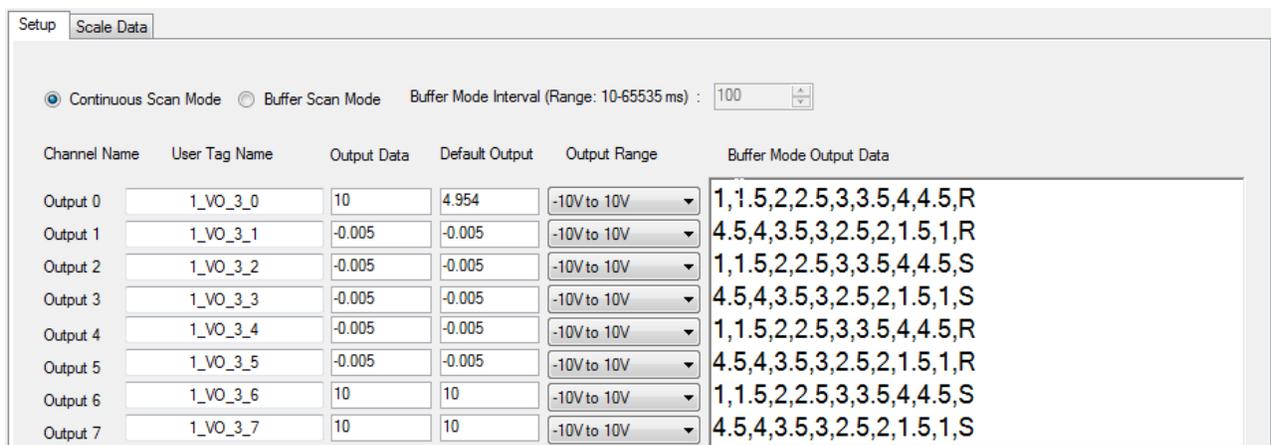


Figure 18: ReDAQ Shape Interface to MAQ20-VO

Data stored in the MAQ20 registers is in counts. To convert this to engineering units, use the count mapping tables in the appendix of the specific MAQ20 Hardware User Manual.

Table 3: MAQ20-VO Range Assignment

Range	Standard Output Voltage	Equivalent Counts	Over/Under Range	Equivalent Counts	Volts per Count
0	-10V to +10V (Default)	98 to 3998	-10.5V to +10.5V	0 to 4095	0.005128
1	-5V to +5V	1073 to 3023	-5.25V to +5.25V	1024 to 3072	0.005128
2	-2.5V to +2.5V	1561 to 2536	-2.625V to +2.625V	1536 to 2560	0.005128
3	0 to +10V	2048 to 3998	0 to +10.5V	2048 to 4095	0.005128
4	0 to +5V	2048 to 3023	0 to +5.25V	2048 to 3072	0.005128
5	0 to +2.5V	2048 to 2536	0 to +2.625V	2048 to 2560	0.005128

The VI does not have the ability to configure the output ranges, but this could be added to the VI by adding a Write Multiple Holding Registers VI and writing to the appropriate registers.

To enter data to be written to the module in engineering units, count mapping for the MAQ20-VO module has been built into the VI. Range and count mapping are applied to the data to be written and then the resulting signal representation in counts is sent to the module.

