



D7000 SERIES USERS MANUAL



Version 1.0.0.1

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WARRANTY

DGH warrants each D7000 series module to be free from defects in materials and workmanship under normal conditions of use and service and will replace any component found to be defective, on its return to DGH, transportation charges prepaid within one year of its original purchase. DGH assumes no liability, expressed or implied, beyond its obligation to replace any component involved. Such warranty is in lieu of all other warranties expressed or implied.

WARNING

The circuits and software contained in D7000 series modules are proprietary. Purchase of these products does not transfer any rights or grant any license to the circuits or software used in these products. Disassembling or decompiling of the software program is explicitly prohibited. Reproduction of the software program by any means is illegal.

As explained later in this document, all setups are performed entirely from the outside of the D7000 module. There is no need to open the module because there are no user-serviceable parts inside. Removing the cover or tampering with, modifying, or repairing by unauthorized personnel will automatically void the warranty. DGH is not responsible for any consequential damages.

RETURNS

When returning products for any reason, contact the factory and request a Return Authorization Number and shipping instructions. Write the Return Authorization Number on the outside of the shipping box. DGH strongly recommends that you insure the product for value prior to shipping. Items should not be returned collect as they will not be accepted.

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1.0 Introduction

The D7000 series modules are a complete family of Ethernet based data acquisition modules. The product family includes multi-channel analog input measurement modules, multiple channel analog output modules, discrete digital input and discrete digital output modules.

The D7000 series modules communicate using several different Ethernet protocols, including the Modbus TCP/IP protocol. This protocol is very popular in the data acquisition and process control industries. Modbus TCP/IP is supported by all commercial data acquisition software programs in the market place. Thus, providing instant connectivity to wide variety of software programs for almost any budget.

Data values can also be read from the modules using the REST (Representational State Transfer) protocol. Devices that support the REST protocol often use the HTTP protocol to transmit read and write data requests, or to delete data. The REST protocol is a lightweight alternative to other protocols and services such as RPC (Remote Procedure Calls) and Web Services (SOAP, WSDL, et al.). Later, we outline how simple the REST protocol really is. Note: The REST is not a "standard".

Model Numbers

The D7000 series consists of three different types of modules: Analog Input modules, an Analog Output module and three discrete digital input/output modules. The analog input modules contain seven differential input channels and can measure DC voltages, 4-20mA current loops and thermocouples. Each input channel is user configurable for a unique input range.

The D7100 module measures seven differential DC voltage signals and offers five different measurement ranges, including +/-25mV, +/-50mV, +/-100mV, +/-1V, +/-5V and +/-10V.

The D7200 module measures seven differential 4-20mA current loops using a +/-20mA input range.

The D7300 module measures seven differential thermocouples and supports eight different thermocouple types, including the J, K, T, E, R, S, B and C types.

The D7400 module can measure seven differential DC voltages, 4-20mA current and thermocouples. The DC voltage ranges and thermocouple types are the same as listed above and the range of each channel is user-selectable.

The D7500 analog output module contains two output channels for generating either a DC voltage or current output. Each analog output channel is user-selectable as either a voltage output or a current output. The analog output signals can be used to control items such as motors, valves, and other control devices. Each analog output channel also contains a programmable communications watchdog timer for instances when communications to the module is lost.

The D7710 digital input module contains fifteen discrete inputs for monitoring switches or contact closures from field devices. The digital inputs contain internal 22K ohm pull-up resistors from each bit on the module connector to +5Vdc. Thus, there is no need for external biasing resistors.

The D7720 digital output module contains fifteen discrete digital outputs that are open-collector outputs that can be connected up to 30Vdc and can sink 100mA per bit. The open-collector allows the modules to be used in a wider variety of control applications. The digital output module also contains a programmable communications watchdog timer that will return the discrete digital outputs to a known safe condition in the event of a communications link failure.

The D7730 digital input / output module contains eight digital outputs and seven digital inputs. The input and output bits contain the same specifications as the D7710 and D7720 described above.

Communications

The D7000 series modules Ethernet I/O modules connect directly to a LAN (local area network) or WAN (wide area network) using an Ethernet RJ45 connection. An Ethernet CAT-5 cable is used to connect each module to a network router or hub. Once the module is connected to the router or hub, apply power to the module.

Network IP Address

The D7000 requires an Ethernet network IP address in order to communicate. The IP address can be specified using either a Static or a DHCP IP address. Static IP addresses are unique network address values assigned by the user. Care must be taken to ensure that each Static IP is unique to the network. Knowledge of the network addressing is required to prevent duplication of address values. If necessary, consult your network system administrator for a unique IP address value.

Dynamic Host Configuration Protocol (DHCP) IP addresses are assigned automatically by a DHCP server that is normally located inside of the network router. DHCP ensures that every device on the network contains a unique network address. Using DHCP is the easiest method of connecting devices to a network and requires no knowledge of the network addressing.

DHCP is the easiest method of connecting devices to a network. However, it may not be the best for an industrial application. Especially since a new IP address is assigned when the device is connected to the network or powered on. If the IP address changes when the device is connected to the network then supervisory control software may lose connection with the device when the address changes.

Consider using a Static IP address in applications where the device IP address is entered verbatim in to the host supervisory software.

Protocols

The D7000 series modules use two different protocols for communications with a host supervisory computer. The two protocols are the Modbus TCP/IP protocol and the REST protocol.

Modbus TCP/IP Protocol

The D7000 primary method of communications is the Modbus TCP/IP protocol. The Modbus TCP/IP protocol is a Master / Slave protocol. Typically, a host computer transmits a command over a local area network to a slave device. The command is considered as a request for the module to perform a specific task or function. The module will perform the task and then return any required data. The D7000 is considered a Modbus TCP/IP slave device and supports many of the standard Modbus Functions. See the list of supported functions in Chapter 4.0 of this document.

REST Protocol

The D7000 series supports the REST protocol for communicating data values back to a host computer. The REST protocol is a version of HTTP protocol that can be used to read data values, peak and valley readings, scale minimum and maximums, and the channel range settings. The amount of items returned is dependent upon the module type, analog input, analog output or digital I/O. Refer to the detailed description of the REST protocol in Chapter 4.0 of this document.

Operating Modes

The D7000 series contains several different modes of operation. First, the module can operate as a simple measurement or control module where a supervisory computer reads or writes commands to the device. This would be considered the normal mode of operation.

Peer-To-Peer

The D7000 series contains a Peer-To-Peer mode where two modules can be paired together and communicate over a network. In Peer-to-Peer mode, an analog input module can be paired with an analog output module. Or, a digital input module can be paired with a digital output module. One module considered the sender and the other is considered the receiver. This mode can be used to duplicate analog or digital signals in multiple locations over a network. The modules use the Modbus TCP/IP protocol to communicate. The data values are communicated at a user-specified time interval.

Thingspeak.Com Cloud Service

The D7000 series support connections to the Thingspeak.Com cloud service. Sensor data measured with the D7000 can be uploaded and stored on the Thingspeak cloud service. The data values are stored on the Thingspeak cloud servers indefinitely and can be exported at anytime to a local disk file using a Comma-Separated-Value file format. The local disk file can then be imported into a spreadsheet program for future analysis. The data values are communicated at a user-specified time interval.

Email On Limits

The D7000 series can send email messages based on signal limits.

See Chapter 4.0 for a more detailed explanation of the protocols and operating modes.

2.0 Web Browser Configuration

Getting Started

The D7000 series modules contain a web browser interface for configuring the device. A menu bar is located at the top of each web page. The “Configuration” menu selection links to a web page that contains all the user-selectable options for each module. Other individual web pages are used to display module status and the configuration values. All web pages can be viewed using any the common web browsers found on most computers today. Examples are Internet Explorer, FireFox, Chrome and others.

The browser interface contains many web pages that display system status and configuration values for specific module features. There is a menu bar at the top of each page and one menu selection links to the module “Configuration” page. The Configuration page selection allows a user to change or adjust any of the user-selectable options within the device. This web page can be configured as accessible to anyone or password protected to prevent unauthorized changes.

Network Configuration

The D7000 series modules require a network IP address in order to communicate. There are two methods of providing an IP address. The most common method is to use DHCP where a router automatically assigns a network address. The other method is to specify a static or fixed IP address manually. When using a static IP address care must be taken to ensure that a unique IP address is assigned to each module. Using the same IP address on multiple modules or devices will result in communications fault conditions.

D7400 Voltage, Current, Thermocouple Input Ethernet Module

Home Network Data Values Peer-to-Peer Email Limits Connectivity Configuration

Network Parameters

Obtain IP Address Value
DHCP Mode

IP Address 192 168 1 150

Gateway Address 192 168 1 1

DNS Server Address 192 168 1 1

Subnet Mask 255 255 255 0

Modbus Port 502

Security Configuration

Username Value

Password

Clear Peak & Valley Readings No

Web Browser Control Enabled

Channel Tag, Range & Scaling Values

Channel	Tag Name	Range	User Scaling	User Min	User Max
CH1	CH1-Tag	+/-10V	Range		

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Figure 1.0 Configuration Settings

The D7000 series modules are shipped with DHCP automatic network configuration enabled and they will obtain their IP addresses from a network router. It may be necessary to view the “connected devices” table on the network router in order to determine the IP address assigned to each device.

Username and Password

The D7000 series modules can utilize simple Username and Password security to protect the Configuration screen values. When values are entered into the Username and Password text boxes then the D7000 will generate a Login box before entering the Configuration screen. All other web pages will only display values and therefore are not protected by a username and password login.

Clear Peak & Valley Readings

The D7000 series modules Peak and Valley readings are the highest and lowest values that have been detected for each channel during normal operation. The D7000 series contain a micro controller to perform the Ethernet processing functions and a signal processing controller handles all of the analog I/O or digital I/O processing. The Ethernet controller reads the signal processor data values and then compares each channel reading the channel Peak and Valley readings. When the update is complete the new Peak and Valley readings are stored in EEPROM for review at a later time.

The Clear Peak & Valley Readings drop down listbox feature allows all of the peak and valley readings to be removed from memory. If “yes” is selected then the Peak and Valley readings will be erased when the “Apply” button is pressed at the bottom of the “Configuration” page. The value will default back to “No” when the web page is reloaded.

Web Browser Control

The Web Browser Control feature allows a user to manage the device through a Web Browser. Select Enable or Disable for the desired operation during normal operation. Select Enable and allow the module to be managed and configured using a web browser. Select Disable to turn off the web browser management.

As a general practice, disabling the web browser control during normal operation will allow the module to process more requests from other functions. It will also limit user access lower the possibility of unauthorized changes. The web browser management can be turned back on using the D6000 Utility Software.

Channel Tag, Range and Scaling Values

D7400 Voltage, Current, Thermocouple Input Ethernet Module

Home Network Data Values Peer-to-Peer Email Limits Connectivity Configuration

Channel Tag, Range & Scaling Values

Channel	Tag Name	Range	User Scaling	User Min	User Max
CH1	<input type="text" value="CH1-Tag"/>	+/-10V	Range	<input type="text"/>	<input type="text"/>
CH2	<input type="text" value="CH2-Tag"/>	+/-10V	Range	<input type="text"/>	<input type="text"/>
CH3	<input type="text" value="CH3-Tag"/>	+/-10V	Range	<input type="text"/>	<input type="text"/>
CH4	<input type="text" value="CH4-Tag"/>	+/-10V	Range	<input type="text"/>	<input type="text"/>
CH5	<input type="text" value="CH5-Tag"/>	+/-10V	Range	<input type="text"/>	<input type="text"/>
CH6	<input type="text" value="CH6-Tag"/>	+/-10V	Range	<input type="text"/>	<input type="text"/>
CH7	<input type="text" value="CH7-Tag"/>	+/-10V	Range	<input type="text"/>	<input type="text"/>

Internet of Things (IOT) Configuration

IOT Interval: 30 Seconds

HTTP Post Action: /update HTTP/1.1

API Host Name: 52.1.229.129

API Host Key: THINGSPEAKAPIKEY

API Write Key:

CH1 Field Name: CH1-Tag

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Figure 2.0 Configuration Settings, Continued.

A Tag Name can be associated with each analog and digital I/O channel in the D7000 series modules. The Tag name is an arbitrary string of characters that might represent the control function being performed (by that channel). For example, a digital output may have an assigned Tag name of “Start Motor”. The Tag Name values are also displayed on several of the web browser pages. Empty Tag names may prevent associated channel values from being displayed in certain configurations.

A Range drop down listbox is provided on the web browser configuration page to specify the analog voltage or current range of each channel. Select the analog range and these values will be activated and stored when the APPLY button is depressed at the bottom of the page.

A Scaling drop down list box is provided on the web browser configuration page to specify the scaling technique for each analog channel. The Scaling list box selections include User specified scaling values or the raw 16-bit unsigned integer Modbus values.

Two text boxes are also provided to hold the user specified minimum and maximum scaling values. When User scaling is selected then the data values displayed in the web pages will be linearly scaled such that the user minimum equals minus full-scale and user maximum equals positive full-scale. All data values in between are linearly interpolated.

If Raw Scaling is specified then the Raw Modbus data values between 0 and 65535 will be displayed. These values represent the percentage of the full scale range.

Internet of Things (IOT) Configuration

D7400 Voltage, Current, Thermocouple Input Ethernet Module

Home Network Data Values Peer-to-Peer Email Limits Connectivity Configuration

Internet of Things (IOT) Configuration

IOT Interval: 30 Seconds

HTTP Post Action: /update HTTP/1.1

API Host Name: 52.1.229.129

API Host Key: THINGSPEAKAPIKEY

API Write Key:

CH1 Field Name: CH1-Tag

CH2 Field Name: CH2-Tag

CH3 Field Name: CH3-Tag

CH4 Field Name: CH4-Tag

CH5 Field Name: CH5-Tag

CH6 Field Name: CH6-Tag

CH7 Field Name: CH7-Tag

Peer To Peer Configuration

Interval: Disabled

CH1	to	255	255	255	255	Disabled
CH2	to	255	255	255	255	Disabled

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Figure 3.0 Configuration Settings, Continued.

The Internet of Things (IOT) configuration values must be specified correctly in order to begin uploading module data values to the Thingspeak.Com cloud service. See the working configuration values in Figure 3.0 above.

The IOT Interval is the user-specified time interval that the module will upload data values to Thingspeak.com.

The HTTP Post Action is the method used upload data values to the cloud service.

The API Host Name is specified by the cloud service. It can be in the form of a domain name such as 'api.thingspeak.com'. Or, it can be an IP address value as illustrated in Figure 3.0 above.

The API Host Key and Write Key are values specified by the cloud service and are specific to the device when defined in the cloud.

A Field Name can be associated with each analog and digital I/O channel. The Tag name is an arbitrary string of characters that might represent the control function being performed (by that channel). For example, a digital output may have an assigned Tag name of "Start Motor". The Tag Name values are also displayed on several of the web browser pages. Empty Tag names may prevent associated channel values from being uploaded in certain configurations.

Peer-To-Peer Configuration

D7400 Voltage, Current, Thermocouple Input Ethernet Module

Home	Network	Data Values	Peer-to-Peer	Email Limits	Connectivity	Configuration
------	---------	-------------	--------------	--------------	--------------	---------------

Peer To Peer Configuration

Interval: Disabled

Channel	to	255	255	255	255	Disabled
CH1	to	255	255	255	255	Disabled
CH2	to	255	255	255	255	Disabled
CH3	to	255	255	255	255	Disabled
CH4	to	255	255	255	255	Disabled
CH5	to	255	255	255	255	Disabled
CH6	to	255	255	255	255	Disabled
CH7	to	255	255	255	255	Disabled

Email On Limits Configuration

Interval: Disabled

Email with SSL: Disabled

Send To Address: _____

Receive From Address: _____

Email Subject: _____

Email Server: _____

Acct Username: _____

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Figure 4.0 Configuration Settings, Continued.

The D7000 series Peer-To-Peer is enabled by selecting an Interval Time other than “Disabled” as illustrated in Figure 4.0 above.