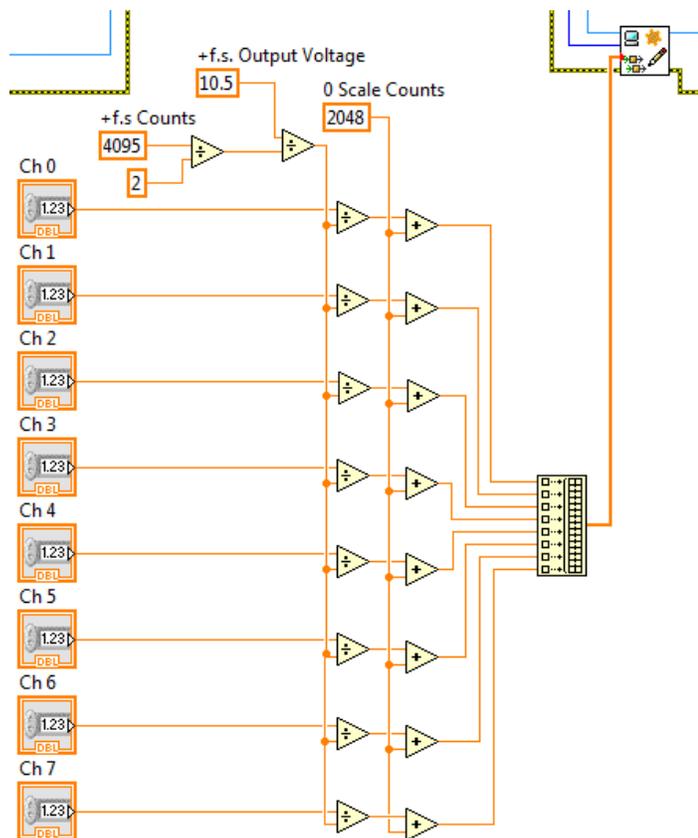


Figure 19: Entering MAQ20-VO Data in Engineering Units

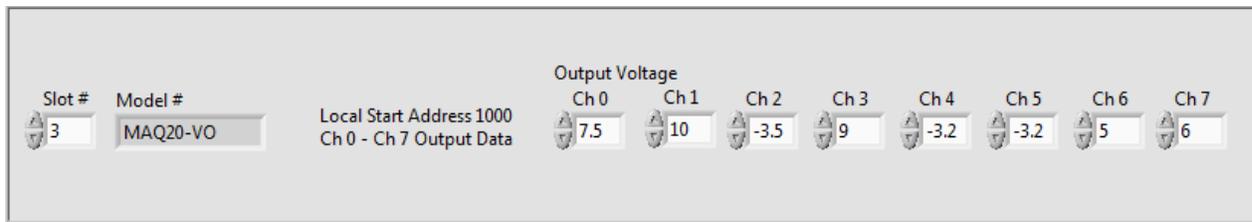


Figure 20: MAQ20-VO VI User Interface

## 11.0 MAQ20 Discrete Input & Output Module Interface

A Read Holding Registers VI is used to read the module Model #. Slot # is multiplied by 2000 to generate the address offset.

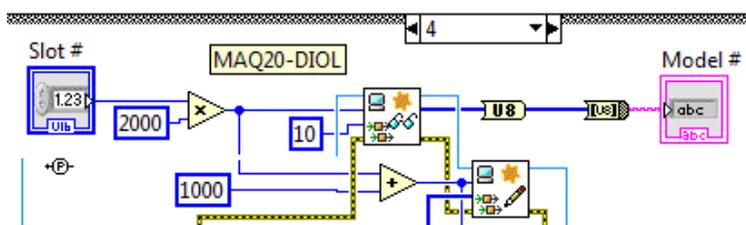


Figure 21: MAQ20-DIOL Basic VI Structure

To determine the addresses to read from and write to, use the Address Map for the MAQ20-DIOL Discrete I/O Module found in the appendix of MA1043 MAQ20-DIOL Discrete IO Module Hardware User Manual. An excerpt from the MAQ20-DIOL 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 and Special Function Selection						
Start Address	Read/Write	Number of Registers	Contents	Description	Data Range	Data type
1000	R/W	10	DIO States, Binary Representation, Inverted Logic  Addr 1000 = LSB Addr 1009 =MSB	Example: Starting at address 1009 and decreasing to address 1000, MSB to LSB DI4 to DI0 and DO4 to DO0 = 1011011000. Data written to an input channel will be ignored. Data written to an output channel committed to a Special Function returns an error. Default = 1 for all channels.	DO0 – DO4 Inverted Logic 0 = switch closed 1 = switch open  DI0 – DI4 Inverted Logic 0 = input > threshold 1 = input < threshold	INT16

The MAQ20-DIOL module in the demonstration system has a registration number of 4 and an address offset of  $2000 * 4 = 8000$ .

The addresses to write to are:

8000 (address offset) + 1000 (MAQ20-DIOL Ch DO0) = 9000  
 through  
 8000 (address offset) + 1004 (MAQ20-DIOL Ch DO4) = 9004

and the addresses to read from are:

8000 (address offset) + 1005 (MAQ20-DIOL Ch DI0) = 9005  
 through  
 8000 (address offset) + 1009 (MAQ20-DIOL Ch DI3) = 9009

Although the data is Boolean, the MAQ20 stores it as INT16 and uses holding register R/W operations for access.