In Peer-to-Peer Mode, each analog or digital channel can be transmitted individually to another D7000 module by specifying the receiving module IP address. The module must be of the same signal type. Meaning, analog input modules transmit to analog output modules. Likewise with digital input to digital output modules.

Analog Input modules can send to either Channel #1 or Channel #2 on a two channel analog output module. Specify CH1 or CH2 using the drop down list box to the right of the IP address. Unused channels can be disabled by selecting “Disabled” in the drop down list box.

When configuring the analog output or digital output modules, enter the IP address of the sending module.

Email on Limits Configuration

D7400 Voltage, Current, Thermocouple Input Ethernet Module

Home	Network	Data Values	Peer-to-Peer	Email Limits	Connectivity	Configuration
------	---------	-------------	--------------	--------------	--------------	---------------

Email On Limits Configuration

Interval: Disabled

Email with SSL: Disabled

Send To Address: _____

Receive From Address: _____

Email Subject: _____

Email Server: _____

Acct Username: _____

Acct Password: _____

Email Port: 110

Channel	Disabled	0.00
CH1	Disabled	0.00
CH2	Disabled	0.00
CH3	Disabled	0.00
CH4	Disabled	0.00
CH5	Disabled	0.00
CH6	Disabled	0.00
CH7	Disabled	0.00

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Figure 5.0 Configuration Settings, Continued.

IMPORTANT: The D7000 series “Email on Limits” mode of operation requires access to an external email server. The module “does not” contain an internal mail server!!

Configuration of the “Email on Limits” mode requires the user to have an email account and knowledge of the account SMTP server settings. Free email accounts can be obtained on the internet from several providers. This mode has been successfully tested with a account. We recommend that users do not use their personal or work email accounts in this mode.

The D7000 series Email on Limits mode is enabled by selecting an Interval Time other than “Disabled” as illustrated in Figure 5.0 above.

The eight email account settings underneath the Interval list box must be obtained from the email service that was chosen for use in this mode. See the Gmail settings below that were used to perform product testing.

PARAMETERS	GMAIL
Email with SSL	
Send To Address	
Receive From Address	
Email Subject	
Email Server	
Email Acct Username	
Email Acct Password	
Email Port	

Figure 6.0 Configuration Settings, Continued.

Each D7000 series analog input module contains a drop down list box for each channel that determines the limit testing method that will be performed. There are four different comparisons that can be selected: disabled, equal to a value, less than a value or greater than a value. Select the channel comparison test required or disabled so that no comparison testing is performed.

REST Protocol

The D7000 supports the REST protocol for communicating data values back to a host computer. The REST protocol is a version of HTTP protocol that can be used to read data values, peak and valley readings, scale minimum and maximums, and the channel range settings. Enable or Disable the REST protocol using the drop down list box.

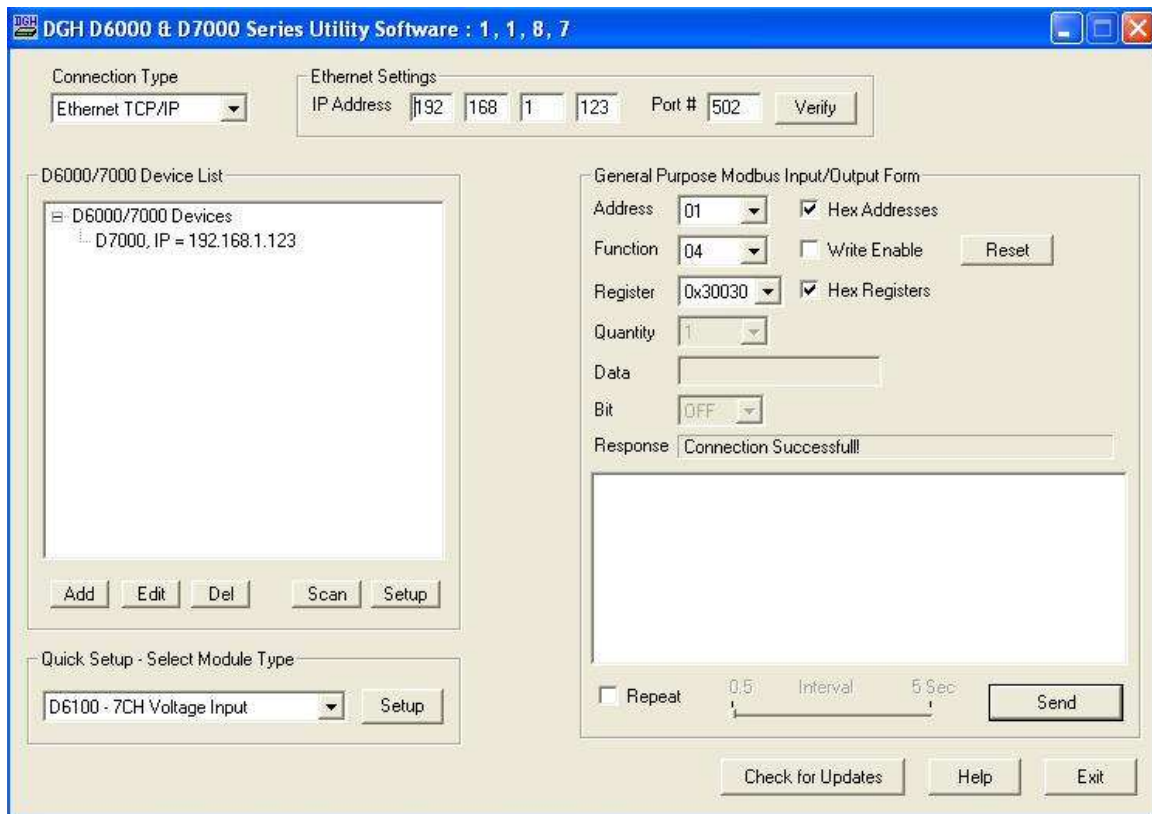
3.0 Utility Software

The D7000 series modules require a software program to change the content in the setup registers. Since the modules communicate via the Modbus TCP/IP protocol, a Modbus Master program or the DGH D7000 series Utility Software will be required to change the module configuration.

The DGH D6000/D7000/D8000 Series Utility Software is the best program to use when configuring a module. The utility software reads the module information, displays the information in easy to understand terms, allows changes to be made via drop-down list boxes and then writes the new values back to the module. The module parameters can also be stored to disk and recalled at a later date.

The Utility Software is provided free of charge on CDROM with a purchase order and the latest version is always downloadable from www.dghcorp.com. The utility software runs on Windows based computers. Simply insert the CDROM into the CDROM drive, or download the Setup.Exe installation program from our website, and then run the installer. The software will install and create a menu section called "DGH DATA ACQUISITION" and the D6000 Utility Software will be located under that selection.

From the computer desktop click the "start" button, select "all programs", select "DGH Data Acquisition" and then select "D6000 Series Utility Software" to run the utility software. When the software opens the first step is to set the "Connection Type" drop down list box to "Ethernet TCP/IP". Then enter the IP address of the D7000 series module and press the "Verify" button to see if the Utility Software can connect to the module. If the connection was successful then "Connection Successful" will appear in the Response block. See below.



After a successful connection test has been performed then the module can be configured. Select the type of module using the drop-down list box under “Quick Setup” in the lower left hand corner of the screen. Then press the “Setup” button and a new screen (see below) will appear that contains list of all the user-selectable module values. Several different screens will appear for the different types of module that are connected. The screen below is for a seven channel current input module.

The screenshot shows the 'DGH D7200 7CH Current Input Module Setup Screen'. The interface is organized into several sections:

- Connection Type:** Ethernet TCP/IP (selected).
- Ethernet Settings:** IP Address 192.168.1.123, Port # 502, with a Verify button.
- Module Setup Configuration:**
 - Communications Settings:** Slave Address 01, Baud Rate 9600, Parity N-8-2.
 - Modbus Delays:** Query (HI) 00 mS, Response (LO) 00 mS.
 - Version Data:** Software 0000.
 - Buttons: Save to Disk, Recall from Disk, Set All Ranges Equal to CH1.
- Channel Settings:** NMR Setting 60 Hz, Small Filter 0 Secs, Large Filter 0 Secs, Ch1 Range Disabled, Ch2 Range Disabled, Ch3 Range Disabled, Ch4 Range Disabled, Ch5 Range Disabled, Ch6 Range Disabled, Ch7 Range Disabled.
- Analog Data Values:**

Chan	Valley (LO)	Data	Peak (HI)
#1	0000	0000	0000
#2	0000	0000	0000
#3	0000	0000	0000
#4	0000	0000	0000
#5	0000	0000	0000
#6	0000	0000	0000
#7	0000	0000	0000

Buttons: Clear LO, Scan, Clear HI. Interval (Sec) 0.5 to 5.
- Communications Status:** Slave Address 01, Hex Addressing checked, Hex Data unchecked.
- Buttons:** Read Setup, Apply Setup, Help, Close.

Ensure that the Module Address in the lower left corner remains at “01” and then press the “Read Setup” button. The screen will populate with the existing module configuration data.

The user-selectable values will be displayed in an easy to understand format and new selections can be made using the drop-down list boxes. The drop-down list boxes make the configuration process easy and accurate because erroneous values cannot be entered.

Once the new module configuration settings have been changed to meet the application requirements then press the “Apply” button to transmit the new settings.

Scan Module

After the module has been properly configured, the software can scan the modules for their present data values in order to verify each channel is functioning properly. This feature is a good troubleshooting or verification tool when the analog signals are connected to the module.

The analog input screens contain a “Scan” button that will start the scanning process. Each data channel is read by requesting the data values from data registers within the module. The analog input data register locations can be found in the Modbus Register map and the data in each register is specific to the module type and channel range specified.

Data Values

The data values are returned in hexadecimal percentage of Full Scale format where a value of 0x0000 represents the minus full scale input of the module. A value of 0xffff represents the positive full scale input of the module. These values can be used as check to ensure that the channels are operating properly when analog input signals are applied to the input terminals.

The data values can also be displayed as a numerical value. The utility software knows the plus and minus full scale limits for each channel. Using the raw hexadecimal percentage of full scale data values the software can convert these readings to millivolts, milliamps, or temperature readings. Simply uncheck the "Display Hex Values" selection underneath the channel readings to display the numeric values.

The scanning process can also log and display the highest (peak) and lowest (valley) readings that were recorded during the scanning process. This is just for indication purposes only.

A scan interval slide control is also provided to speed up or slow down the scanning process. This slide control allows the channels to be scanned at intervals from 0.5 to 5 seconds.

4.0 Protocols and Operating Modes

The D7000 series module contains an Ethernet RJ-45 Ethernet interface for communications. They support two different communications protocols and multiple operating modes.

Modbus TCP/IP Protocol

The primary communications protocol is the Modbus TCP/IP Ethernet protocol. This protocol can communicate over a local area network or the internet. It is widely recognized and supported by all data acquisition and SCADA software programs in the marketplace. Thus, providing instant connectivity to many software programs. See more detailed information about the Modbus TCP/IP protocol further in this chapter.

REST Protocol

The D7000 supports the REST protocol for communicating data values back to a host computer. The REST protocol is a version of HTTP protocol that can be used to read data values, peak and valley readings, scale minimum and maximums, and the channel range settings. The amount of items returned is dependent upon the module type, analog input, analog output or digital I/O. See more detailed information about the REST protocol further in this chapter.

Normal Operating Mode

The D7000 series modules “normal mode” of operation would be communicating data values to a supervisory host computer using the Ethernet Modbus TCP/IP protocol. A host computer would perform all the data reading and writing with standard Modbus commands known as function. Each of the supported functions and their purpose is further in this chapter.

Peer-To-Peer Mode

The D7000 series Peer-to-Peer mode allows an analog input module to send data values to an analog output module in another location. Likewise with digital input and digital output modules. The sending modules perform a measurement on a specific channel and the transmit that value to analog or digital output module. Thus, recreating the measured signal in another location, possibly within the same plant, or another remote location. The signal values are communicated using the Modbus TCP/IP protocol.

Cloud Publishing Mode

The D7000 series modules can transmit data values to the cloud IOT service Thingspeak.com. Analog and digital data values can be uploaded on a timed interval and stored on the Thingspeak servers. Data values can be retrieved, or downloaded, at a later time. The data values can be displayed using Thingspeak trend graphs or viewed from other IOT dashboard applications or websites.

Modbus TCP/IP Protocol

The D7000 series modules utilize the Modbus TCP/IP protocol for communications. The Modbus TCP/IP protocol is widely supported protocol supported by almost all commercial data acquisition programs and programmable controllers in the marketplace. This allows for easy connection of a D7000 series module to an existing system or new application.

The D7000 series modules utilize up to eight different functions from within the Modbus TCP/IP protocol. The number of functions utilized by a module depends on the model type and the features it contains.

The Modbus functions allow users to control every function within a module. The functions and their descriptions are listed below. Each function is also outlined in further detail below.

Function	Description
01	Return coil status of discrete output points
02	Read ON/OFF status of discrete inputs in the slave device
03	Read content of holding registers (4X references) in the slave device
04	Read content of input registers (3X references) in the slave device
05	Force state of a single coil (digital output) to either ON or OFF
06	Preset the state of a single register to a specific value
0F	Force the state of a sequence of coils (digital outputs) to a specific state
10	Preset a sequence of registers (4X references) to specific values

Each Modbus TCP/IP message begins with a six byte preamble. The first two bytes of the preamble make up the “Transaction Identifier” and both bytes are typically “0”. The second two bytes make up the “Protocol Identifier” and both bytes are typically “0”. The last two bytes of the preamble contain the length of the message. The high byte of the message length is “0” and the low byte contains the number of bytes that follow the preamble.

All Modbus TCP/IP messages, commands and responses, contain a preamble as outlined above. The preamble values have been left out of the Modbus Function examples below.

Function 01 – Read Coil Status

This function returns the coil status of discrete digital output points. A typical function 01 command and response is detailed below:

Command Usage:

Address	One Byte Slave Address
Function	One Byte Function Number
Addr HI	Starting Address HI Byte
Addr LO	Starting Address LO Byte
Data HI	Typically ZERO
Data LO	Number of bits, limited to 1..64

Response Message:

Address	One Byte Slave Address	
Function	One Byte Function Number	
Register Number	Number of data bytes	Typically returns four bytes
Data HI	Data Coils (27-20)	
Data LO	Data Coils (35-28)	
Data HI	Data Coils (43-36)	
Data LO	Data Coils (51-44)	

Function 02 – Read Input Status

Read the ON/OFF status of discrete digital input bits in the slave device. A typical function 02 command and response is detailed below:

Command Usage:

Address	One Byte Slave Address
Function	One Byte Function Number
Addr HI	Starting Address HI Byte
Addr LO	Starting Address LO Byte
Data HI	Typically ZERO
Data LO	Number of bits, limited to 1..64

Response Message:

Address	One Byte Slave Address	
Function	One Byte Function Number	
Register Number	Number of data bytes	Typically returns four bytes
Data HI	Data Coils (27-20)	
Data LO	Data Coils (35-28)	
Data HI	Data Coils (43-36)	
Data LO	Data Coils (51-44)	

Function 03 – Read Holding Registers

This function returns the contents of hold registers (4X references) in the slave device. A typical function 03 command and response is detailed below:

Command Usage:

Address	One Byte Slave Address
Function	One Byte Function Number
Addr HI	Starting Register Address HI Byte
Addr LO	Starting Register Address LO Byte
Data HI	Typically ZERO
Data LO	Number of registers

Response Message:

Address	One Byte Slave Address	
Function	One Byte Function Number	
Register Number	Number of data bytes	Typically returns two bytes
Data HI	HI Byte (8-bits)	
Data LO	LO Byte (8-bits)	

Function 04 – Read Input Registers

This function returns the contents of hold registers (3X references) in the slave device. A typical function 04 command and response is detailed below:

Command Usage:

Address	One Byte Slave Address
Function	One Byte Function Number
Addr HI	Starting Register Address HI Byte
Addr LO	Starting Register Address LO Byte
Data HI	Typically ZERO
Data LO	Number of registers

Response Message:

Address	One Byte Slave Address	
Function	One Byte Function Number	
Register Number	Number of data bytes	Typically returns two bytes
Data HI	HI Byte (8-bits)	
Data LO	LO Byte (8-bits)	

Function 05 – Force Single Coil

This function forces the state of a single coil (digital output) to either the ON or OFF state. A typical function 05 command and response is listed below:

Command Usage:

Address	One Byte Slave Address
Function	One Byte Function Number

Addr HI	Coil Address HI Byte
Addr LO	Coil Address LO Byte

Data HI	Force Data HI
Data LO	Force Data LO

Data Values: The proper values are either 0xFF00 to enable (Turn ON) a bit or 0x0000 to disable (turn off) a bit.

Response Message:

Address	One Byte Slave Address
Function	One Byte Function Number

Addr HI	Coil Address HI Byte	Same value as in command above.
Addr LO	Coil Address LO Byte	Same value as in command above.

Data HI	Force Data HI	Same value as in command above.
Data LO	Force Data LO	Same value as in command above.

Function 06 – Preset Single Register

This function presets the state of a single register to a specific value. A typical function 06 command and response is listed below:

Command Usage:

Address	One Byte Slave Address
Function	One Byte Function Number
Addr HI	Starting Register Address HI Byte
Addr LO	Starting Register Address LO Byte
Data HI	Force Data HI
Data LO	Force Data LO

Response Message:

Address	One Byte Slave Address	
Function	One Byte Function Number	
Addr HI	Register Address HI Byte	Same value as in command above.
Addr LO	Register Address LO Byte	Same value as in command above.
Data HI	Preset Data value HI	Same value as in command above.
Data LO	Preset Data value LO	Same value as in command above.

Function 0F – Force Multiple Coils

This function is used to force the state of multiple coils (digital outputs) in a digital output module. A typical function 0F command and response is listed below:

Command Usage:

Address	One Byte Slave Address
Function	One Byte Function Number
Starting Addr HI	Starting Address HI Byte
Starting Addr LO	Starting Address LO Byte
Qty Coils HI	Number of Coils to Write HI
Qty Coils LO	Number of Coils to Write LO
Byte Count	Number of Data Bytes Transmitted
Force Data HI	Force Data HI
Force Data LO	Force Data LO

Response Message:

Address	One Byte Slave Address	
Function	One Byte Function Number	
Starting Addr HI	Starting Address HI Byte	Same value as in command above.
Starting Addr LO	Starting Address LO Byte	Same value as in command above.
Qty Coils HI	Qty Coils HI	Same value as in command above.
Qty Coils LO	Qty Coils LO	Same value as in command above.

Function 10 – Preset Multiple Registers

This function presets the state of multiple registers to specific values. A typical function 10 command and response is listed below:

Command Usage:

Address	One Byte Slave Address
Function	One Byte Function Number
Starting Addr HI	Starting Register Address HI Byte
Starting Addr LO	Starting Register Address LO Byte
Num Registers HI	Number of Registers to Write HI
Num Registers LO	Number of Registers to Write LO
Byte Count	Number of Data Bytes Transmitted
Data HI	Force Data HI
Data LO	Force Data LO

Response Message:

Address	One Byte Slave Address	
Function	One Byte Function Number	
Starting Addr HI	Starting Address HI Byte	Same value as in command above.
Starting Addr LO	Starting Address LO Byte	Same value as in command above.
Num Registers HI	Preset Data value HI	Same value as in command above.
Num Registers LO	Preset Data value LO	Same value as in command above.

Modbus Exceptions

The following Modbus Exception (Error Codes) may be returned from the D7000 series modules. These Exception Codes are returned when an error is detected within the command messages transmitted to the module. All Exception Code numbers are indicated below with a detailed description of possible causes.

Modbus Exception Codes		
Exception	Name	Description
01	Illegal Function	This exception code is generated when the module does not recognize the function code.
02	Illegal Data Address	This exception code is generated when the module does not support the specified data address in the command.
03	Illegal Data Value	This exception code is generated if the command data is out of range for the function.
06	Slave Busy	This exception code is generated during the first 3 seconds after the module is reset or powered up.
07	Negative Acknowledge	This exception code is generated if the command tries to write a value into the module EEPROM without being write-enabled first.

REST Protocol

5.0 Modules and Register Maps

The D7000 series modules are a complete family of data acquisition modules. Mixing and matching the D7000 series modules together in an application provides any user with the ability to build a complete measurement and process control system. The family of modules includes multi-channel analog input modules, multiple channel analog output modules, and digital I/O modules.

D7100 Voltage Input Module

The [D7100](#) series analog input modules contain seven differential inputs for measuring DC voltages. Each input can be individually configured to measure one of six different voltage ranges. The input ranges are: $\pm 0.025\text{V}$, $\pm 0.05\text{V}$, $\pm 0.10\text{V}$, $\pm 1\text{V}$, $\pm 5\text{V}$ and $\pm 10\text{V}$.

D7200 Current Input Module

The [D7200](#) series analog input module contains seven differential inputs for measuring current signals such as 4-20mA loops. The analog input range is factory configured for $\pm 20\text{mA}$.

D7300 Thermocouple Input Module

The [D7300](#) series analog input module contains seven differential inputs for measuring thermocouple probes. Each input can be individually configured to measure one of eight different thermocouple types. The supported thermocouple types are: J, K, T, E, R, S, B and C.

D7400 Voltage, Thermocouple and Current Input Module

The [D7400](#) series analog input module contains seven differential inputs for measuring DC voltages, thermocouples and current. Each input can be individually configured to measure one of fourteen different ranges. The supported thermocouple types are: J, K, T, E, R, S, B and C. The DC voltage input ranges are: $\pm 0.025\text{V}$, $\pm 0.05\text{V}$, $\pm 0.10\text{V}$, $\pm 1\text{V}$, $\pm 5\text{V}$ and $\pm 10\text{V}$ and the current input range is $\pm 20\text{mA}$.

D7500 Analog Output Module

The [D7500](#) series analog output modules contain two analog output channels for generating either a voltage or current output signal. Each analog output channel contains two user-selectable voltage output ranges and two current output ranges. These analog output signals can be used as control inputs for items such as motor controls, valve controls, and other control devices. Each analog output channel also contains a programmable communications watchdog timer for instances when communications to the module is lost.

D7700 Digital Inputs/Output Module

The [D7700](#) series modules each contain 15-bits of digital inputs or digital outputs. The D7710 15-bit digital input module contains internal pull-ups on each bit for direct connection to dry contact switches.

The D7720 digital output modules contain fifteen open-collector outputs that can be connected up to 30Vdc and can sink 100mA per bit. The open-collector outputs allow the modules to be used in a wide variety of control applications. The digital output module also contains a programmable communications watchdog timer for accidental instances where communication to the module is lost.

5.1 D7100 - Seven Channel Voltage Input Module

Overview

The D7100 series analog input modules contain seven differential analog inputs that can measure six different DC voltage ranges. Each analog input channel is user programmable and may be assigned to measure a different range. Any unused channels can be disabled.

Analog to Digital Converter

The D7100 series analog input modules contain a 16-bit analog to digital converter to perform the signal conversion to digital information. The analog to digital converter performs a total of 25 conversions per second. Meaning, if all 7 channels were enabled the each channel would be measured 3+ times per second. The conversion rate per channel can be improved by disabling any unused channels.

Features and Register Assignments

The D7100 series analog input modules contain many user-selectable features. The user can select all features such as baud rate, parity type, analog range selection and digital filtering. The complete list of features is illustrated in the "[Seven Analog Voltage Input Register Assignments](#)" register map below. The register map format is used for consistency with the Modbus TCP/IP protocol. The register map contains the register numbers in decimal format, register description, acceptable data values, and list of what each value means. These registers can be written to using most any Modbus master program or using the DGH D7000 series utility software.

Note: All Modbus Register values in the tables below are represented as "decimal" numbers.

Factory Initial Values

The D7100 series analog module features are initialized at the factory with a set of "Initial Values". A complete list of factory "[Initial Values](#)" can be found in the table below

Calibration

The D7100 series analog input modules are shipped from the factory as fully calibrated devices. Throughout the lifetime of the module there may be need to verify or adjust the calibration of the device. The verification and adjustment process should only be completed using NIST traceable calibration equipment. A D7100 series [Calibration procedure](#) is included below.

Connector Pin Designations

The D7100 series module uses two 3.81mm removable plugs for connecting signals to the module. One two-pin connector is for the power supply connections. A second sixteen-pin connector is used to connect analog input signals to the module. The [pin designations](#) for each connector are printed on the module label and are listed in a table below.

5.1.2 Seven Voltage Input Pin Assignments and Specifications

Connections

Power & Serial Communications

<u>Pin Number</u>	<u>Pin</u>	<u>Designator</u>
1	GND	- Power Supply
2	+VS	+ Power Supply

Analog Input Pin Assignments

<u>Pin Number</u>	<u>Pin</u>	<u>Designator</u>
1	CH1+	CH1 +Input
2	CH1-	CH1 -Input
3	CH2+	CH2 +Input
4	CH2-	CH2 -Input
5	CH3+	CH3 +Input
6	CH3-	CH3 -Input
7	CH4+	CH4 +Input
8	CH4-	CH4 -Input
9	CH5+	CH5 +Input
10	CH5-	CH5 -Input
11	CH6+	CH6 +Input
12	CH6-	CH6 -Input
13	CH7+	CH7 +Input
14	CH7-	CH7 -Input
15	ISO. GND	Isolated GND
16	ISO. GND	Isolated GND

Specifications

Analog Inputs 7 Channels

User Selectable Input Ranges
 Bipolar Voltage 10V, 5V, 1V,
 0.1V, 0.05V,
 0.025V

Differential Reading
 CH to CH

Protocol
 TCP Modbus TCP/IP

Power Supply
 Voltage +10-30Vdc
 Power 1.4W

Connectors
 Spacing 3.81mm
 Max Wire Size 14-24 AWG
 Max Current 8 Amperes

Serial LED Displays
 Transmit (Top) TxData
 Receive (Bottom) RxData

5.1.3 Seven Voltage Input Initial Values

Module Parameter	Value
Slave Address*	1
Baud Rate*	9600
Parity Type*	None
Modbus Response Delay	3mS
Modbus Query Delay	0mS
Conversion Rate	60Hz
Large Signal Filter	0 Seconds
Small Signal Filter	0 Seconds
Channel 0 Range	+/-10Vdc
Channel 1 Range	+/-10Vdc
Channel 2 Range	+/-10Vdc
Channel 3 Range	+/-10Vdc
Channel 4 Range	+/-10Vdc
Channel 5 Range	+/-10Vdc
Channel 6 Range	+/-10Vdc

*** = These values should not be changed.**

5.1.4 Seven Voltage Input Register Assignments

Register	Description	Function	Value	Description
40001	Slave Address	R/W	1-DF	Factory set to 0x0001.
40002	UART Setup	R/W		Factory set to 0x0035 = 9600, 8, N, 1.
40003	Modbus Delays	R/W	0-303F	<p><u>Bits 0-7</u> The Response Delay in milliseconds. This is required when the RS-485 adapter cannot tri-state immediately after the last character is transmitted from the host. Maximum value is 63mS. Factory default value is 3.</p> <p><u>Bits 8-15</u> The End of Query Delay in milliseconds (48mS max). This is an additional time that the module will wait prior to marking the end of the message. Slower host computers may not be able transmit a continuous message stream, thereby creating gaps between characters exceeding the normal 3.5 character times limit. Factory default value is 0. Factory set, 0x0003.</p>
40033	Software Version	R		Factory set, Code Version.
40048	Last Converted Chan, Conversion Counter	R	0-06FF	<p><u>Bits 0-7</u> The counter increments each conversion and rolled over after FF. The Conversion Counter indicates when the data registers have been updated.</p> <p><u>Bits 8-10</u> Input channel last conversion stored. The information is useful when all channel data is read back with 1 query. The user can identify which channels have been converted since the last query as long as the time between queries is less than 8 conversion times. Initialized to '0x0000' on device reset.</p>
40049	Channel 0 Data	R	0-FFFF	Data - Ch 0, Offset binary, zero=0x8000.
40050	Channel 1 Data	R	0-FFFF	Data - Channel 1
40051	Channel 2 Data	R	0-FFFF	Data - Channel 2
40052	Channel 3 Data	R	0-FFFF	Data - Channel 3
40053	Channel 4 Data	R	0-FFFF	Data - Channel 4
40054	Channel 5 Data	R	0-FFFF	Data - Channel 5
40055	Channel 6 Data	R	0-FFFF	Data - Channel 6

40095	Misc. Setup	R/W	0-1	<p>Bit 0 – Normal Mode Rejection Setting 0 – 60Hz, 25 Hz Conversion Speed. 1 – 50Hz, 20 Hz Conversion Speed. Factory set to 0x0000.</p>																														
40096	Signal Filtering	R/W	0-3F	<p>This register controls all channels. Time constants are only approximate values.</p> <table> <thead> <tr> <th>Bits 0-3</th> <th>Small Filter Time Constant(Secs)</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td></tr> <tr><td>1</td><td>0.5</td></tr> <tr><td>2</td><td>1</td></tr> <tr><td>3</td><td>2</td></tr> <tr><td>4</td><td>4</td></tr> <tr><td>5</td><td>8</td></tr> <tr><td>6</td><td>16</td></tr> <tr><td>7</td><td>32</td></tr> </tbody> </table> <table> <thead> <tr> <th>Bits 4-7</th> <th>Large Filter Time Constant(Secs)</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td></tr> <tr><td>1</td><td>0.5</td></tr> <tr><td>2</td><td>1</td></tr> <tr><td>3</td><td>2</td></tr> <tr><td>4-7</td><td>Reserved</td></tr> </tbody> </table> <p>Factory set to 0x0000.</p>	Bits 0-3	Small Filter Time Constant(Secs)	0	0	1	0.5	2	1	3	2	4	4	5	8	6	16	7	32	Bits 4-7	Large Filter Time Constant(Secs)	0	0	1	0.5	2	1	3	2	4-7	Reserved
Bits 0-3	Small Filter Time Constant(Secs)																																	
0	0																																	
1	0.5																																	
2	1																																	
3	2																																	
4	4																																	
5	8																																	
6	16																																	
7	32																																	
Bits 4-7	Large Filter Time Constant(Secs)																																	
0	0																																	
1	0.5																																	
2	1																																	
3	2																																	
4-7	Reserved																																	
40097	Setup Channel 0	R/W	0-F	<p>Channel 0 range. Non-volatile write protected register. If the EEPROM cannot be written because of not being enabled, it replies with a Negative Acknowledge Exception response 07h. Modbus function code 10h is limited to 4 data values.</p> <table> <thead> <tr> <th>Range:</th> <th>Bits 0-7 Hex</th> </tr> </thead> <tbody> <tr><td>Disable Channel</td><td>00</td></tr> <tr><td>+/-10V</td><td>01</td></tr> <tr><td>+/-5V</td><td>02</td></tr> <tr><td>+/-1V</td><td>03</td></tr> <tr><td>+/-0.100V</td><td>04</td></tr> <tr><td>+/-0.050V</td><td>05</td></tr> <tr><td>+/-0.025V</td><td>06</td></tr> </tbody> </table> <p>Factory set to 0x0001.</p>	Range:	Bits 0-7 Hex	Disable Channel	00	+/-10V	01	+/-5V	02	+/-1V	03	+/-0.100V	04	+/-0.050V	05	+/-0.025V	06														
Range:	Bits 0-7 Hex																																	
Disable Channel	00																																	
+/-10V	01																																	
+/-5V	02																																	
+/-1V	03																																	
+/-0.100V	04																																	
+/-0.050V	05																																	
+/-0.025V	06																																	
40098	Setup Channel 1	R/W	0-F	<p>Holds Channel 1 range. Factory set to 0x0001.</p>																														
40099	Setup Channel 2	R/W	0-F	<p>Holds Channel 2 range. Factory set to 0x0001.</p>																														
40100	Setup Channel 3	R/W	0-F	<p>Holds Channel 3 range. Factory set to 0x0001.</p>																														
40101	Setup Channel 4	R/W	0-F	<p>Holds Channel 4 range. Factory set to 0x0001.</p>																														
40102	Setup Channel 5	R/W	0-F	<p>Holds Channel 5 range. Factory set to 0x0001.</p>																														
40103	Setup Channel 6	R/W	0-F	<p>Holds Channel 6 range. Factory set to 0x0001.</p>																														
40114	Trim Zero, 10V Range	WP	0	<p>Forces all Channel Data Registers to 8000h, with input signal equal to zero. Apply calibration signal at least 15 seconds prior to calibrating to all channels. Calibration Acknowledge Exception Response. Calibration takes 20 seconds.</p>																														
40115	Trim Zero, 5V Range	WP	0	<p>Refer to Modbus register 40114.</p>																														
40116	Trim Zero, 1V Range	WP	0	<p>Refer to Modbus register 40114.</p>																														