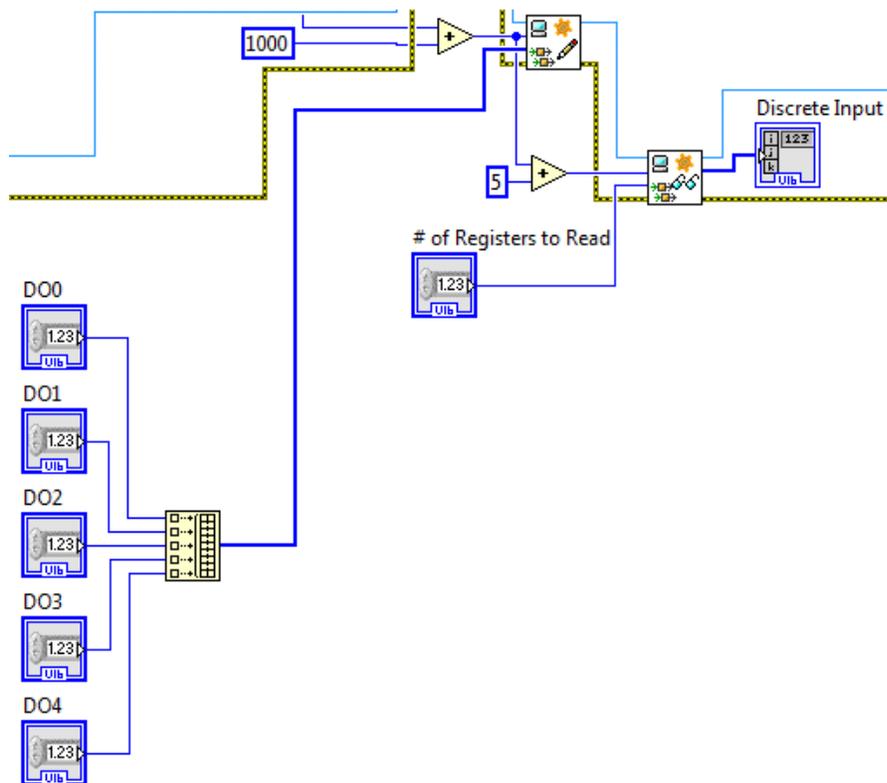


Figure 22: Reading and Writing Discrete I/O Data From and To MAQ20-DIOL

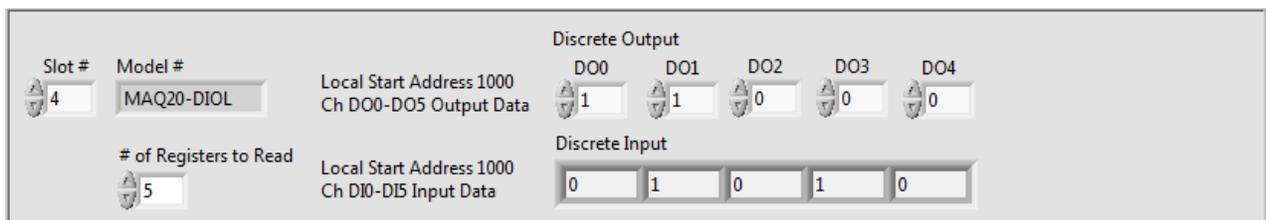


Figure 23: MAQ20-DIOL VI User Interface

## 12.0 Reading and Writing Data with the MAQ20 LabVIEW VI

The complete VI allows read/write operations to MAQ20 modules in up to 5 slots, or a MAQ20 data acquisition system comprised of one Communications Module and 4 I/O Modules.