40117	Trim Zero, 0.1V Range	WP	0	Refer to Modbus register 40114. Apply calibration signal at least 1 minute prior to calibrating to all channels.
40118	Trim Zero, 0.05V Range	WP	0	Refer to Modbus register 40114. Apply calibration signal at least 1 minute prior to calibrating to all channels.
40119	Trim Zero, 0.025V Range	WP	0	Refer to Modbus register 40114. Apply calibration signal at least 1 minute prior to calibrating to all channels.
40146	Trim FS, 10V Range	WP	D000-FFFF	Forces all Channel Data Registers to written value, with appropriate input signal. Apply calibration signal at least 15 seconds prior to calibrating to all channels. Acknowledge Exception Response. Calibration takes 20 seconds. See note 1.
40147	Trim FS, 5V Range	WP	D000-FFFF	See Modbus Register 40146.
40148	Trim FS, 1V Range	WP	D000-FFFF	See Modbus Register 40146.
40149	Trim FS, 0.1V Range	WP	D000-FFFF	See Modbus Register 40146. Apply calibration signal at least 1 minute prior to calibrating to all channels.
40150	Trim FS, 0.05V Range	WP	D000-FFFF	See Modbus Register 40146. Apply calibration signal at least 1 minute prior to calibrating to all channels.
40151	Trim FS, 0.025V Range	WP	D000-FFFF	See Modbus Register 40146. Apply calibration signal at least 1 minute prior to calibrating to all channels.
40241	Control Register	W		0 – Normal operation (NOP) 1 – Remote Reset (write protected) 2 – Write Enable 5 – Initialize Host Communication setup

Functions:

R Read Only
R/W Read/Write
WP Write-Protected

5.1.5 Seven Channel Voltage Input Module Calibration Procedure

Required Equipment:

1. Computer running the DGH Utility Software or another Modbus Master program.
2. A NIST traceable DC Voltage Standard with +/-10Vdc range.

Setup Steps – Perform Calibration Steps in Order Listed:

1. Allow unit to warm up for 15 minutes.
2. Short all the +Input pins together using short jumper wires.
3. Short all the -Input pins together using short jumper wires.
4. Connect the +Input wires to the Positive terminal on the DC voltage calibrator.
5. Connect the -Input wires to the Negative terminal on the DC voltage calibrator.
6. Install the DGH Utility Software or another Modbus Master Program to communicate with, and calibrate with the module via serial port or a TCP/IP connection.

Trim Zero:

1. Set the DC calibrator voltage output to +0.0000Vdc.
2. Use the DGH Utility Software or a Modbus Master program to perform steps #3 & #5.
3. Set all channels to the same range. Start with +/-10Vdc range, work downward as per values in Table 1.0.
4. Trim Zero on all channels.
 - a. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - b. Retrieve Trim Zero register value for specific range from Table 2.0 below.
 - c. Write value of 0x00h to Range Trim Zero register, (ie. 40114 for +/-10V).
 - d. Perform steps #4a through #4c to trim zero on each range.

Trim Span:

1. Set the DC calibrator voltage output to +10.000Vdc.
2. Use the DGH Utility Software or a Modbus Master program to perform steps #3 & #5.
3. Set all channels to the same range. Start with +/-0.025Vdc range, work upward as per values in Table 3.0.
4. Trim Span on each channel.
 - a. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - b. Retrieve Trim Span register value for specific range from Table 2.0 below.
 - c. Write value of 0xfffe to Trim Span register, (ie. 40146 for +/-10V).
 - d. Perform steps #4a through #4c to trim span on each range.

5.1.6 Seven Channel Voltage Input Calibration Tables:

Seven Channel Range Register Values			
Channel	Range Control	Range Values	
Channel 0	40097	00	Disabled
Channel 1	40098	01	+/-10V
Channel 2	40099	02	+/-5V
Channel 3	40100	03	+/-1V
Channel 4	40101	04	+/-0.1V
Channel 5	40102	05	+/-0.05V
Channel 6	40103	06	+/-0.025V

Table 1.0 Register Setup Values.

Trim Zero Registers and Calibration Values		
Range	Register	Value
+/-10Vdc	40114	0000
+/-5Vdc	40115	0000
+/-1Vdc	40116	0000
+/-0.1Vdc	40117	0000
+/-0.05Vdc	40118	0000
+/-0.025Vdc	40119	0000

Table 2.0 Trim Zero Registers and Values.

Trim Span Registers and Calibration Values		
Range	Register	Value
+/-0.025Vdc	40151	FFFE
+/-0.05Vdc	40150	FFFE
+/-0.1Vdc	40149	FFFE
+/-1Vdc	40148	FFFE
+/-5Vdc	40147	FFFE
+/-10Vdc	40146	FFFE

Table 3.0 Trim Span Registers and Values.

5.2 D7200 - Seven Channel Current Input Module

Overview

The D7200 series analog input module contains seven differential analog inputs for measuring current signals such as 4-20mA loops. Each analog input channel can measure current signals up to +/-20mA. Any unused channels can be disabled.

Analog to Digital Converter

The D7200 series analog input modules contain a 16-bit analog to digital converter to perform the signal conversion to digital information. The analog to digital converter performs a total of 25 conversions per second. Meaning, if all 7 channels were enabled the each channel would be measured 3+ times per second. The conversion rate per channel can be improved by disabling any unused channels.

Features and Register Assignments

The D7200 series analog input modules contain many user-selectable features. The user can select all features such as baud rate, parity type, analog range selection and digital filtering. The complete list of features is illustrated in the "[Seven Channel Analog Current Input Register Assignments](#)" register map below. The register map format is used for consistency with the Modbus RTU protocol. The register map contains the register numbers in decimal format, register description, acceptable data values, and list of what each value means. These registers can be written to using most any Modbus master program or using the DGH D6000 series utility software.

Note: All Modbus Register values in the tables below are represented as "decimal" numbers.

Factory Initial Values

The D7200 series analog module features are initialized at the factory with a set of "Initial Values". A complete list of factory "[Initial Values](#)" can be found in the table below.

Calibration

The D7200 series analog input modules are shipped from the factory as fully calibrated devices. Throughout the lifetime of the module there may be need to verify or adjust the calibration of the device. The verification and adjustment process should only be completed using NIST traceable calibration equipment. A D7200 series [Calibration procedure](#) is included below.

Connector Pin Designations

The D7200 series module uses two 3.81mm removable plugs for connecting signals to the module. One two-pin connector is for the power supply connections. A second sixteen-pin connector is used to connect analog input signals to the module. The [pin designations](#) for each connector are printed on the module label and are listed in a table below.

5.2.2 Seven Channel Current Input Specifications

Connections

Power & Serial Communications

<u>Pin Number</u>	<u>Pin</u>	<u>Designator</u>
1	GND	- Power Supply
2	+VS	+ Power Supply

Analog Input Pin Assignments

<u>Pin Number</u>	<u>Pin</u>	<u>Designator</u>
1	CH1+	CH1 +Input
2	CH1-	CH1 -Input
3	CH2+	CH2 +Input
4	CH2-	CH2 -Input
5	CH3+	CH3 +Input
6	CH3-	CH3 -Input
7	CH4+	CH4 +Input
8	CH4-	CH4 -Input
9	CH5+	CH5 +Input
10	CH5-	CH5 -Input
11	CH6+	CH6 +Input
12	CH6-	CH6 -Input
13	CH7+	CH7 +Input
14	CH7-	CH7 -Input
15	ISO. GND	Isolated GND
16	ISO. GND	Isolated GND

Specifications

Analog Inputs	7 Channels
Input Range	
Current	+/-20mA
Differential Reading	
CH to CH	+/-10Vdc
Protocol	
TCP	Modbus TCP/IP
Power Supply	
Voltage	+10-30Vdc
Power	1.4W
Connectors	
Spacing	3.81mm
Max Wire Size	14-24 AWG
Max Current	8 Amperes
Serial LED Displays	
Transmit (Top)	TxData
Receive (Bottom)	RxData

5.2.3 Seven Channel Current Input Module Initial Values

Module Parameter	Value
Slave Address*	1
Baud Rate*	9600
Parity Type*	None
Modbus Response Delay	3mS
Modbus Query Delay	0mS
Conversion Rate	60Hz
Large Signal Filter	0 Seconds
Small Signal Filter	0 Seconds
Channel 0 Range	+/-20mA
Channel 1 Range	+/-20mA
Channel 2 Range	+/-20mA
Channel 3 Range	+/-20mA
Channel 4 Range	+/-20mA
Channel 5 Range	+/-20mA
Channel 6 Range	+/-20mA

*** = These values should not be changed.**

5.2.4 Seven Channel Current Input Register Assignments

Register	Description	Functions	Value	Description
40001	Slave Address	R/W	1-DF	Factory set to 0x0001.
40002	UART Setup	R/W		Factory set to 0x0035 = 9600, 8, N, 1.
40003	Modbus Delays	R/W	0-303F	<p><u>Bits 0-7</u> The Response Delay in milliseconds. This is required when the RS-485 adapter cannot tri-state immediately after the last character is transmitted from the host. Maximum value is 63mS. Factory default value is 3.</p> <p><u>Bits 8-15</u> The End of Query Delay in milliseconds (48mS max). This is an additional time that the module will wait prior to marking the end of the message. Slower host computers may not be able transmit a continuous message stream, thereby creating gaps between characters exceeding the normal 3.5 character times limit. Factory default value is 0. Factory set, 0x0003.</p>
40033	Software Version	R		Factory set, Code Version.
40048	Last Converted Chan, Conversion Counter	R	0-06FF	<p><u>Bits 0-7</u> The counter increments each conversion and rolled over after FF. The Conversion Counter indicates when the data registers have been updated.</p> <p><u>Bits 8-10</u> Input channel last conversion stored. The information is useful when all channel data is read back with 1 query. The user can identify which channels have been converted since the last query as long as the time between queries is less than 8 conversion times. Initialized to '0x0000' on device reset.</p>
40049	Channel 0 Data	R	0-FFFF	Data - Ch 0, Offset binary, zero=0x8000.
40050	Channel 1 Data	R	0-FFFF	Data - Channel 1
40051	Channel 2 Data	R	0-FFFF	Data - Channel 2
40052	Channel 3 Data	R	0-FFFF	Data - Channel 3
40053	Channel 4 Data	R	0-FFFF	Data - Channel 4
40054	Channel 5 Data	R	0-FFFF	Data - Channel 5
40055	Channel 6 Data	R	0-FFFF	Data - Channel 6

40095	Misc. Setup	R/W	0-1	<p>Bit 0 – Normal Mode Rejection Setting 0 – 60Hz, 25 Hz Conversion Speed. 1 – 50Hz, 20 Hz Conversion Speed. Factory set to 0x0000.</p>																														
40096	Signal Filtering	R/W	0-3F	<p>This register controls all channels. Time constants are only approximate values.</p> <table border="0"> <tr> <td><u>Bits 0-3</u></td> <td><u>Small Filter Time Constant(Secs)</u></td> </tr> <tr> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>0.5</td> </tr> <tr> <td>2</td> <td>1</td> </tr> <tr> <td>3</td> <td>2</td> </tr> <tr> <td>4</td> <td>4</td> </tr> <tr> <td>5</td> <td>8</td> </tr> <tr> <td>6</td> <td>16</td> </tr> <tr> <td>7</td> <td>32</td> </tr> </table> <table border="0"> <tr> <td><u>Bits 4-7</u></td> <td><u>Large Filter Time Constant(Secs)</u></td> </tr> <tr> <td>0</td> <td>0</td> </tr> <tr> <td>1</td> <td>0.5</td> </tr> <tr> <td>2</td> <td>1</td> </tr> <tr> <td>3</td> <td>2</td> </tr> <tr> <td>4-7</td> <td>Reserved</td> </tr> </table> <p>Factory set to 0x0000.</p>	<u>Bits 0-3</u>	<u>Small Filter Time Constant(Secs)</u>	1	0	1	0.5	2	1	3	2	4	4	5	8	6	16	7	32	<u>Bits 4-7</u>	<u>Large Filter Time Constant(Secs)</u>	0	0	1	0.5	2	1	3	2	4-7	Reserved
<u>Bits 0-3</u>	<u>Small Filter Time Constant(Secs)</u>																																	
1	0																																	
1	0.5																																	
2	1																																	
3	2																																	
4	4																																	
5	8																																	
6	16																																	
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0	0																																	
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2	1																																	
3	2																																	
4-7	Reserved																																	
40097	Setup Channel 0	R/W	0-F	<p>Channel 0 range. Non-volatile write protected register. If the EEPROM cannot be written because of not being enabled, it replies with a Negative Acknowledge Exception response 07h. Modbus function code 10h is limited to 4 data values.</p> <table border="0"> <tr> <td><u>Range:</u></td> <td><u>Bits 0-7 Hex</u></td> </tr> <tr> <td>Disable Channel</td> <td>00</td> </tr> <tr> <td>+/-20mA</td> <td>03</td> </tr> </table> <p>Factory set to 0x0003.</p>	<u>Range:</u>	<u>Bits 0-7 Hex</u>	Disable Channel	00	+/-20mA	03																								
<u>Range:</u>	<u>Bits 0-7 Hex</u>																																	
Disable Channel	00																																	
+/-20mA	03																																	
40098	Setup Channel 1	R/W	0-F	<p>Holds Channel 1 range. Factory set to 0x0003.</p>																														
40099	Setup Channel 2	R/W	0-F	<p>Holds Channel 2 range. Factory set to 0x0003.</p>																														
40100	Setup Channel 3	R/W	0-F	<p>Holds Channel 3 range. Factory set to 0x0003.</p>																														
40101	Setup Channel 4	R/W	0-F	<p>Holds Channel 4 range. Factory set to 0x0003.</p>																														
40102	Setup Channel 5	R/W	0-F	<p>Holds Channel 5 range. Factory set to 0x0003.</p>																														
40103	Setup Channel 6	R/W	0-F	<p>Holds Channel 6 range. Factory set to 0x0003.</p>																														
40116	Trim Zero, +/-20mA Range	WP	0	<p>Force all channel data to 0x8000, input signal = 0. Wait 15 Secs, Write 0x0000.</p>																														
40148	Trim FS, +/-20mA Range	WP	D000-FFFE	<p>Force all channel data to top of range, Wait 15 Sec, Write value (0xfffe if +F.S.).</p>																														
40241	Control Register	W		<p>0 – Normal operation (NOP) 1 – Remote Reset (write protected) 2 – Write Enable 5 – Initialize Host Communication setup</p>																														

Functions:

R Read Only
R/W Read/Write
WP Write-Protected

5.2.5 Seven Channel Current Input Calibration Procedure

Required Equipment:

1. Computer running the DGH Utility Software or another Modbus Master program.
2. A NIST traceable DC Current Standard with +/-20mA range.