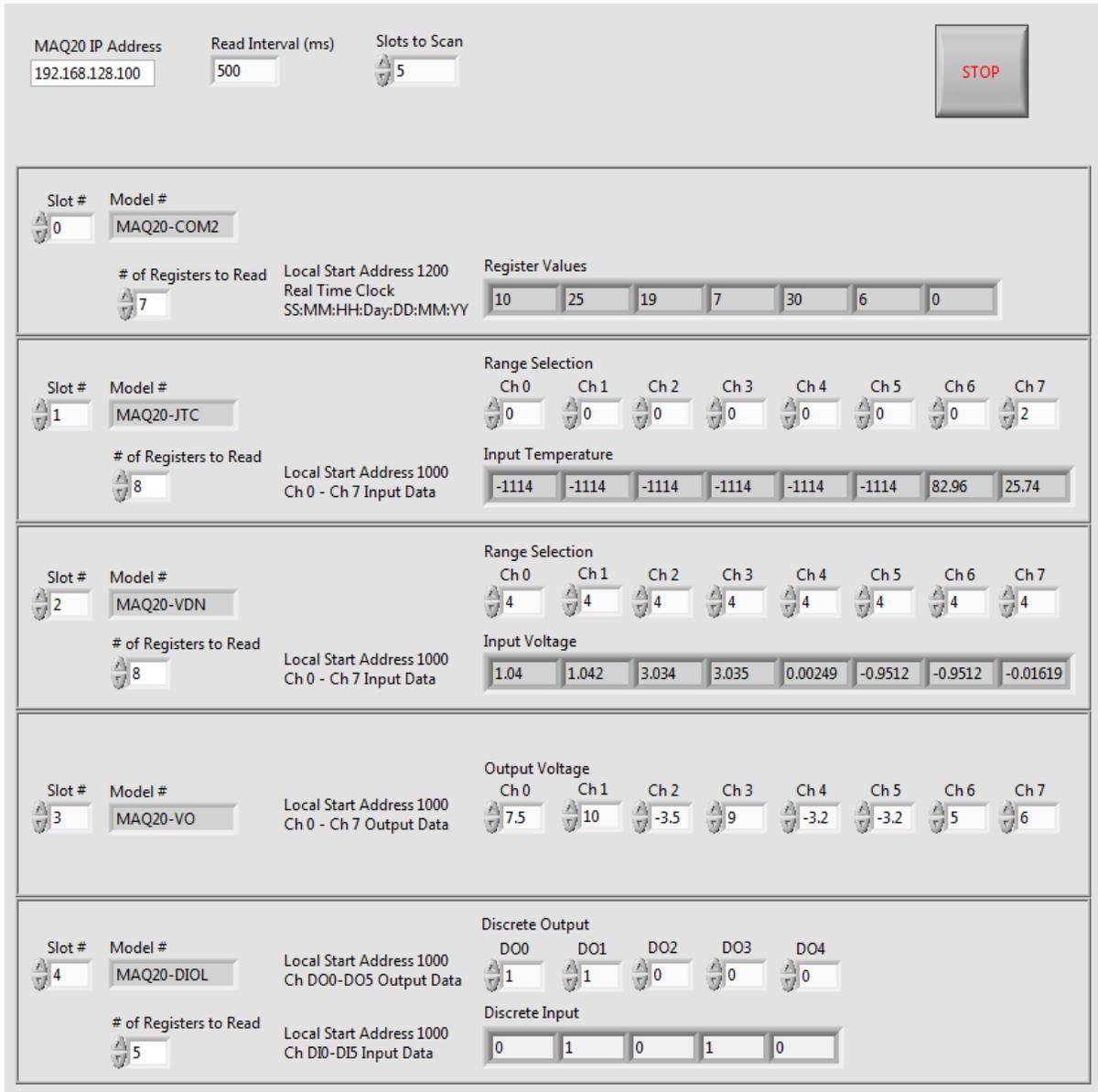


Figure 24: MAQ20 VI User Interface

The number of read interval, number of slots to scan, slot displayed, and the number of registers to read are all selectable by the user. This VI has a user interface optimized for the following system configuration:

- Slot 0 MAQ20-COM4
- Slot 1 MAQ20-JTC
- Slot 2 MAQ20-VDN
- Slot 3 MAQ20-VO
- Slot 4 MAQ20-DIOL

It will interface to other modules placed in these slots.

The interface to each type of MAQ20 module has been built into a Case Structure, and this is embedded in a For Loop, so each module is scanned sequentially and continuously.