Setup Steps – Perform Calibration Steps in Order Listed:

1. Allow unit to warm up for 15 minutes.
2. Connect the positive lead of DC current calibrator to Ch1 +Input terminal.
3. Connect the Ch1 –Input terminal the Ch2 +Input terminal.
4. Connect the Ch2 –Input terminal the Ch3 +Input terminal.
5. Connect the Ch3 –Input terminal the Ch4 +Input terminal.
6. Connect the Ch4 –Input terminal the Ch5 +Input terminal.
7. Connect the Ch5 –Input terminal the Ch6 +Input terminal.
8. Connect the Ch6 –Input terminal the Ch7 +Input terminal.
9. Connect the negative lead of the DC current calibrator to Ch7 –Input terminal.
10. Install the DGH Utility Software or another Modbus Master Program to communicate with, and calibrate with the module via serial port or a TCP/IP connection.
11. Using the DGH Utility Software configure all channels for the +/-20mA range using the data values in Table 1.0 below.

Trim Zero:

1. Set the DC calibrator current output to +0.00mA. Wait 30 seconds.
2. Trim Zero on all channels.
 - a. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - b. Trim Zero on all seven channels by writing a value of 0x0000h to Trim Zero register 40116. See Table 2.0 below.

Trim Span:

1. Set the DC calibrator current output to +20.000mA. Wait 30 seconds.
2. Trim Span on all channels.
 - a. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - b. Trim Span on all seven channels by writing a value of 0xfffe to Trim Span register 40148. See Table 3.0 below.

5.2.6 Seven Channel Current Input Calibration Tables:

Seven Channel Current Register Values		
Channel	Range Control	Range Values
Channel 0	40097	0 = Disabled 3 = +/-20mA
Channel 1	40098	
Channel 2	40099	
Channel 3	40100	
Channel 4	40101	
Channel 5	40102	
Channel 6	40103	

Table 1.0 Register Setup Values.

Trim Zero Register and Calibration Value		
Range	Register	Value
+/-20mA	40116	0000

Table 2.0 Trim Zero Register and Value.

Trim Span Register and Calibration Value		
Range	Register	Value
+/-20mA	40148	FFFE

Table 3.0 Trim Span Register and Value.

5.3 D7300 - Seven Channel Thermocouple Input Module

Overview

The D7300 series analog input module contains seven differential inputs for measuring thermocouple signals. Each analog input channel is user programmable and may be assigned to measure one of 8 different thermocouple types. The D7300 can measure thermocouple types J, K, T, E, R, S, B and C. Any unused channels can be disabled.

Analog to Digital Converter

The D7300 series analog input modules contain a 16-bit analog to digital converter to perform the signal conversion to digital information. The analog to digital converter performs a total of 25 conversions per second. Meaning, if all 7 channels were enabled the each channel would be measured 3+ times per second. The conversion rate per channel can be improved by disabling any unused channels.

Features and Register Assignments

The D7300 series analog input modules contain many user-selectable features. The user can select all features such as baud rate, parity type, analog range selection and digital filtering. The complete list of features is illustrated in the "[Seven Channel Analog Thermocouple Input Register Assignments](#)" register map below. The register map format is used for consistency with the Modbus RTU protocol. The register map contains the register numbers in decimal format, register description, acceptable data values, and list of what each value means. These registers can be written to using most any Modbus master program or using the DGH D6000 series utility software.

Note: All Modbus Register values in the tables below are represented as "decimal" numbers.

Factory Initial Values

The D7300 series analog module features are initialized at the factory with a set of "Initial Values". A complete list of factory "[Initial Values](#)" can be found in the table below.

Calibration

The D7300 series analog input modules are shipped from the factory as fully calibrated devices. Throughout the lifetime of the module there may be need to verify or adjust the calibration of the device. The verification and adjustment process should only be completed using NIST traceable calibration equipment. A D7300 series [Calibration procedure](#) is included below.

Connector Pin Designations

The D7300 series module uses two 3.81mm removable plugs for connecting signals to the module. One two-pin connector is for the power supply connections. A second sixteen-pin connector is used to connect analog input signals to the module. The [pin designations](#) for each connector are printed on the module label and are listed in a table below.

5.3.2 Seven Channel Thermocouple Input Specifications

Connections

Power & Serial Communications

<u>Pin Number</u>	<u>Pin</u>	<u>Designator</u>
1	GND	- Power Supply
2	+VS	+ Power Supply

Analog Input Pin Assignments

<u>Pin Number</u>	<u>Pin</u>	<u>Designator</u>
1	CH1+	CH1 +Input
2	CH1-	CH1 -Input
3	CH2+	CH2 +Input
4	CH2-	CH2 -Input
5	CH3+	CH3 +Input
6	CH3-	CH3 -Input
7	CH4+	CH4 +Input
8	CH4-	CH4 -Input
9	CH5+	CH5 +Input
10	CH5-	CH5 -Input
11	CH6+	CH6 +Input
12	CH6-	CH6 -Input
13	CH7+	CH7 +Input
14	CH7-	CH7 -Input
15	ISO. GND	Isolated GND
16	ISO. GND	Isolated GND

Specifications

Analog Inputs	7 Channels
Input Type	Thermocouple
Differential Reading	CH to CH
Protocol	TCP
Power Supply	Voltage
Power	Power
Connectors	Spacing
	Max Wire Size
	Max Current
Serial LED Displays	Transmit (Top)
	Receive (Bottom)

J,K,T,E,R,S,B,C

+/-10Vdc

Modbus TCP/IP

+10-30Vdc
1.4W

3.81mm
14-24 AWG
8 Amperes

TxData
RxData

5.3.3 Seven Channel Thermocouple Input Module Initial Values

Module Parameter	Value
Slave Address*	1
Baud Rate*	9600
Parity Type*	None
Modbus Response Delay	3mS
Modbus Query Delay	0mS
Conversion Rate	60Hz
Large Signal Filter	0 Seconds
Small Signal Filter	0 Seconds
Channel 0 Range	J-Tc Type
Channel 1 Range	J-Tc Type
Channel 2 Range	J-Tc Type
Channel 3 Range	J-Tc Type
Channel 4 Range	J-Tc Type
Channel 5 Range	J-Tc Type
Channel 6 Range	J-Tc Type

*** = These values should not be changed.**

5.3.4 Seven Channel Thermocouple Input Register Assignments

Register	Description	Functions	Value	Description
40001	Slave Address	R/W	1-DF	Factory set to 0x0001.
40002	UART Setup	R/W		Factory set to 0x0035 = 9600, 8, N, 1.
40003	Modbus Delays	R/W	0-303F	<p><u>Bits 0-7</u> The Response Delay in milliseconds. This is required when the RS-485 adapter cannot tri-state immediately after the last character is transmitted from the host. Maximum value is 63mS. Factory default value is 3.</p> <p><u>Bits 8-15</u> The End of Query Delay in milliseconds (48mS max). This is an additional time that the module will wait prior to marking the end of the message. Slower host computers may not be able transmit a continuous message stream, thereby creating gaps between characters exceeding the normal 3.5 character times limit. Factory default value is 0. Factory set, 0x0003.</p>
40033	Software Version	R		Factory set, Code Version.
40048	Last Converted Chan, Conversion Counter	R	0-06FF	<p><u>Bits 0-7</u> The counter increments each conversion and rolled over after FF. The Conversion Counter indicates when the data registers have been updated.</p> <p><u>Bits 8-10</u> Input channel last conversion stored. The information is useful when all channel data is read back with 1 query. The user can identify which channels have been converted since the last query as long as the time between queries is less than 8 conversion times. Initialized to '0x0000' on device reset.</p>
40049	Channel 0 Data	R	0-FFFF	Data - Ch 0, Offset binary, zero=0x8000.
40050	Channel 1 Data	R	0-FFFF	Data - Channel 1
40051	Channel 2 Data	R	0-FFFF	Data - Channel 2
40052	Channel 3 Data	R	0-FFFF	Data - Channel 3
40053	Channel 4 Data	R	0-FFFF	Data - Channel 4
40054	Channel 5 Data	R	0-FFFF	Data - Channel 5
40055	Channel 6 Data	R	0-FFFF	Data - Channel 6

40095	Misc. Setup	R/W	0-1	<p>Bit 0 – Normal Mode Rejection Setting 0 – 60Hz, 25 Hz Conversion Speed. 1 – 50Hz, 20 Hz Conversion Speed. Factory set to 0x0000.</p>																										
40096	Signal Filtering	R/W	0-3F	<p>This register controls all channels. Time constants are only approximate values.</p> <p><u>Bits 0-3</u> <u>Small Filter Time Constant(Secs)</u></p> <table> <tr><td>2</td><td>0</td></tr> <tr><td>1</td><td>0.5</td></tr> <tr><td>2</td><td>1</td></tr> <tr><td>3</td><td>2</td></tr> <tr><td>4</td><td>4</td></tr> <tr><td>5</td><td>8</td></tr> <tr><td>6</td><td>16</td></tr> <tr><td>7</td><td>32</td></tr> </table> <p><u>Bits 4-7</u> <u>Large Filter Time Constant(Secs)</u></p> <table> <tr><td>0</td><td>0</td></tr> <tr><td>1</td><td>0.5</td></tr> <tr><td>2</td><td>1</td></tr> <tr><td>3</td><td>2</td></tr> <tr><td>4-7</td><td>Reserved</td></tr> </table> <p>Factory set to 0x0000.</p>	2	0	1	0.5	2	1	3	2	4	4	5	8	6	16	7	32	0	0	1	0.5	2	1	3	2	4-7	Reserved
2	0																													
1	0.5																													
2	1																													
3	2																													
4	4																													
5	8																													
6	16																													
7	32																													
0	0																													
1	0.5																													
2	1																													
3	2																													
4-7	Reserved																													
40097	Setup Channel 0	R/W	0-F	<p>Channel 0 range. Non-volatile write protected register. If the EEPROM cannot be written because of not being enabled, it replies with a Negative Acknowledge Exception response 07h. Modbus function code 10h is limited to 4 data values.</p> <table> <thead> <tr> <th>Range:</th> <th>Bits 0-7 Hex</th> </tr> </thead> <tbody> <tr><td>Disable Channel</td><td>00</td></tr> <tr><td>J-Tc (-200-760C)</td><td>21</td></tr> <tr><td>K-Tc (-150-1250C)</td><td>22</td></tr> <tr><td>T-Tc (-200-400C)</td><td>23</td></tr> <tr><td>E-Tc (-100-1000C)</td><td>24</td></tr> <tr><td>R-Tc (+0-1750C)</td><td>25</td></tr> <tr><td>S-Tc (+0-1750C)</td><td>26</td></tr> <tr><td>B-Tc (+0-1820C)</td><td>27</td></tr> <tr><td>C-Tc (+0-2315C)</td><td>28</td></tr> </tbody> </table> <p>Factory set to 0x0003.</p>	Range:	Bits 0-7 Hex	Disable Channel	00	J-Tc (-200-760C)	21	K-Tc (-150-1250C)	22	T-Tc (-200-400C)	23	E-Tc (-100-1000C)	24	R-Tc (+0-1750C)	25	S-Tc (+0-1750C)	26	B-Tc (+0-1820C)	27	C-Tc (+0-2315C)	28						
Range:	Bits 0-7 Hex																													
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S-Tc (+0-1750C)	26																													
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C-Tc (+0-2315C)	28																													
40098	Setup Channel 1	R/W	0-F	<p>Holds Channel 1 range. Factory set to 0x0003.</p>																										
40099	Setup Channel 2	R/W	0-F	<p>Holds Channel 2 range. Factory set to 0x0003.</p>																										
40100	Setup Channel 3	R/W	0-F	<p>Holds Channel 3 range. Factory set to 0x0003.</p>																										
40101	Setup Channel 4	R/W	0-F	<p>Holds Channel 4 range. Factory set to 0x0003.</p>																										
40102	Setup Channel 5	R/W	0-F	<p>Holds Channel 5 range. Factory set to 0x0003.</p>																										
40103	Setup Channel 6	R/W	0-F	<p>Holds Channel 6 range. Factory set to 0x0003.</p>																										
40116	Trim Zero, +/-20mA Range	WP	0	<p>Force all channel data to 0x8000, input signal = 0. Wait 15 Secs, Write 0x0000.</p>																										
40148	Trim FS, +/-20mA Range	WP	D000-FFFE	<p>Force all channel data to top of range, Wait 15 Sec, Write value (0xffff if +F.S.).</p>																										
40241	Control Register	W		<p>0 – Normal operation (NOP) 1 – Remote Reset (write protected) 2 – Write Enable 5 – Initialize Host Communication setup</p>																										

5.3.5 Seven Channel Thermocouple Input Calibration Procedure

Required Equipment:

1. Computer running the DGH Utility Software or another Modbus Master program.
2. A NIST traceable DC Voltage Standard.

Setup Steps – Perform Calibration Steps in Order Listed:

1. Allow unit to warm up for 15 minutes.
2. Connect the positive lead of DC current calibrator to Ch1 +Input terminal.
3. Connect the Ch1 –Input terminal the Ch2 +Input terminal.
4. Connect the Ch2 –Input terminal the Ch3 +Input terminal.
5. Connect the Ch3 –Input terminal the Ch4 +Input terminal.
6. Connect the Ch4 –Input terminal the Ch5 +Input terminal.
7. Connect the Ch5 –Input terminal the Ch6+Input terminal.
8. Connect the Ch6 –Input terminal the Ch7 +Input terminal.
9. Connect the negative lead of the DC current calibrator to Ch7 –Input terminal.
10. Install the DGH Utility Software or another Modbus Master Program to communicate with, and calibrate with the module via serial port or a TCP/IP connection.
11. Using the DGH Utility Software configure all channels for the +/-20mA range using the data values in Table 1.0 below.

Trim Zero:

1. Set the DC calibrator current output to +0.00mV. Wait 30 seconds.
2. Trim Zero on all channels.
 - a. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - b. Trim Zero on all seven channels by writing a value of 0x0000h to Trim Zero register 40116. See Table 2.0 below.

Trim Span:

1. Set the DC calibrator current output to +20.000mA. Wait 30 seconds.
2. Trim Span on all channels.
 - a. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - b. Trim Span on all seven channels by writing a value of 0xfffe to Trim Span register 40148. See Table 3.0 below.

Trim CJC's:

1. Set the input signal to ----.
2. Set all module channels to the J-Thermocouple range.
3. Use the DGH Utility Software or a Modbus Master program to perform steps #4 & #5.
4. Trim Zero on each input channel
 - a. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - b. Write a value of 0x0000h to register 40114.
5. Apply input signal to each channel from Table x.xx.
 - a. Wait 1 minute.
 - b. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - c. Write a value of 0xfffe

Trim Thermocouples:

1. Set the input signal to -----.
2. Set all module channels to the J-Thermocouple range.
3. Use the DGH Utility Software or a Modbus Master program to perform steps #4 & #5.
4. Trim Zero on each input channel
 - a. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - b. Write a value of 0x0000h to register 40114.
5. Apply input signal to each channel from Table x.xx.
 - a. Wait 1 minute.
 - b. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - c. Write a value of 0xfffe

5.3.5 Seven Channel Thermocouple Input Calibration Tables:

Seven Channel Range Register Values			
Channel	Range Control	Range Values	
Channel 0	40097	00	Disabled
Channel 1	40098	04	+/-0.1V
Channel 2	40099	05	+/-0.05V
Channel 3	40100	06	+/-0.025V
Channel 4	40101	21	J-Type TC
Channel 5	40102	22	K-Type TC
Channel 6	40103	23	T-Type TC
		24	E-Type TC
		25	R-Type TC
		26	S-Type TC
		27	B-Type TC
		28	C-Type TC

Table 1.0 Register Setup Values.

Trim Zero Registers and Calibration Values		
Range	Register	Value
+/-10Vdc	40114	0000
+/-5Vdc	40115	0000
+/-1Vdc	40116	0000
+/-0.1Vdc	40117	0000
+/-0.05Vdc	40118	0000
+/-0.025Vdc	40119	0000

Table 2.0 Trim Zero Registers and Values.