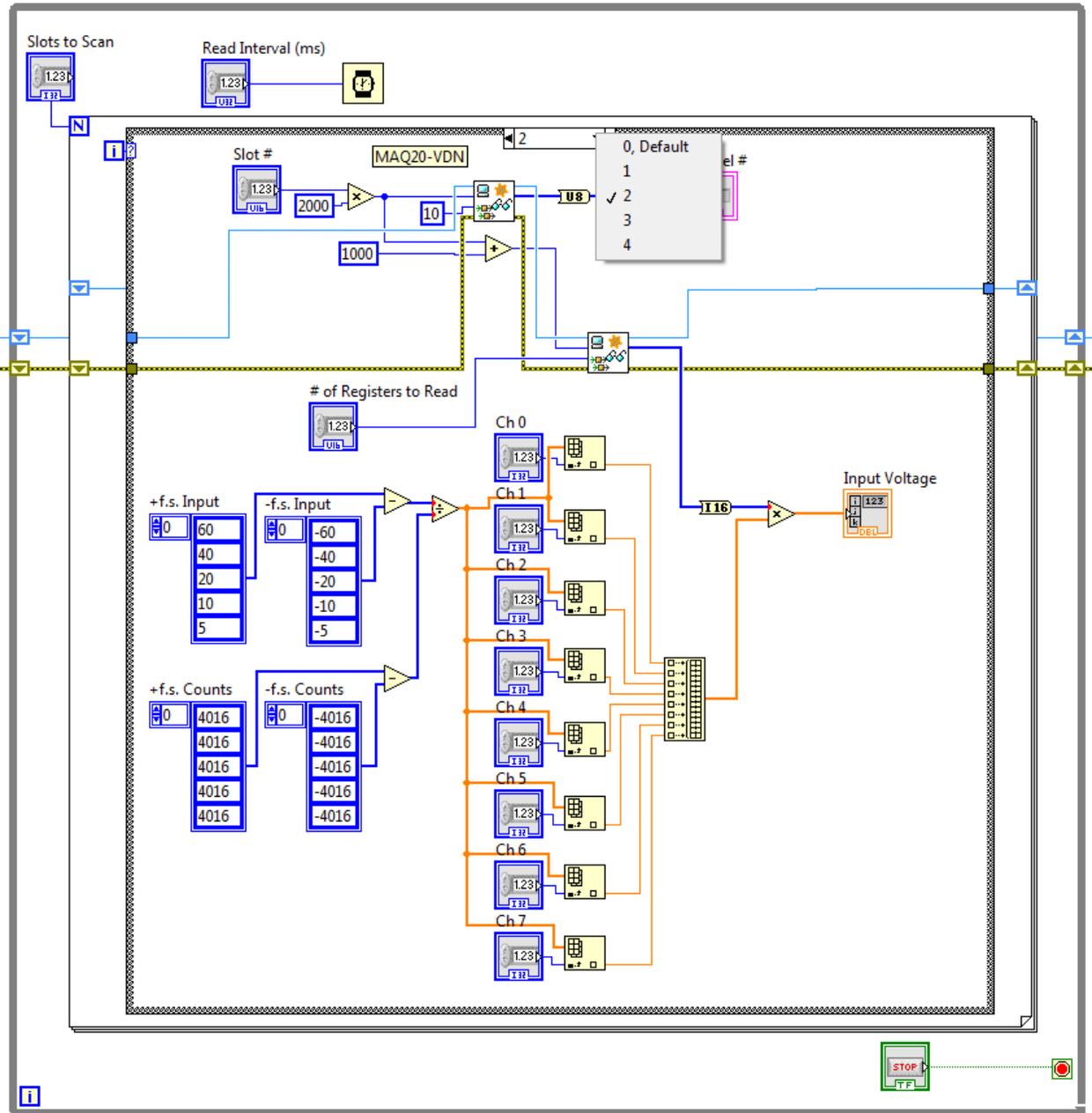


Figure 25: MAQ20 Basic VI Structure

### 13.0 Operating the MAQ20 Process Simulator with the MAQ20 LabVIEW VI

The I/O channels presented in this manual are interrelated on the MAQ20DEMO-B Demonstration Suitcase and Process Simulator, so the following exercises can be performed once the system has been configured as outlined in the previous sections.

#### 13.1 Read Ambient Temperature

On the demonstration system, the MAQ20-JTC module Ch 7 measures the thermocouple protruding from the Process Simulator.

Run the VI and observe the ambient temperature read on Channel 7. Touch the thermocouple protruding from the Process Simulator and observe the temperature change.

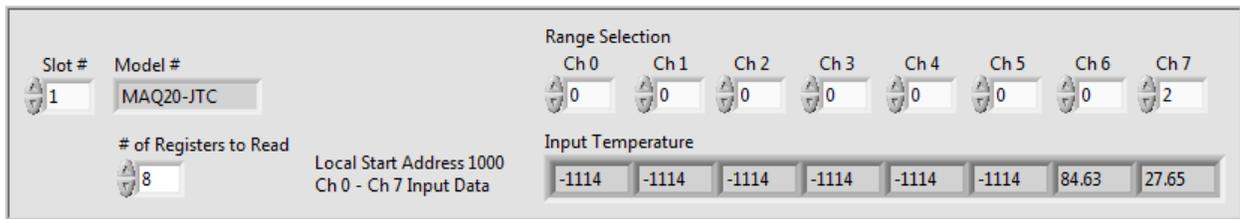


Figure 26: Reading Ambient Temperature using MAQ20-JTC

#### 13.2 Control the VOUT1 LED Bar

On the demonstration system, the orange LED bar display is controlled by MAQ20-VO Ch 0.

Run the VI and enter MAQ20-VO Ch 0 values between -10V and +10V. Observe the voltage change in the VOUT1 LED bar display.

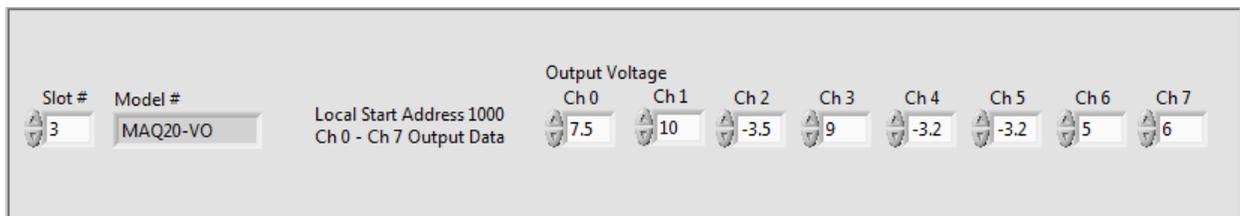


Figure 27: Process Simulator VOUT1 LED Bar Control

#### 13.3 Read VOUT2 LED Bar Control Monitor

On the demonstration system, MAQ20-VDN module Ch 0 measures a 0 to 3V signal for the green LED bar display, labeled VOUT2. The green LED bar display is controlled by Motor Pot 1 when MAQ20-VO Ch 1 is set to -10V and it is controlled by MAQ20-VO Ch 2 when MAQ20-VO Ch 1 is set to +10V.

Run the VI and set MAQ20-VO Ch 1 to -10V. Rotate Motor Pot 1 and observe the voltage change on MAQ20-VDN Ch 0 and the change in the green LED bar display.

Set MAQ20-VO Ch 1 to +10V. Enter MAQ20-VO Ch 2 values between -10V and +10V and observe the voltage change on MAQ20-VDN Ch 0 and the change in the VOUT2 LED bar display.