Trim Span Registers and Calibration Values		
Range	Register	Value
+/-0.025Vdc	40151	FFFE
+/-0.05Vdc	40150	FFFE
+/-0.1Vdc	40149	FFFE
+/-1Vdc	40148	FFFE
+/-5Vdc	40147	FFFE
+/-10Vdc	40146	FFFE

Table 3.0 Trim Span Registers and Values.

CJC Calibration Registers and Values			
Channels	Register	Increase Value	Decrease Value
0..3	40129	0001	0000
4..6	40130	0001	0000

Table 4.0 Trim CJC Registers and Values.

5.4 D7400 - Seven Channel Voltage, Thermocouple, Current Input Module

Overview

The D7400 series analog input module contains seven analog inputs for measuring voltages, thermocouples and current. Each analog input channel is user programmable and may be assigned to different input types.

When measuring voltages or thermocouples, simply use the Utility Software to select the type of signal and range. When configuring any channel to measure current loops or 4-20mA signals then the Input range can be set to either the +/-1Vdc or +/-20mA selections. The module uses the +/-1Vdc range to measure current up to 20mA.

When measuring current signals then a measurement sense resistor must be enabled via jumpers inside the module. Each channel has a jumper strip that must be shorted using a provided shorting bar to enable the sense resistor. The sense resistor is internally connected directly across the channel+ and channel- input pins. See the D7400 board layout below for instructions on taking the module and enabling the jumpers.

Analog to Digital Converter

The D7400 series analog input modules contain a 16-bit analog to digital converter to perform the signal conversion to digital information. The analog to digital converter performs a total of 25 conversions per second. Meaning, if all 7 channels were enabled the each channel would be measured 3+ times per second. The conversion rate per channel can be improved by disabling any unused channels.

Features and Register Assignments

The D7400 series analog input modules contain many user-selectable features. The user can select all features such as baud rate, parity type, analog range selection and digital filtering. The complete list of features is illustrated in the "[Seven Channel Voltage, Thermocouple and Current Input Register Assignments](#)" register map below. The register map format is used for consistency with the Modbus RTU protocol. The register map contains the register numbers in decimal format, register description, acceptable data values, and list of what each value means. These registers can be written to using most any Modbus master program or using the DGH D6000 series utility software.

Note: All Modbus Register values in the tables below are represented as "decimal" numbers.

Factory Initial Values

The D7400 series analog module features are initialized at the factory with a set of "Initial Values". A complete list of factory "[Initial Values](#)" can be found in the table below.

Calibration

The D7400 series analog input modules are shipped from the factory as fully calibrated devices. Throughout the lifetime of the module there may be need to verify or adjust the calibration of the device. The verification and adjustment process should only be completed using NIST traceable calibration equipment. A D7400 series [Calibration procedure](#) is included below.

Connector Pin Designations

The D7400 series module uses two 3.81mm removable plugs for connecting signals to the module. One two-pin connector is for the power supply connections. A second sixteen-pin connector is used to connect analog input signals to the module. The [pin designations](#) for each connector are printed on the module label and are listed in a table below.

5.4.1 Seven Channel Voltage, Thermocouple, Current Input Pin Assignments and Specifications

Connections

Power & Serial Communications

<u>Pin Number</u>	<u>Pin</u>	<u>Designator</u>
1	GND	- Power Supply
2	+VS	+ Power Supply

Analog Input Pin Assignments

<u>Pin Number</u>	<u>Pin</u>	<u>Designator</u>
1	CH1+	CH1 +Input
2	CH1-	CH1 -Input
3	CH2+	CH2 +Input
4	CH2-	CH2 -Input
5	CH3+	CH3 +Input
6	CH3-	CH3 -Input
7	CH4+	CH4 +Input
8	CH4-	CH4 -Input
9	CH5+	CH5 +Input
10	CH5-	CH5 -Input
11	CH6+	CH6 +Input
12	CH6-	CH6 -Input
13	CH7+	CH7 +Input
14	CH7-	CH7 -Input
15	ISO. GND	Isolated GND
16	ISO. GND	Isolated GND

Specifications

Analog Inputs	7 Channels
User Selectable Input Ranges	
Bipolar Voltage	10V, 5V, 1V, 0.1V, 0.05V, 0.025V
Thermocouple	J,K,T,E,R,S,B,C
Current	+/-20mA
Differential Reading	CH to CH
Protocol	Modbus TCP/IP
TCP	
Power Supply	
Voltage	+10-30Vdc
Power	1.4W
Connectors	
Spacing	3.81mm
Max Wire Size	14-24 AWG
Max Current	8 Amperes
Serial LED Displays	
Transmit (Top)	TxData
Receive (Bottom)	RxData

5.4.2 Seven Channel Voltage, Thermocouple and Current Input Initial Values

Module Parameter	Value
Slave Address	1
Baud Rate	9600
Parity Type	None
Modbus Response Delay	3mS
Modbus Query Delay	0mS
Conversion Rate	60Hz
Large Signal Filter	0 Seconds
Small Signal Filter	0 Seconds
Channel 1 Range	+/-10Vdc
Channel 2 Range	+/-10Vdc
Channel 3 Range	+/-10Vdc
Channel 4 Range	+/-10Vdc
Channel 5 Range	+/-10Vdc
Channel 6 Range	+/-10Vdc
Channel 7 Range	+/-10Vdc

5.4.3 Seven Channel Voltage, Thermocouple and Current Input Register Assignments

Register	Description	Functions	Value	Description
40001	Slave Address	R/W	1-DF	Factory set to 0x0001.
40002	UART Setup	R/W		<p><u>Bits 0-4 Baud Rate</u> 5=9600 6=19.2K 7=38.4K 8=57.6K 9=115.2K</p> <p><u>Bits 5-6 Parity</u> 0=No Parity, 8-N-2 1=Odd 2=Even 3=No Parity, 8-N-1 Factory set to 0x0035 = 9600, 8, N, 1.</p>
40003	Modbus Delays	R/W	0-303F	<p><u>Bits 0-7</u> The Response Delay in milliseconds. This is required when the RS-485 adapter cannot tri-state immediately after the last character is transmitted from the host. Maximum value is 63mS. Factory default value is 3.</p> <p><u>Bits 8-15</u> The End of Query Delay in milliseconds (48mS max). This is an additional time that the module will wait prior to marking the end of the message. Slower host computers may not be able transmit a continuous message stream, thereby creating gaps between characters exceeding the normal 3.5 character times limit. Factory default value is 0. Factory set, 0x0003.</p>
40033	Software Version	R		Factory set, Code Version.
40048	Last Converted Chan, Conversion Counter	R	0-06FF	<p><u>Bits 0-7</u> The counter increments each conversion and rolled over after FF. The Conversion Counter indicates when the data registers have been updated.</p> <p><u>Bits 8-10</u> Input channel last conversion stored. The information is useful when all channel data is read back with 1 query. The user can identify which channels have been converted since the last query as long as the time between queries is less than 8 conversion times. Initialized to '0x0000' on device reset.</p>
40049	Channel 1 Data	R	0-FFFF	Data - Ch 1, Offset binary, zero=0x8000.
40050	Channel 2 Data	R	0-FFFF	Data - Channel 2
40051	Channel 3 Data	R	0-FFFF	Data - Channel 3
40052	Channel 4 Data	R	0-FFFF	Data - Channel 4
40053	Channel 5 Data	R	0-FFFF	Data - Channel 5
40054	Channel 6 Data	R	0-FFFF	Data - Channel 6
40055	Channel 7 Data	R	0-FFFF	Data - Channel 7

40095	Misc. Setup	R/W	0-1	<p>Bit 0 – Normal Mode Rejection Setting 0 – 60Hz, 25 Hz Conversion Speed. 1 – 50Hz, 20 Hz Conversion Speed. Factory set to 0x0000.</p>																																		
40096	Signal Filtering	R/W	0-3F	<p>This register controls all channels. Time constants are only approximate values.</p> <table> <thead> <tr> <th>Bits 0-3</th> <th>Small Filter Time Constant(Secs)</th> </tr> </thead> <tbody> <tr><td>3</td><td>0</td></tr> <tr><td>1</td><td>0.5</td></tr> <tr><td>2</td><td>1</td></tr> <tr><td>3</td><td>2</td></tr> <tr><td>4</td><td>4</td></tr> <tr><td>5</td><td>8</td></tr> <tr><td>6</td><td>16</td></tr> <tr><td>7</td><td>32</td></tr> </tbody> </table> <table> <thead> <tr> <th>Bits 4-7</th> <th>Large Filter Time Constant(Secs)</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td></tr> <tr><td>1</td><td>0.5</td></tr> <tr><td>2</td><td>1</td></tr> <tr><td>3</td><td>2</td></tr> <tr><td>4-7</td><td>Reserved</td></tr> </tbody> </table> <p>Factory set to 0x0000.</p>	Bits 0-3	Small Filter Time Constant(Secs)	3	0	1	0.5	2	1	3	2	4	4	5	8	6	16	7	32	Bits 4-7	Large Filter Time Constant(Secs)	0	0	1	0.5	2	1	3	2	4-7	Reserved				
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1	0.5																																					
2	1																																					
3	2																																					
4-7	Reserved																																					
40097	Setup Channel 1	R/W	0-F	<p>Channel 1 range. Non-volatile write protected register. If the EEPROM cannot be written because of not being enabled, it replies with a Negative Acknowledge Exception response 07h. Modbus function code 10h is limited to 4 data values.</p> <table> <thead> <tr> <th>Range:</th> <th>Bits 0-7 Hex</th> </tr> </thead> <tbody> <tr><td>Disable Channel</td><td>00</td></tr> <tr><td>+/-10V</td><td>01</td></tr> <tr><td>+/-5V</td><td>02</td></tr> <tr><td>+/-1V</td><td>03</td></tr> <tr><td>+/-0.100V</td><td>04</td></tr> <tr><td>+/-0.050V</td><td>05</td></tr> <tr><td>+/-0.025V</td><td>06</td></tr> <tr><td>J-Tc (-200-760C)</td><td>21</td></tr> <tr><td>K-Tc (-150-1250C)</td><td>22</td></tr> <tr><td>T-Tc (-200-400C)</td><td>23</td></tr> <tr><td>E-Tc (-100-1000C)</td><td>24</td></tr> <tr><td>R-Tc (+0-1750C)</td><td>25</td></tr> <tr><td>S-Tc (+0-1750C)</td><td>26</td></tr> <tr><td>B-Tc (+0-1820C)</td><td>27</td></tr> <tr><td>C-Tc (+0-2315C)</td><td>28</td></tr> <tr><td>+/-20mA Current</td><td>03 (Special)</td></tr> </tbody> </table> <p>Factory set to 0x0001.</p>	Range:	Bits 0-7 Hex	Disable Channel	00	+/-10V	01	+/-5V	02	+/-1V	03	+/-0.100V	04	+/-0.050V	05	+/-0.025V	06	J-Tc (-200-760C)	21	K-Tc (-150-1250C)	22	T-Tc (-200-400C)	23	E-Tc (-100-1000C)	24	R-Tc (+0-1750C)	25	S-Tc (+0-1750C)	26	B-Tc (+0-1820C)	27	C-Tc (+0-2315C)	28	+/-20mA Current	03 (Special)
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C-Tc (+0-2315C)	28																																					
+/-20mA Current	03 (Special)																																					
40098	Setup Channel 2	R/W	0-F	<p>Holds Channel 2 range. Factory set to 0x0001.</p>																																		
40099	Setup Channel 3	R/W	0-F	<p>Holds Channel 3 range. Factory set to 0x0001.</p>																																		
40100	Setup Channel 4	R/W	0-F	<p>Holds Channel 4 range. Factory set to 0x0001.</p>																																		
40101	Setup Channel 5	R/W	0-F	<p>Holds Channel 5 range. Factory set to 0x0001.</p>																																		
40102	Setup Channel 6	R/W	0-F	<p>Holds Channel 6 range. Factory set to 0x0001.</p>																																		
40103	Setup Channel 7	R/W	0-F	<p>Holds Channel 7 range. Factory set to 0x0001.</p>																																		
40114	Trim Zero, 10V Range	WP	0	<p>Forces all Channel Data Registers to 8000h, with input signal equal to zero. Apply calibration signal at least 15 seconds prior to calibrating to all</p>																																		

				channels. Calibration Acknowledge Exception Response. Calibration takes 20 seconds.
40115	Trim Zero, 5V Range	WP	0	Refer to Modbus register 40072.
40116	Trim Zero, 1V Range	WP	0	Refer to Modbus register 40072.
40117	Trim Zero, 0.1V Range	WP	0	Refer to Modbus register 40072. Apply calibration signal at least 1 minute prior to calibrating to all channels.
40118	Trim Zero, 0.05V Range	WP	0	Refer to Modbus register 40072. Apply calibration signal at least 1 minute prior to calibrating to all channels.
40119	Trim Zero, 0.025V Range	WP	0	Refer to Modbus register 40072. Apply calibration signal at least 1 minute prior to calibrating to all channels.
40129	Trim CJC 0	WP	0-1	Pre-calibrate appropriate mV range. Attach thermocouple to channel 1, with measurement end in ice bath. Writing a 1 will increase Modbus TC output. Writing a 0 will decrease Modbus TC output. No Trim for R, S, B, C Types.
40130	Trim CJC 1	WP	0-1	Pre-calibrate appropriate mV range. Attach thermocouple to channel 5, with measurement end in ice bath. Writing a 1 will increase Modbus TC output. Writing a 0 will decrease Modbus TC output. No Trim for R, S, B, C Types.
40146	Trim FS, 10V Range	WP	D000-FFFFE	Forces all Channel Data Registers to written value, with appropriate input signal. Apply calibration signal at least 15 seconds prior to calibrating to all channels. Acknowledge Exception Response. Calibration takes 20 seconds. See note 1.
40147	Trim FS, 5V Range	WP	D000-FFFFE	See Modbus Register 40146.
40148	Trim FS, 1V Range	WP	D000-FFFFE	See Modbus Register 40146.
40149	Trim FS, 0.1V Range	WP	D000-FFFFE	See Modbus Register 40146. Apply calibration signal at least 1 minute prior to calibrating to all channels.
40150	Trim FS, 0.05V Range	WP	D000-FFFFE	See Modbus Register 40146. Apply calibration signal at least 1 minute prior to calibrating to all channels.
40151	Trim FS, 0.025V Range	WP	D000-FFFFE	See Modbus Register 40146. Apply calibration signal at least 1 minute prior to calibrating to all channels.
40241	Control Register	W		0 – Normal operation (NOP) 1 – Remote Reset (write protected) 2 – Write Enable 5 – Initialize Host Communication setup

Functions:

R Read Only
R/W Read/Write
WP Write-Protected

5.4.4 Seven Channel Voltage, Thermocouple and Current Input Calibration Procedure

Required Equipment:

1. Computer running the DGH Utility Software or another Modbus Master program.
2. A NIST traceable DC Voltage Standard with +/-10Vdc range.

Setup Steps – Perform Calibration Steps in Order Listed:

1. Allow unit to warm up for 15 minutes.
2. Short all the +Input pins together using short jumper wires.
3. Short all the -Input pins together using short jumper wires.
4. Connect the +Input wires to the Positive terminal on the DC voltage calibrator.
5. Connect the -Input wires to the Negative terminal on the DC voltage calibrator.
6. Install the DGH Utility Software or another Modbus Master Program to communicate with, and calibrate with the module via serial port or a TCP/IP connection.

Trim Zero:

1. Set the DC calibrator voltage output to +0.0000Vdc.
2. Use the DGH Utility Software or a Modbus Master program to perform steps #3 & #5.
3. Set all channels to the same range. Start with +/-10Vdc range, work downward as per values in Table 1.0.
4. Trim Zero on all channels.
 - a. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - b. Retrieve Trim Zero register value for specific range from Table 2.0 below.
 - c. Write value of 0x00h to Range Trim Zero register, (ie. 40114 for +/-10V).
 - d. Perform steps #4a through #4c to trim zero on each range.