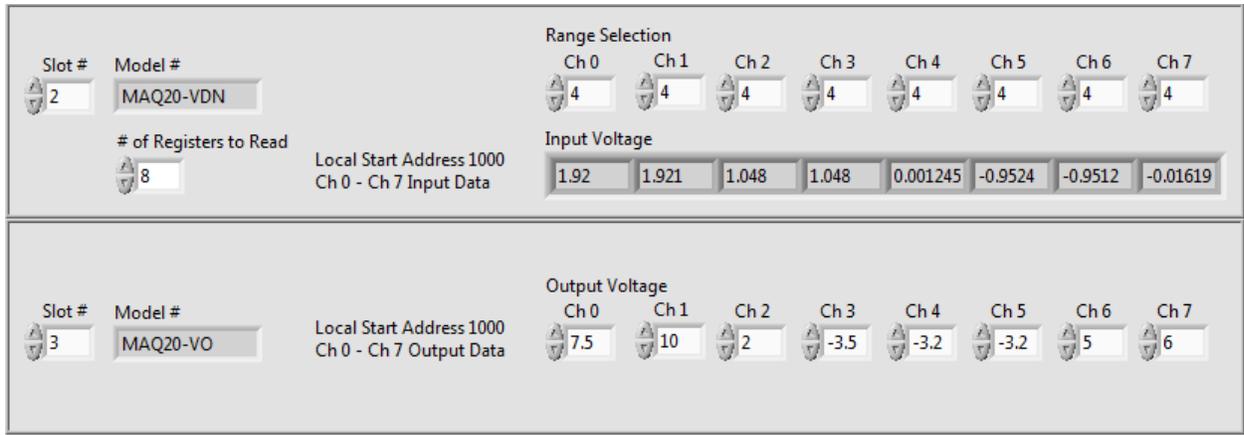


Figure 28: Process Simulator VOUT2 LED Bar Control and Monitor

### 13.4 Control TC Heat 1 and TC Heat 2

On the demonstration system, the MAQ20-JTC module Ch 6 measures the signal from a simulated heated thermocouple. TC Heat 1 control is driven by MAQ20-VO Ch 4 and TC Heat 2 control is driven by MAQ20-VO Ch 5. MAQ20-VDN module Ch 5 measure the 0 to +3V TC Heat 1 control signal and MAQ20-VDN module Ch 6 measure the 0 to +3V TC Heat 2 control signal.

Run the VI and set MAQ20-VO Ch 4 and Ch 5 to values between 0V and +10V. The intensity of the TC Heat indicators represent the magnitude of the heater control voltages. Observe the simulated temperature change on MAQ20-JTC Ch 6 and observe the heat control voltages on MAQ20-VDN Ch 5 and Ch 6.

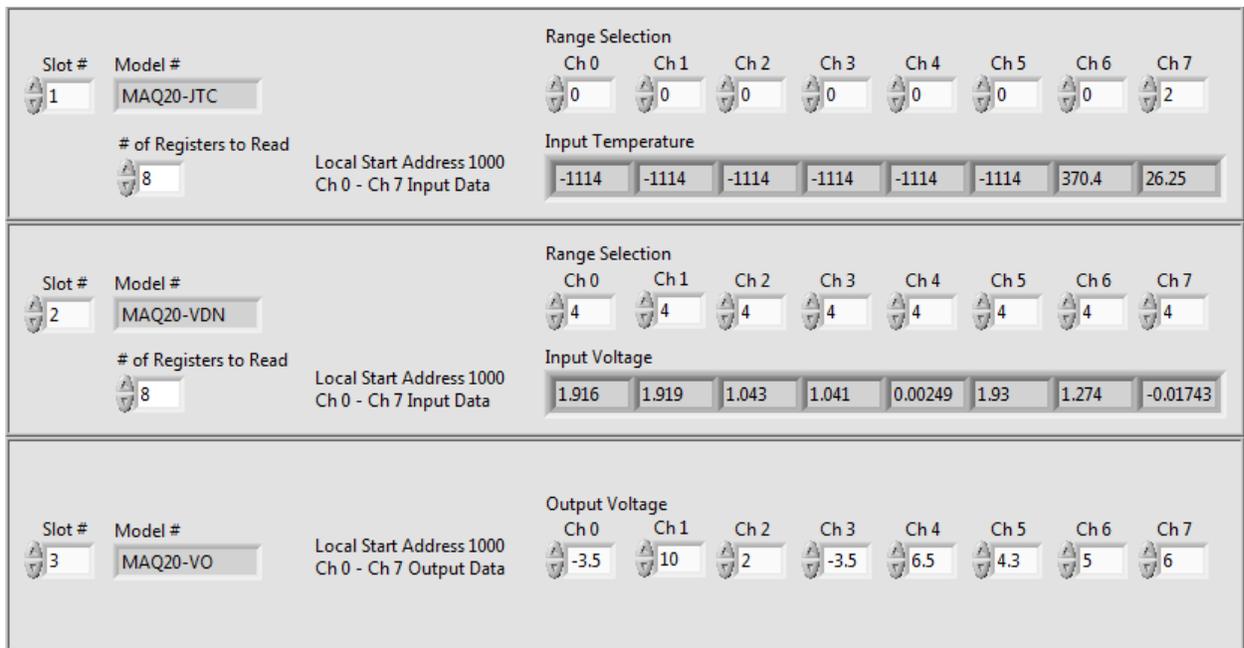


Figure 29: Process Simulator Heated TC Control and Monitor

### 13.5 Read Bat Toggle Switch Position

On the demonstration system, MAQ20-DIOL module input channels DI0 through DI4 are connected to bat toggle switches SW1 through SW5 respectively. The discrete input channels read logic 1 for the bat toggle switch in the left position and the LED off and logic 0 for the bat toggle switch in the right position and the LED on.

Run the VI. Operate switches SW1 – SW5 on the Process Simulator and observe the state change on Discrete Input Ch 0 – Ch 4.

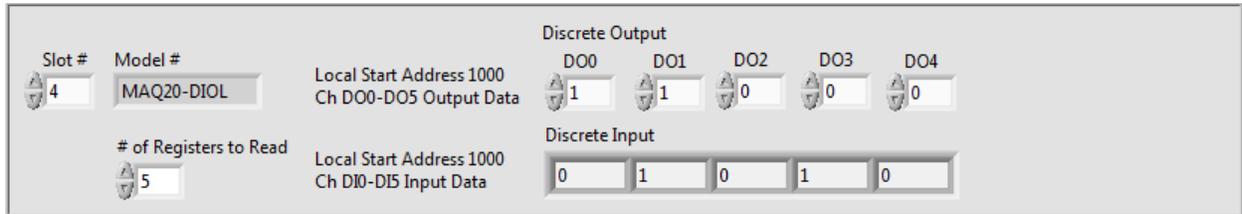


Figure 30: Process Simulator Bat Toggle Monitor

### 13.6 Control Motor Pot 1 and Motor Pot 2

On the demonstration system, MAQ20-DIOL module output channels DO1 and DO2 are connected to Motor Pot 1 FWD and REV controls respectively and output channels DO3 and DO4 are connected to Motor Pot 2 FWD and REV controls respectively. MAQ20-VDN module Ch 0 measures a 0 to 3V signal for the green LED bar display, labeled VOUT2 and MAQ20-VDN module Ch 2 measures a 0 to 3V signal for the blue LED bar display, labeled VOUT3. The green LED bar display is controlled by Motor Pot 1 when MAQ20-VO Ch 1 is set to -10V and the blue LED bar display is controlled by Motor Pot 2 when MAQ20-VO Ch 1 is set to -10V.

Run the VI and set MAQ20-VO Ch 4 to -10V. Change the value of channel DO1 to turn on or off forward motion (clockwise) or the value of channel DO2 to turn on or off reverse motion (counter-clockwise) for Motor Pot 1. Observe the voltage change on MAQ20-VDN Ch 0 and the change in the green LED bar display.

Change the value of channel DO3 to turn on or off forward motion (clockwise) or the value of channel DO4 to turn on or off reverse motion (counter-clockwise) for Motor Pot 2. Observe the voltage change on MAQ20-VDN Ch 2 and the change in the blue LED bar display.

The Motor Pot controls have the following truth-table:

Channel DO1	Channel DO2	Motor Pot Rotation
0	0	None
1	0	CW
0	1	CCW
1	1	None

Channel DO3	Channel DO4	Motor Pot Rotation
0	0	None
1	0	CW
0	1	CCW
1	1	None

## 14.0 LabVIEW VI File

The VI was created in LabVIEW 2014 and does not require any special toolkits to run. It is titled *MAQ20 IO Module Interface TCP Example.vi*, and is available for download from the Software Download Center at [www.dataforth.com/maq20\\_download.aspx](http://www.dataforth.com/maq20_download.aspx)

## 15.0 References

[Dataforth MAQ20 Software Download Center](#)

[MAQ20 Configuration Software Tool](#)

[ReDAQ Shape Software for MAQ20](#)

[MAQ20 Hardware and Software User Manuals](#)

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[www.ni.com/getting-started/labview-basics/](http://www.ni.com/getting-started/labview-basics/)

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

## Application Support

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

## Returns/Repair Policy

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

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

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

**Dataforth Corporation**  
**3331 E. Hemisphere Loop**  
**Tucson, AZ 85706 USA**

An RMA Request Form and instructions for processing are also found at [www.dataforth.com](http://www.dataforth.com).

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