Trim Span:

1. Set the DC calibrator voltage output to +10.000Vdc.
2. Use the DGH Utility Software or a Modbus Master program to perform steps #3 & #5.
3. Set all channels to the same range. Start with +/-0.025Vdc range, work upward as per values in Table 3.0.
4. Trim Span on each channel.
 - a. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - b. Retrieve Trim Span register value for specific range from Table 2.0 below.
 - c. Write value of 0xfffe to Trim Span register, (ie. 40146 for +/-10V).
 - d. Perform steps #4a through #4c to trim span on each range.

Trim CJC's:

1. Set the input signal to -----.
2. Set all module channels to the J-Thermocouple range.
3. Use the DGH Utility Software or a Modbus Master program to perform steps #4 & #5.
4. Trim Zero on each input channel
 - a. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - b. Write a value of 0x0000h to register 40114.
5. Apply input signal to each channel from Table x.xx.
 - a. Wait 1 minute.
 - b. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - c. Write a value of 0xfffe

Trim Thermocouples:

1. Set the input signal to -----.
2. Set all module channels to the J-Thermocouple range.
3. Use the DGH Utility Software or a Modbus Master program to perform steps #4 & #5.
4. Trim Zero on each input channel
 - a. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - b. Write a value of 0x0000h to register 40114.
5. Apply input signal to each channel from Table x.xx.
 - a. Wait 1 minute.
 - b. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - c. Write a value of 0xfffe

5.4.5 Seven Channel Voltage, Thermocouple and Current Input Calibration Tables:

Seven Channel Range Register Values			
Channel	Range Control	Range Values	
Channel 1	40097	00	Disabled
Channel 2	40098	01	+/-10V
Channel 3	40099	02	+/-5V
Channel 4	40100	03	+/-1V
Channel 5	40101	04	+/-0.1V
Channel 6	40102	05	+/-0.05V
Channel 7	40103	06	+/-0.025V
		21	J-Type TC
		22	K-Type TC
		23	T-Type TC
		24	E-Type TC
		25	R-Type TC
		26	S-Type TC
		27	B-Type TC
		28	C-Type TC

Table 1.0 Register Setup Values.

Trim Zero Registers and Calibration Values		
Range	Register	Value
+/-10Vdc	40114	0000
+/-5Vdc	40115	0000
+/-1Vdc	40116	0000
+/-0.1Vdc	40117	0000
+/-0.05Vdc	40118	0000
+/-0.025Vdc	40119	0000

Table 2.0 Trim Zero Registers and Values.

Trim Span Registers and Calibration Values		
Range	Register	Value
+/-0.025Vdc	40151	FFFE
+/-0.05Vdc	40150	FFFE
+/-0.1Vdc	40149	FFFE
+/-1Vdc	40148	FFFE
+/-5Vdc	40147	FFFE
+/-10Vdc	40146	FFFE

Table 3.0 Trim Span Registers and Values.

CJC Calibration Registers and Values			
Channels	Register	Increase Value	Decrease Value
0..3	40129	0001	0000
4..6	40130	0001	0000

Table 4.0 Trim CJC Registers and Values.

5.4.6 D7400 Current Channel Enable:

Overview

The following information details how to open the D7400 module and enable or disable current channels.

Default from the Factory

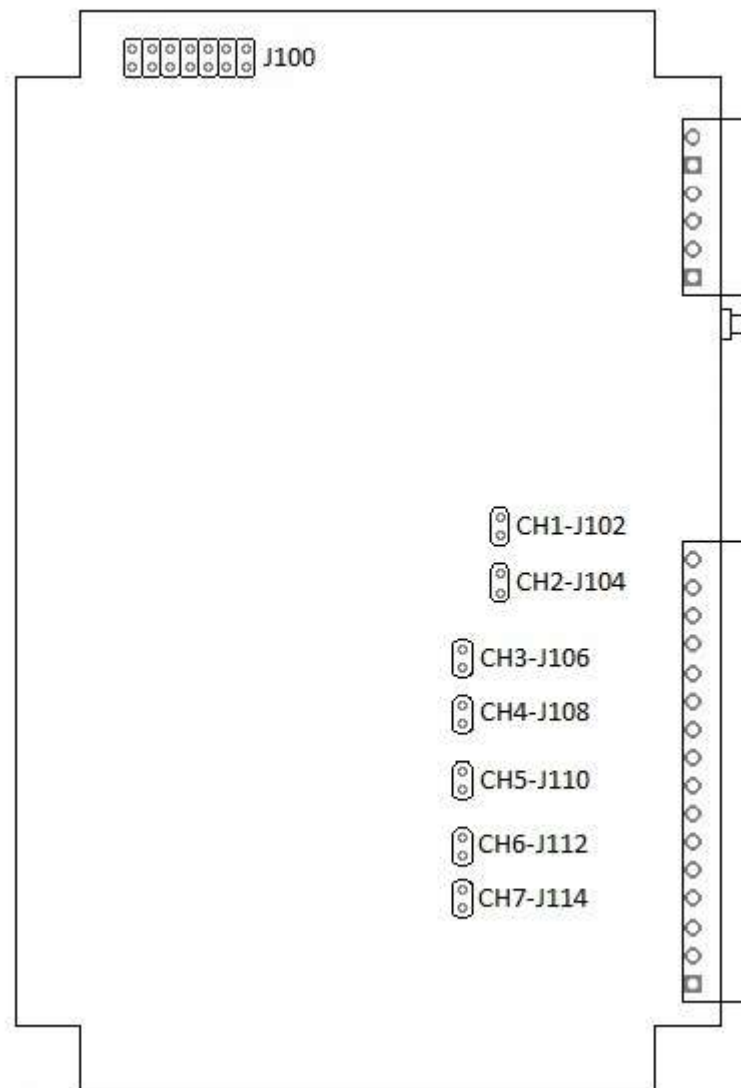
No current enabling jumpers are installed at the factory. All channels are initialized as voltage inputs.

Open the Module

Remove the top cover of the D7400 module by unscrewing the four screws on the top cover. With the cover removed, locate J100, a storage strip that contains up to seven unused jumpers. Then locate the CH1 through CH7 jumper strips that enable current channels.

Move the Jumpers

To enable any channel as a current input channel, simply move a jumper from J100 to the specific channel jumper strip. To disable a current input channel, simply move the jumper from the channel jumper strip back to J100. See the image below for the location of the pin strips versus channels.



5.5 D7500 Two Channel Analog Output Module

Overview

The D7500 series analog output module contains two 12-bit analog outputs for controlling process control devices. Each analog output signal can be configured as either a voltage or current output. Two voltage ranges and two current ranges can be selected for maximum flexibility to control many different process control devices.

Analog Outputs

The D7500 series analog outputs can be configured as either voltage outputs or current outputs.

Features and Register Assignments

The D7500 series modules contain many user-selectable features. The user can select all features such as baud rate, parity type, power-on “safe” analog output value and communications watchdog timer interval. The complete list of features is illustrated in the [“Two Channel Analog Output Register Assignments”](#) register map below. The register map format is used for consistency with the Modbus RTU protocol. The register map contains the register numbers in decimal format, register description, acceptable data values, and list of what each value means. These registers can be written to using most any Modbus master program or using the DGH D6000 series utility software.

Note: All Modbus Register values in the tables below are represented as “decimal” numbers.

Factory Initial Values

The D7700 series analog output modules are initialized at the factory with a set of “Initial Values”. A complete list of factory [“Initial Values”](#) can be found in the table below.

Communications Watchdog Timer

The D7500 series digital output module contains a user-programmable communications watchdog timer. The communications watchdog timer can be used to force the analog output signals to a known “safe” condition in the event that communications are lost to the module. The known “safe” condition can be user-programmed into the module Initial Value register.

Connector Pin Designations

The D7500 series module uses two 3.81mm removable plugs for connecting signals to the module. One two-pin connector is for the power supply connections. A second eight-pin connector is used to connect analog output signals to control devices. The [pin designations](#) for each connector are printed on the module label and are listed in a table below.

5.5.1 Two Channel Analog Output Pin Assignments and Specifications

Connections

Power & Serial Communications

<u>Pin Number</u>	<u>Pin</u>	<u>Designator</u>
1	GND	- Power Supply
2	+VS	+ Power Supply

Analog Output Pin Assignments

<u>Pin Number</u>	<u>Pin</u>	<u>Designator</u>
1	CH1 +I	#1-+Current Out
2	CH1 -I	#1- -Current Out
3	CH1 +V	#1- +Voltage Out
4	CH1 -V	#1- -Voltage Out
5	CH2 +I	#2- +Current Out
6	CH2 -I	#2- -Current Out
7	CH2 +V	#2- +Voltage Out
8	CH2 -V	#2- -Voltage Out

Notes:

- Each channel can be used as either a voltage output or a current output. But not both at the same time.
- When using a channel as a current output there must be no connections on +/-V Output pins.

Specifications

Analog Outputs 2 Channels

User Selectable Input Ranges
Voltage Ranges 0-10V,
 +/-10V,

Current Ranges 4-20mA,
 0-20mA

Protocol

TCP Modbus TCP/IP

Power Supply

Voltage +10-30Vdc

Power 2.1W

Connectors

Spacing 3.81mm

Max Wire Size 14-24 AWG

Max Current 8 Amperes

Serial LED Displays

Transmit (Top) TxData

Receive (Bottom) RxData

5.5.2 Two Channel Analog Output Register Assignments

Register	Description	Functions	Value	Description
40001	Slave Address	R/WP	1-DF	Factory set to 0x0001.
40002	UART Setup	R/WP	5-9	Factory set to 0x0035 = 9600, 8, N, 1.
40003	Modbus Delays	R/WP	0-303F	<p><u>Bits 0-7</u> The Response Delay in milliseconds. This is required when the RS-485 adapter cannot tri-state immediately after the last character is transmitted from the host. Maximum value is 63mS. Factory default value is 3.</p> <p><u>Bits 8-15</u> The End of Query Delay in milliseconds (48mS max). This is an additional time that the module will wait prior to marking the end of the message. Slower host computers may not be able transmit a continuous message stream, thereby creating gaps between characters exceeding the normal 3.5 character times limit. Factory default value is 0. Factory set to 0x0003.</p>
40033	Software Version	R		Factory set from data value in source code.
40049	Analog Out CH1	R/W	0-FFFF	0= -FS, FFFF= +FS, Set analog output, DAC value after slewing.
40050	Analog Out Ch2	R/W	0-FFFF	See Register 49.
40065	Slope CH1	R/W	0-12	<p>On the fly slope. Reset default slope from EEPROM.</p> <p>0 – Immediate 1 – 0.156% Span/s 2 – 0.310 3 – 0.625 4 – 1.25 5 – 2.50 6 – 5 7 – 10 8 – 20 9 – 40 A – 80 B – 160 C – 320 D – 640 E – 1280 F – 2560 10 – 5120 11 – 10240 12 – 20480</p> <p>$V/S = \% \text{ Span/s (Span)}/100$ i.e. for slope= 10, $5120(10)/100=512V/S$ Factory set to 0x0000.</p>
40066	Slope CH2	R/W	0-1FFFF	<p>On the fly slope. Factory set to 0x0000.</p>
40097	ADC Read CH1	R	0-FFFF	Readback CH1, 8 bit resolution.
40098	ADC Read CH2	R		Readback CH2, 8 bit resolution.
40113	Present Output CH1	R	0-FFFF	Normalized present DAC value. Present Output may differ from Setpoint, if output has not reached to its final value.
40114	Present Output CH2	R	0-FFFF	Normalized present DAC value. Present Output may differ from Setpoint, if output has not reached to its final value.

40144	Watchdog Time-out Interval	RWP	0-FFFF	The interval of time in seconds that must lapse after the last communication to the module or since power was applied, before the Watchdog is triggered and the outputs are set to the Initial Value. Effective immediately. The purpose of the Watchdog Timer is to force the analog outputs to a known safe value in the event of a host or communications link failure. The Watchdog Timer may be disabled, by setting the value to FFFF Hex. Accuracy is 10%. Factory set to 0xFFFF.
40145	Setup CH1	RWP		Holds Channel 1 range and slope setup. On the fly slope changed immediately. Setup change is immediate. <u>Bits 0-2</u> 0 – 0-10V 1 – +/-10V 2 – 4-20mA 3 – 0-20mA <u>Bits 3-7</u> 0 – Immediate 1 – 0.156% Span/s 2 – 0.31 3 – 0.625 4 – 1.25 5 – 2.50 6 – 5 7 – 10 8 – 20 9 – 40 A – 80 B –160 C – 320 D – 640 E – 1280 F – 2560 10 – 5120 11 – 10240 12 – 20480 V/S=% Span/s (Span)/100 i.e. for slope= 10, 5120(10)/100=512V/S Factory set to 0x0000.
40146	Initial Value CH1	RWP	0-FFFF	Power-Up or Reset analog output value. Factory set to 0x0000.
40147	Setup CH2	RWP		Holds Channel 2 range and slope setup. Factory set to 0x0000.
40148	Initial Value CH2	RWP	0-FFFF	Power-Up or Reset analog output value. Factory set to 0x0000.
40177	Increase Min Output Calibration	WP	0-1	Increases output of selected channel, by 1 LSB. Output must be previously set to minimum value in table xx. Repeat as needed get the desired output. The effect is immediate. Write 0 for Channel 1 Write 1 for Channel 2
40178	Decrease Min Output Calibration	WP	0-1	Decreases output of selected channel, by 1 LSB. Output must be previously set to minimum value in table xx. Repeat as needed to get desired output. The effect is immediate. Write 0 for Channel 1 Write 1 for Channel 2

40179	Increase Max Output Calibration	WP	0-1	Increases output of selected channel, by 1 LSB. Output must be previously set to maximum value in table xx. Repeat as needed get the desired output. The effect is immediate. Write 0 for Channel 1 Write 1 for Channel 2
40180	Decrease Max Output Calibration	WP	0-1	Decreases output of selected channel, by 1 LSB. Output must be previously set to maximum value in table xx. Repeat as needed to get desired output. The effect is immediate. Write 0 for Channel 1 Write 1 for Channel 2
40181	Trim ADC	WP	0-1	Forces output of selected channel (data value) to minimum and maximum values momentarily, and calibrates readback ADC to coincide. Output is then restored to original value when calibration is completed. The effect is immediate.
40241	Control	W		0 – Normal operation (NOP) 1 – Remote Reset (write protected) 2 – Write Enable 5 – Initialize Host communications setup

Functions:

R Read Only
R/W Read/Write
WP Write-Protected

Notes:

1. Values written to Registers 40049 and 40050 **must not** be preceded by a Write-Protect command.

5.5.3 Two Channel Analog Output Initial Factory Values

Module Parameter	Value
Slave Address*	1
Baud Rate*	9600
Parity Type*	None
Modbus Response Delay	3mS
Modbus Query Delay	0mS
Conversion Rate	60Hz
Channel 0 on the fly slope	Immediate
Channel 1 on the fly slope	Immediate
Watchdog Timer Low Word	0xffff, = Disabled
Channel 0 Range	0-10Vdc
Channel 0 Slope	Immediate
Channel 0 Initial Value	0Vdc
Channel 1 Range	0-10Vdc
Channel 1 Slope	Immediate
Channel 1 Initial Value	0Vdc

*** = These values should not be changed.**

5.5.4 Analog Voltage Output Calibration Procedure

Required Equipment

1. Computer running the DGH Utility Software or another Modbus Master program.
2. A NIST traceable Digital multimeter (DMM) with +/-10Vdc range.

Setup Steps – Perform Calibration Steps in Order Listed:

1. Allow unit to warm up for 15 minutes.
2. Connect positive (+) lead of the DMM to the Ch1+Vout terminal.
3. Connect negative (-) lead of the DMM to the Ch1 IsoGnd terminal.
4. Install the DGH Utility Software or another Modbus Master Program to communicate with, and calibrate with the module via serial port or a TCP/IP connection.
5. Remove all connections to the +Iout and –Iout terminals on Ch1 and Ch2.

Trim Negative Full Scale:

1. Using the DGH Utility Software configure both Ch1 and Ch2 analog output ranges to the +/-10Vdc range. See Table 1.0 below for register and data values.
2. Use the DGH Utility Software set Ch1 and Ch2 analog outputs to their –Full Scale value. See Table 2.0 below for register and data values.
3. Trim Negative Full Scale.
 - a. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - b. Trim the Negative Full Scale output using the register and data value in Table 3.0 below. Write value the channel value to the proper register to increase or decrease the analog output signal to match the –Full Scale output value.
4. Move the DMM leads to the Ch2 +Vout and IsoGnd terminals.
5. Repeat steps 3a and 3b to trim the negative full-scale output of Ch2.

Trim Positive Full Scale:

1. Move the DMM leads to the Ch1 +Vout and –Vout terminals.
2. Use the DGH Utility Software set Ch1 and Ch2 analog outputs to their +Full Scale value. See Table 2.0 below for register and data values.
3. Trim Positive Full Scale.
 - a. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - b. Trim the Positive Full Scale output using the register and data value in Table 4.0 below. Write value the channel value to the proper register to increase or decrease the analog output signal to match the +Full Scale output value.
4. Move the DMM leads to the Ch2 +Vout and IsoGnd terminals.
5. Repeat steps 3a and 3b to trim the positive full-scale output of Ch2.

Using the DGH Utility Software set the Ch1 and Ch2 analog output ranges to +10Vdc range.
Repeat steps above calibrate the 0-10Vdc range.

5.5.5 Analog Current Output Calibration Procedure

Required Equipment

1. Computer running the DGH Utility Software or another Modbus Master program.
2. A NIST traceable Digital multimeter (DMM) with 0-20mA range.

Setup Steps – Perform Calibration Steps in Order Listed:

1. Allow unit to warm up for 15 minutes.
2. Connect positive (+) lead of the DMM to the Ch1 +Iout terminal.
3. Connect negative (-) lead of the DMM to the Ch1 -Iout terminal.
4. Install the DGH Utility Software or another Modbus Master Program to communicate with, and calibrate with the module via serial port or a TCP/IP connection.
5. Remove all connections to the +Vout and –Vout terminals on Ch1 and Ch2.

Trim Negative Full Scale:

1. Using the DGH Utility Software configure both Ch1 and Ch2 analog output ranges to the 0-20mA range. See Table 1.0 below for register and data values.
2. Use the DGH Utility Software set Ch1 and Ch2 analog outputs to their –Full Scale value. See Table 2.0 below for register and data values.
3. Trim Negative Full Scale.
 - a. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - b. Trim the Negative Full Scale output using the register and data value in Table 3.0 below. Write value the channel value to the proper register to increase or decrease the analog output signal to match the –Full Scale output value.
4. Move the DMM leads to the Ch2 +Iout and –Iout terminals.
5. Repeat steps 3a and 3b to trim the negative full-scale output of Ch2.

Trim Positive Full Scale:

1. Move the DMM leads to the Ch1 +Iout and –Iout terminals.
2. Use the DGH Utility Software set Ch1 and Ch2 analog outputs to their +Full Scale value. See Table 2.0 below for register and data values.
3. Trim Positive Full Scale.
 - a. Write a value of 0x0002h to Control Register 40241 to Write-Enable the module.
 - b. Trim the Positive Full Scale output using the register and data value in Table 4.0 below. Write value the channel value to the proper register to increase or decrease the analog output signal to match the +Full Scale output value.
4. Move the DMM leads to the Ch2 +Iout and –Iout terminals.
5. Repeat steps 3a and 3b to trim the positive full-scale output of Ch2.

Using the DGH Utility Software set the Ch1 and Ch2 analog output ranges to 4-20mA range.
Repeat steps above to calibrate the 4-20mA range.

5.5.6 Analog Output Calibration Register Tables and Values

<u>Channel Range Registers and Values</u>		
<u>Channel</u>	<u>Range Control</u>	<u>Range Values</u>
Channel 1	40145	0 = 0-10Vdc
Channel 2	40146	1 = +/-10Vdc 2 = 4-20mA 3 = 0-20mA

Table 1.0 Analog Output Range Registers and Values.

<u>Analog Output Registers</u>			
<u>Channel</u>	<u>Register</u>	<u>Force -FS Output</u>	<u>Force +FS Output</u>
Channel 1	40049	0000	FFFF
Channel 2	40050	0000	FFFF

Table 2.0 Analog Output Register and Calibration Values.

<u>Trim Negative Full Scale Calibration Registers and Values</u>			
<u>Register</u>	<u>-Full Scale Output Adjust</u>	<u>CH1</u>	<u>CH2</u>
40177	Increase Signal	0000	0001
40178	Decrease Signal	0000	0001

Table 3.0 Trim Negative Full Scale Calibration Registers and Values.

<u>Trim Positive Full Scale Calibration Registers and Values</u>			
<u>Register</u>	<u>+Full Scale Signal Adjust</u>	<u>CH1</u>	<u>CH2</u>
40179	Increase Signal	0000	0001
40180	Decrease Signal	0000	0001

Table 4.0 Trim Positive Full Scale Calibration Registers and Values.

5.6 D7710 - Fifteen Bit Digital Input Module

Overview

The D7710 series module contains fifteen digital inputs to monitor process signals such as logic-level status, relay contacts, switch closures, and dry-contacts.

Digital Inputs

The D7710 digital input bits accept signals between +/-30Vdc without damage and contain internal 10K pull-up resistors for direct connection to dry-contacts.

The digital input logic level switching levels are less than 1.0Vdc for logic “0” and greater than +3.5Vdc for a logic “1”.

Features and Register Assignments

The D7710 series digital input modules contain many user-selectable features. The complete list of features is illustrated in the [“Fifteen Bit Digital I/O Register Assignments”](#) map below. The register map format is used for consistency with the Modbus RTU protocol. The register map contains the register numbers in decimal format, register description, acceptable data values, and list of what each value means. These registers can be written to using most any Modbus master program or using the DGH D6000 series utility software.

Note: All Modbus Register values in the tables below are represented as “decimal” numbers.

Connector Pin Designations

The D7710 series module uses two 3.81mm removable plugs for connecting signals to the module. One two-pin connector is for the power supply connections. A second sixteen-pin connector is used to connect digital signals to the module. The [pin designations](#) for each connector are printed on the module label and are listed in a table below.

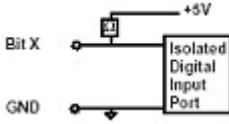
5.6.2 Fifteen Bit Digital Input Specifications

Connections

Power and Serial Communications

Pin Number	Pin	Designator
1	GND	- Power Supply
2	+VS	+ Power Supply

Typical Input



Digital Input Pin Assignments

Bit Number	Pin Designator
1	B01
2	B02
3	B03
4	B04
5	B05
6	B06
7	B07
8	B08
9	B09
10	B10
11	B11
12	B12
13	B13
14	B14
15	B15
16	ISO. GND

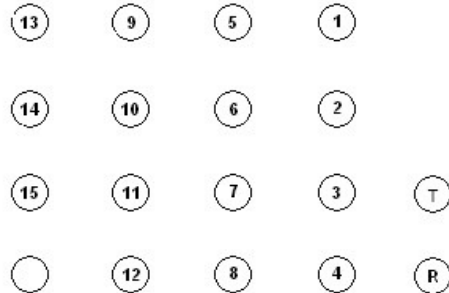
Specifications

Digital Inputs	15
Input Bit	
Internal Pull-up	10K to +5Vdc
Max Voltage	+/-30Vdc
Logic '0'	<1.0Vdc
Logic '1'	>3.5Vdc
Isolation	
GND to IGND	500Vrms
Protocol	
TCP	Modbus TCP/IP
Power Supply	
Voltage	+10-30Vdc
Power	0.75W

Connectors	
Spacing	3.81mm
Max Wire Size	14-24 AWG
Max Current	8 Amperes

LED Designators	
01-15	Bit LO = On
F	Always Off
T	TxData
R	RxData

LED Display



Digital Input/Output LEDES

5.6.3 Fifteen Bit Digital Input Initial Factory Values

Module Parameter	Value
Slave Address*	1
Baud Rate*	9600
Parity Type*	None
Modbus Response Delay	3mS
Modbus Query Delay	0mS

*** = These values should not be changed.**

5.6.4 Fifteen Bit Digital Input Register Assignments

Register	Description	Functions	Value	Description
40001	Slave Address	R/WP	1-DF	Factory set to 0x0001.
40002	UART Setup	R/WP		Factory set to 0x0035 = 9600, 8, N, 1.
40003	Modbus Delays	R/WP	0-303F	<p><u>Bits 0-7</u> The Response Delay in milliseconds. This is required when the RS-485 adapter cannot tri-state immediately after the last character is transmitted from the host. Maximum value is 63mS. Factory default value is 3.</p> <p><u>Bits 8-15</u> The End of Query Delay in milliseconds (48mS max). This is an additional time that the module will wait prior to marking the end of the message. Slower host computers may not be able transmit a continuous message stream, thereby creating gaps between characters exceeding the normal 3.5 character times limit. Factory default value is 0. See Note 2. Factory set to 0x0003.</p>
40033	Software Version	R		Factory set, Code Version.
40241	Control Register	W		<p>0 – Normal operation (NOP) 1 – Remote Reset (write protected) 2 – Write Enable 3 – Synchronous Data sample 5 – Init Host Com Setup</p>

Functions:

R Read Only
R/W Read/Write
WP Write-Protected

Discrete Coil (DI) Mapping Table			
Address (hex)	Channel #	Coil #	Using Function Codes 01 and 02
0	0	1	“
1	1	2	“
2	2	3	“
:			
15	15	15	“
100	0	1	Sync Input Data
101	1	2	“
102	2	3	“
:			
10E	14	15	“

5.7 D7720 - Fifteen Bit Digital Output Module

Overview

The D7720 series digital output module contains fifteen digital outputs for controlling process control devices such as relays, lamps, annunciators and other ON/OFF devices.

Digital Outputs

The D7720 series open-collector digital outputs can be pulled up to +30Vdc max and each bit can sink up to 100mA. The open-collector output provides maximum flexibility to control many different process control devices.

Features and Register Assignments

The D7720 series digital output modules contain many user-selectable features. The complete list of features is illustrated in the [“Fifteen Bit Digital I/O Register Assignments”](#) register map below. The register map format is used for consistency with the Modbus RTU protocol. The register map contains the register numbers in decimal format, register description, acceptable data values, and list of what each value means. These registers can be written to using most any Modbus master program or using the DGH D6000 series utility software.

Note: All Modbus Register values in the tables below are represented as “decimal” numbers.

Factory Initial Values

The D7720 series digital output modules are initialized at the factory with a set of “Initial Values”. A complete list of factory “Initial Values” can be found in the table below.

Communications Watchdog Timer

The D7720 series digital output module contains a user-programmable communications watchdog timer. The communications watchdog timer can be used to force the digital outputs to a known “safe” condition in the event of a communications lost to the module. The known “safe” condition can be user-programmed into the module Initial Value register.

Connector Pin Designations

The D7720 series module uses two 3.81mm removable plugs for connecting signals to the module. One two-pin connector is for the power supply connections. A second sixteen-pin connector is used to connect digital signals to the module. The [pin designations](#) for each connector are printed on the module label and are listed in a table below.

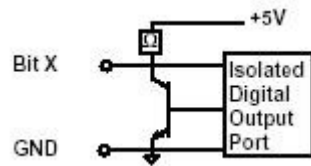
5.7.2 Fifteen Bit Digital Output Specifications

Connections

Power and Serial Communications

Pin Number	Pin	Designator
1	GND	- Power Supply
2	+VS	+ Power Supply

Typical Output Circuit



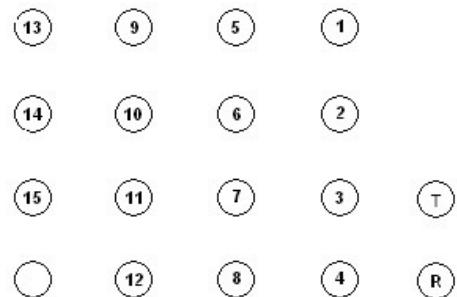
Digital Output Pin Assignments

Bit Number	Pin Designator
1	B01
2	B02
3	B03
4	B04
5	B05
6	B06
7	B07
8	B08
9	B09
10	B10
11	B11
12	B12
13	B13
14	B14
15	B15
16	ISO. GND

Specifications

Digital Outputs	15
Output Bit	
Open-Collector	30Vdc, 100mA
Vsat	0.3V @ 100mA
Short Circuit	500mA max
Type	Sinking
Isolation	
GND to IGND	500Vrms
Watchdog Timer	
Range	0 to 655.35 Sec
Resolution	0.35 Sec
Protocol	
TCP	Modbus TCP/IP
Power Supply	
Voltage	+10-30Vdc
Power	1.0W
Connectors	
Spacing	3.81mm
Max Wire Size	14-24 AWG
Max Current	8 Amperes
LED Designators	
01-15	Bit LO = On
F	Always Off
T	TxData
R	RxData

LED Display



Digital Input/Output LEDES

5.7.3 Fifteen Bit Digital Output Initial Factory Values

Module Parameter	Value
Slave Address*	1
Baud Rate*	9600
Parity Type*	None
Modbus Response Delay	3mS
Modbus Query Delay	0mS
Digital Output Initial Value	0x0000 = All Outputs Off
Watchdog Timer Low Word	0xffff, = Disabled

*** = These values should not be changed.**

5.7.4 Fifteen Bit Digital Output Register Assignments

Register	Description	Functions	Value	Description
40001	Slave Address	R/WP	1-DF	Factory set to 0x0001.
40002	UART Setup	R/WP		Factory set to 0x0035 = 9600, 8, N, 1.
40003	Modbus Delays	R/WP	0-303F	<p><u>Bits 0-7</u> The Response Delay in milliseconds. This is required when the RS-485 adapter cannot tri-state immediately after the last character is transmitted from the host. Maximum value is 63mS. Factory default value is 3.</p> <p><u>Bits 8-15</u> The End of Query Delay in milliseconds (48mS max). This is an additional time that the module will wait prior to marking the end of the message. Slower host computers may not be able transmit a continuous message stream, thereby creating gaps between characters exceeding the normal 3.5 character times limit. Factory default value is 0. See Note 2. Factory set to 0x0003.</p>
40033	Software Version	R		Factory set, Code Version.
40096	Watchdog Timer Interval	R/WP	0.FFFF	<p>The interval of time in seconds that must elapse after the last communication to the module or since the power was applied, before the outputs are set to the Initial Value. The purpose of the Watchdog Timer is to force the digital outputs to a known safe value in the event of a host or communications link failure. The Watchdog Timer may be disabled by setting the value to 0xFFFF hex. Factory set to 0xFFFF.</p>
40097	Initial Value	R/WP	0.FFFF	<p>Starting condition of Coils 1-15. Bit #0 is Ch0. Initial Value bits set to Logic 1 will be initialized to the “On” state. Bits set to Logic 0 will be initialized to the “Off” state. Factory Set to 0x0000.</p>
40241	Control Register	W		<p>0 – Normal operation (NOP) 1 – Remote Reset (write protected) 2 – Write Enable 3 – Synchronous Data sample 5 – Init Host Com Setup</p>

Discrete Coil (DI) Mapping Table			
Address (hex)	Channel #	Coil #	Using Function Codes 01 and 02
0	0	1	“
1	1	2	“
2	2	3	“
:			
E	E	E	“
100	0	1	Sync Input Data
101	1	2	“
102	2	3	“
:			
10E	14	15	“

Functions:

R Read Only
R/W Read/Write
WP Write-Protected

Notes: