Users Manual

FOR HI-QMEGA

(VERSION 2.01 DATED 05-07 AND LATER)

HOW TO USE THIS MANUAL

This manual details the operation of the HI-QMEGA series of controllers / indicators. Due to the variety of options and displays that can be ordered with a HI-QMEGA controller, portions of this manual that do not apply to your specific unit may be skipped. Material is presented in five sections:

Introduction, Hardware Options, General Operation, Additional Functions, and Reference.

Introduction - This section covers the basics of using a HI-QMEGA controller. All information necessary to unpack the unit and establish communications can be found here. Also covered is the basic command format and operating mode characteristics.

Hardware Options - Connection diagrams for all HI-QMEGA hardware options are located here. The easy to read diagrams show how to connect inputs, outputs, communication lines, and power supplies.

General Operation - All HI-QMEGA data handling operations are covered in this section. From analog (A/D) inputs to analog (DAC) outputs, linearization to tare and bang-bang control, this section covers the bulk of HI-QMEGA functions and operating methods.

Additional Functions - This section contains miscellaneous HI-QMEGA functions that may be used to aid and enhance HI-QMEGA operation. Included here are emergency and manual control commands, digital input functions, and SHOW commands.

Reference - Connection/wiring diagrams, a troubleshooting guide, command list, ASCII codes, application notes, and technical data can be found in this section.

Should any problems arise while setting up the controller, refer to the Troubleshooting section on page 45 for helpful hints and *0 4.1 DEFAULT* Mode for information on how to return the unit to a known operating state.

Contents

Introduction

This section begins with an overview of HI-QMEGA features and options. It continues with a quick start guide for unpacking the HI-QMEGA and verifying its operation with a short demo. Communications setup and command format are then discussed, along with commands for changing communication parameters. Finally, operating mode commands, which determine how and when the HI-QMEGA performs any functions, is presented.

1.HI-QMEGA Programmable Intelligent Controllers

The HI-QMEGA series of programmable intelligent controllers are rugged and reliable process controllers and displays. With multiple analog input and signal conditioning options, the HI-QMEGA series can interface with most sensors on the market. Serial communications make the HI-QMEGA remarkably simple to set up and use *without* programming! Simply install the unit, set the process variables and/or limits, and the HI-QMEGA will do the rest.

1.1   HI-QMEGA Features

All HI-QMEGA controllers are available with the following:

? Analog inputs	? Non-volatile memory for important parameter storage
? Digital outputs	? Built-in thermocouple linearization
? 500V input isolation	? User definable lookup tables/polynomials
? RS232C, RS485, or RS422 serial communications	? **Satisfaction guarantee**

Optional features include:

? Concurrent RS232C/RS485 communications	? Analog input signal conditioners
? High voltage inputs	? Universal power supply

1.2 Functional Overview

A block diagram of the HI-QMEGA is shown in
Figure 1. Analog inputs are measured, conditioned and sent to the CPU for processing. Serial communications, 4-20mA outputs and 0-5Vdc outputs are all isolated.[1] The CPU handles all data processing, engineering conversions, linearization, and alarms. The display is handled by a second microprocessor.
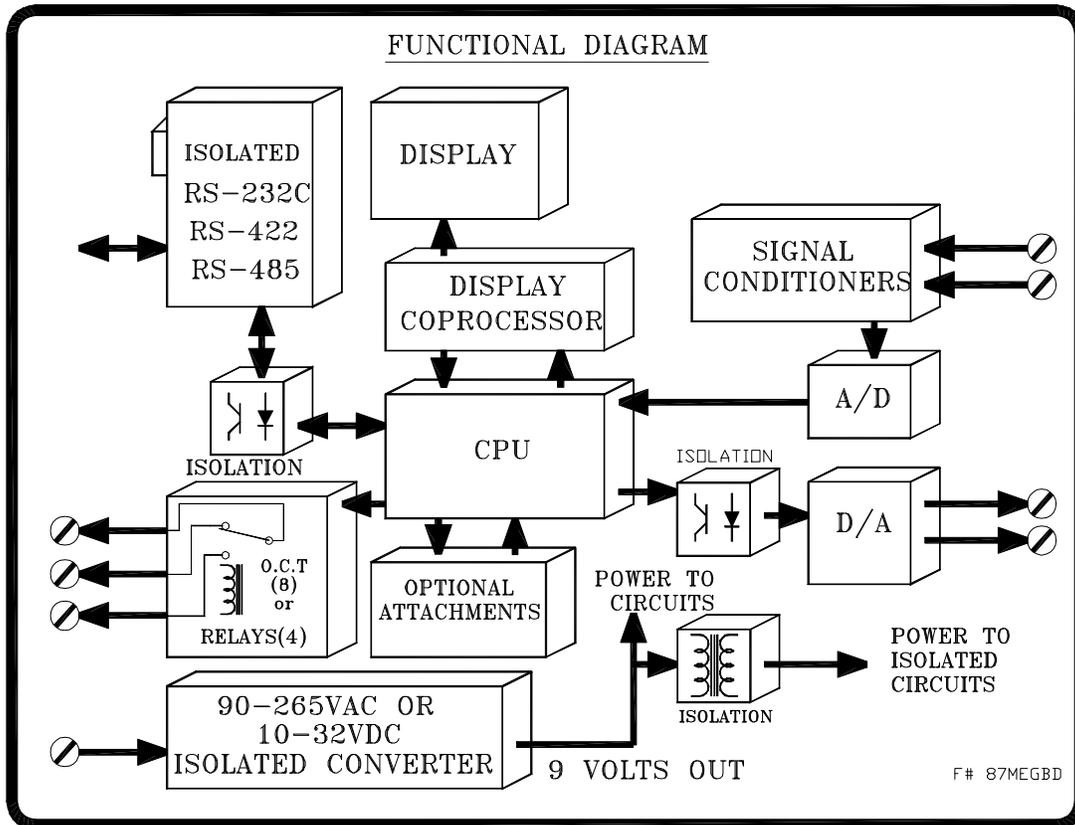
Figure 1: A simplified internal structure of the HI-QMEGA series controllers

1.3 Common Questions

How can a HI-QMEGA controller be used?

The HI-QMEGA line is extremely versatile. Use it for:

- ? Bang-Bang (ON-OFF) control
- ? Temperature Control

- ? Smart Display
- ? part of a DCS/SCADA

What's the difference between a smart and intelligent controller?

As a smart controller, the HI-QMEGA series can receive serial data, display it, perform complex calculations on it, use it to set off alarms, and control external equipment. As an intelligent controller, the HI-QMEGA can take measurements with its own A/D converter to operate independently of other systems or in concert with other computers/controllers.

Do I have to learn a programming language to use a HI-QMEGA controller?

No. The controlling functions of the HI-QMEGA series are pre-programmed. Only process parameters need to be specified for the controller to function properly. Plus, 90% of the HI-QMEGA commands are shared among ALL models. Once you know the commands for one model, changing to a different one is a snap.

Do I need a computer to configure and communicate with a HI-QMEGA controller?

Yes. All basic functions can be accessed through the keypad on the front of the display. Only more advanced functions, like entering user-defined tables and equations, require the use of a computer or hand-held terminal.

What if I need a function not found on the HI-QMEGA?

OTEK offers FREE SOFTWARE DEVELOPMENT for controllers purchased in quantity. Plus, our software library is being continuously expanded. For specialized applications, CUSTOM SOFTWARE can be ordered. Dial (520) 748-7900 to speak to a representative, or FAX your software needs to OTEK Corporation at (520) 790-2808.

1.4   Revision History

Date	Edition	Description	Software Revision
August, 2000	1st.	New Publication	2.75
Nov, 2004	2nd.	Updated delay section	3.03 / 019
October 2006	3rd	Add CPU Fail Mode	3.04

2. Quick Start Guide

This section explains how to remove the HI-QMEGA controller from its box and put it into operation. Its goal is to familiarize the user with the HI-QMEGA.

2.1 Unpacking the Unit

While unpacking the HI-QMEGA unit, inspect it carefully for damage or missing items. If an item is missing or broken, contact your place of purchase immediately. The HI-QMEGA shipping package contains:

(0) HI-QMEGA programmable intelligent controller

(1) *User's Manual* (this manual)

(2) Mounting hardware

2.2 Power Requirements

The standard HI-QMEGA requires 24VDC across its terminals and draws a maximum of 1.5A current. An optional 90-265VAC power input is available. Please refer to the model number on the unit to determine your power input requirement.

2.3 Applying Power to the Unit

Refer to *Power Supply Options* on page 20 to determine which HI-QMEGA terminals are for power. To reduce the risk of electric shock, make all connections while power is OFF.

2.4 A Quick Demo

To verify proper HI-QMEGA operation, run the display demo.

1. Attach a standard serial cable to the D9 connector.

2. Using a communications program type S01DEMO<cr>. The display will start its demo routine. Once verified, remove power and re-apply to reset the unit.

2.5 Installation

The HI-QMEGA is a single piece design consisting of the front housing and rear plate. The front housing is the portion of the device which contains all the critical electronics and the rear plate is the user interface portion of the device.

1. Carefully separate the two portions by removing the two (2) screws located on the top of the housing.

2. Install the wiring as needed through the 1" diameter hole located at the bottom of the housing. Use of a ¾"NPT pipe connector is required for safety reasons.

3. Connect the wires to the two piece plug in connectors .

4. Secure the rear plate to the front housing using the two(2) screws.

5. Mount the unit to the panel, pipe or wall.

3. Communicating With the HI-QMEGA

There are many ways to communicate with a HI-QMEGA. This chapter describes how to communicate using serial communications, including RS-232C, RS-485, and RS-422.

3.1 Serial Communications

The HI-QMEGA series of controllers support the use of RS-232C, RS-485, and RS-422 protocol. Refer to *0 Communication Options* on page 18 for wiring a HI-QMEGA to a communications network, PC, or terminal. The factory preset communications settings are:

9600 baud, 1 start bit, 8 data bits, no parity, 1 stop bit, no flow control

With the serial communication lines properly connected, apply power to the unit. The following power-on message will be transmitted:

```
HI-Q by OTEK
Version 2.75  1996
Address: '01'
Warming-Up...
*
```

If this message does not appear, check to make sure the proper connections have been made to the unit. Also make sure the proper baud rate, flow control, and COM port settings are selected in any communications software being used.

If necessary, hardware flow control may be used with serial communications. The serial port connections shown in *0 Communication Options*, simulate a hardware handshake from the HI-QMEGA. While true handshake signals are not being generated, a PC will send and receive serial data as if the HI-QMEGA is generating the proper signals.

3.1.0 Sending Serial Commands

All commands sent to a HI-QMEGA must be preceded by the letter 'S' and the unit's *address*. Since each controller can be assigned a unique address or "name", multiple units may be connected to the same line without interference. The *current* address for the HI-QMEGA controller is shown in its power-on message and defaults to '01'. Commands may be entered using upper or lowercase characters. Serial input is automatically converted to uppercase. Commands received without a proper address will be ignored. For example, to see the current scale stored in the unit, send the **showin** command:

```
S01 showin <CR>
```

Where 01 is the address shown in the power-on message and <CR> is the carriage return or ENTER key. The unit will respond by displaying the current settings for the input channels.

The asterisk (*) indicates the command was successfully interpreted and executed. An incorrect command will result in a question mark (?) being displayed: ?

3.1.1   Receiving Serial Data (Remote Display)

In this mode the unit will display serial ASCII data received via the DB9 connector. Since the unit is normally configured for streams and channel data manipulation, it must be reconfigured as a remote display for all displays (bargraph and digital). Enter these commands: S01CH1OFF<CR>; S01STREAM1+DISP1<CR>' S01STREAM1+DISP2<CR> (If you want bargraph and digital to match); S01BFS1 NNN<CR> (NNN=Bargraph full scale (0-100%); S01CHN1 NNN<CR> (NNN=Digital value to be displayed (up to maximum # of digits and polarity). See Command Set on Page 50 for additional commands on color changes, etc.

<center>*</center>

Command Format

In this manual, the commands listed for the HI-QMEGA will be given in the following format:

COMMAND<arg1, arg2> [arg3: opt1 opt2] [opt3, opt4, opt5]
        <arg1> =
        [opt1] =

The name of the command is shown in **BOLD** type. Required arguments are placed in <triangle> brackets and optional arguments are in [square] brackets. A colon (:) after an argument means one of the options after it must also be specified. For arguments separated by commas (,) pick only one of the listed choices. For arguments separated by spaces, any number of the arguments may be specified. The <arg1>= and [opt1]= boxes show the allowed parameter values. Empty brackets [] indicate no parameter is specified. Commands will be executed after the HI-QMEGA receives a carriage return or ENTER key. For example:

STREAM<n>= [off serial disp1 disp2 dac1]
STREAM<n> [+,-: serial disp1 disp2 dac1 dac2]

        Determines which outputs are affected by stream <n>.
        []= Shows current outputs affected by stream <n>
        <n>= 1,2,3,4,5,6,7

[off]= Removes all outputs from stream <n>	[disp2]= Sends stream <n> data to display #2(numeric)
[serial]= Sends stream <n> data to serial output	[dac1]= Sends stream <n> data to DAC #1
[disp1]= Sends stream <n> data to display #1 (bargraph)	[dac2]= Sends stream <n> data to DAC #2

A '+' before an argument adds that argument to the existing output list for stream <n>.
A '-' before an argument removes that argument from the existing output list for stream <n>.

This command has one required argument (<n>) and two types of optional arguments. For the first option, **STREAM**<n>= is followed by OFF or a combination of the other arguments:

        STREAM1= serial, disp1, dac1   (Sends stream 1 data to the serial port, dac1)
        STREAM2=   (Shows current stream 2 values)
        STREAM3= off   (Removes all outputs from stream 3)

For the second option, a (+) or (-) precedes each option:

        Stream1 -serial   (Removes serial output from previous stream 1 list)
        Stream1 +dac2 -dac1   (Removes dac1 output from stream1 and adds dac2 output)

<center>**10**</center>

3.1.3 Changing Communications Parameters

The address and baud rate of the HI-QMEGA controller can be changed to suit most communications needs. To change the address, use the **ADDR** command:

ADDR<new address>
        <new address>= New address to give the HI-QMEGA (6 chars. max)

If the current HI-QMEGA address is '01', the following command would change it to 'TANK1':[2]

```
*S01 ADDRTANK1
'TANK1'
*
```

The unit will now ignore the '01' address and respond only to commands that begin with 'S' plus 'TANK1'. To change the communication baud rate, use the **BAUD** command:[3]

BAUD [nn]
        []= Show current baud rate
        [nn]= 1200, 2400, 4800, 9600, 19.2K

When changing baud rates, the unit immediately switches to the new communications setting. After using the baud command, be sure to change any communication software or terminal baud settings to match the new HI-QMEGA baud rate.

3.1.4 Communications on a Network

If more than one HI-QMEGA is connected to the same serial communications network, such as on an RS-485 system, it becomes necessary to limit the amount of serial output from each HI-QMEGA. This can be accomplished by sending the **NET** command to each unit on the network. After receiving the **NET** command, the HI-QMEGA will process data and commands as usual, but will only send serial output in response to the **SEND** command and the **T1** timer. Effectively, the HI-QMEGA becomes a *listener* or *remote* device.

On a typical network, all listeners or remotes are contolled by a single computer. When a response is desired from a particular HI-QMEGA, it is ordered to transmit its most recent readings over the network with the **SEND** command. In this manner, each unit on the network can be "polled" for data when it is needed without having a single unit clog the network.

To enable normal serial responses from the HI-QMEGA, use the **LOC** command. This command allows the HI-QMEGA to transmit serial responses to each received command and indicate its readiness with the asterisk (*) prompt.

3.1.5 Other Commands

Commands relating to specific functions of the HI-QMEGA controller are covered in detail throughout this manual and are listed alphabetically in *The HI-QMEGA Command Set* on page 49.

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[2] The new setting is used until the HI-QMEGA is reset or loses power. See section 0: *Operating Modes* to make permanent changes to HI-QMEGA parameters.

4.   Operating Modes

The HI-QMEGA can be powered-up in one of two distinct operating modes. USER mode is the normal operating mode, and can be used to make the HI-QMEGA take readings and update its outputs automatically on power-up. DEFAULT mode is a special mode used for troubleshooting. In each of these modes, HI-QMEGA operation can be turned on and off under both hardware and software control.

4.1   DEFAULT Mode <u>WARNING:</u> WILL <u>ERASE</u> ALL USER PARAMETERS AND WOULD HAVE TO BE RELOADED!

If the **DEFAULT** command is given or if the default jumper is installed during power-up, the HI-QMEGA enters DEFAULT mode. This mode returns all operating parameters to their default values. This mode is useful for establishing communications with the HI-QMEGA in the event of a non-supported baud rate and for defining new USER parameters.

A listing of DEFAULT parameters for the HI-QMEGA can be found in Default Parameters on page 46.

4.2   USER Mode

 If the default jumper is unconnected during power-up or if the **USER** command is given, the HI-QMEGA enters USER mode. All operating parameters are read from non-volatile memory (eeprom) and HI-QMEGA operations continue according to these values.

4.3   Saving USER Parameters

After the HI-QMEGA has been configured and is operating as desired, the **WRITE (S01 write)** command can be used to save the current operating status. Entering USER mode will recall the saved parameters and resume the operating status present when the last **WRITE** command was given.

4.4   Turning HI-QMEGA Operation On/Off

Unless instructed to do otherwise, the HI-QMEGA patiently waits for commands to execute. It will perform its normal operation of continuously reading inputs and updating outputs only when instructed to RUN.

4.4.1   Run/Stop Commands

The simplest way to enable HI-QMEGA operation is with the **RUN (S01 run)** command. This command instructs the HI-QMEGA to read its inputs and update its outputs until given the **STOP (S01 stop)** command. While running, the HI-QMEGA will still accept commands from the serial input and keypad.

4.4.3 SEND Command

The HI-QMEGA can be instructed to RUN/STOP with the **SEND** command:

SEND[n]
> S01 send <cr> = HI-QMEGA reads inputs and updates outputs once.
> S01 send5 <cr>= HI-QMEGA reads inputs and updates outputs 5 times
> Note: maximum number of consequtive sends is 255 when not in the RUN mode.

This command instructs the HI-QMEGA to RUN for 5 readings. After 5 readings, the HI-QMEGA will automatically return to its previous operating state. While operating under the **SEND** command, the HI-QMEGA will accept serial input, but will not execute serial commands or execute some keypad functions until all [n] readings have been taken.

4.4.4 Initial RUN Delay

After being told to RUN, the HI-QMEGA begins taking readings after executing a programmable delay of up to 255 seconds. This delay can allow a process to warm up after a power-on before the HI-QMEGA takes control. Set this delay with the **IDELAY** (S01 idelay)command:

IDELAY 10 = 10 seconds of initial delay after entering RUN mode
> Note: maximum initial delay time is limited to 255 seconds (4.25 minutes)

Hardware Options

This section covers the different hardware options available with the HI-QMEGA. The types of signals each option uses and its external connections are presented. This information should be used when connecting signals to the HI-QMEGA to verify that all connections are made properly and that the appropriate signal levels are being used.

Because each HI-QMEGA controller has a unique set of input/output options, refer only to the options specified for the particular unit being connected. Use the *master connection diagram* to determine which external terminals are used for each input/output function.

5. Input Options

HI-QMEGA inputs are determined by its part number. This number is located externally on the unit and should be used for reference. See *ordering information* on page 61 to determine the input option for a specific unit.

5.1 Voltage and Current Inputs (DC or AC)

Voltage and Current inputs (DCV, DCA, ACV, ACA, DcmA and ACmA should be connected per the following diagram using terminals 5 and 6 for channel#1, 3 and 4 for channel#2, 1 and 2 for channel#3. Depending on the model number ordered, the input will be either DC or AC. Jumpers inside the front module allow for easy range selection of 500mV, 5V, 50V, 300V, 5mA, 20mA and 500mA.
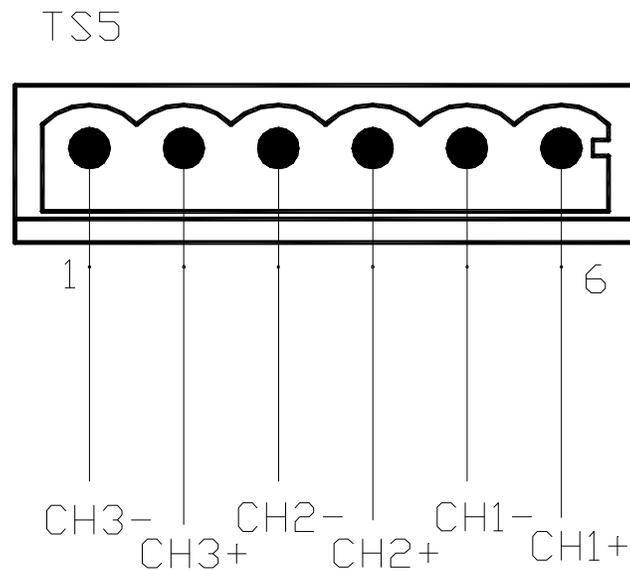
5.4 Strain Gage/RTD/Resistance Inputs

Strain gage, RTD, and resistance inputs should be wired as per the following drawing. When using more than one load cell, the excitation is shared among the cells, the – sense legs are all connected together and the + sense leg is used for signal transmission. Care must be taken to insure that the load cells used are of the proper type.

Strain Gage (Load Cell), RTD, Resistance

TS5

```
  1                          6
+Sense #3
+Sense #2
+Sense #1
-Sense
-Excitation
+Excitation
```

87MEG_SG
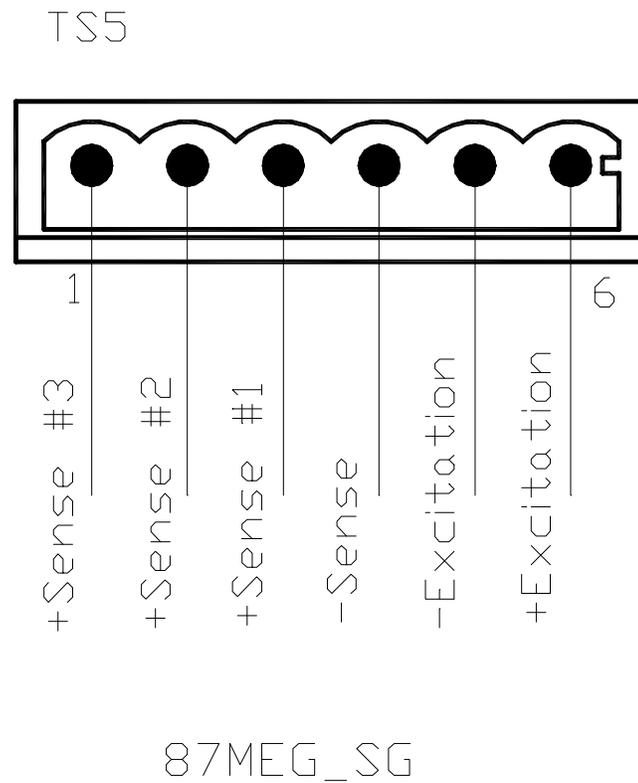
5.5 Thermocouple Inputs

Thermocouples can be connected using the following drawing. The terminals are marked + and – since different thermocouple manufacturers use different colors. In most cases however, the RED wire is the negative or (-) and the other wire is the positive or (+). Diode D5 is used for the junction compensation to obtain extremely accurate temperature measurements. For best results, the thermocouple wire should be connected directly to the HI-QMEGA's terminals. In cases which this is not possible, the use of thermocouple extension wire is acceptable.

Notes:
1. No isolation exists between channels.
2. 2. Do not use grounded thermocouples.

TS5

1   6

CH3−   CH2−   CH1−
      CH3+   CH2+   CH1+
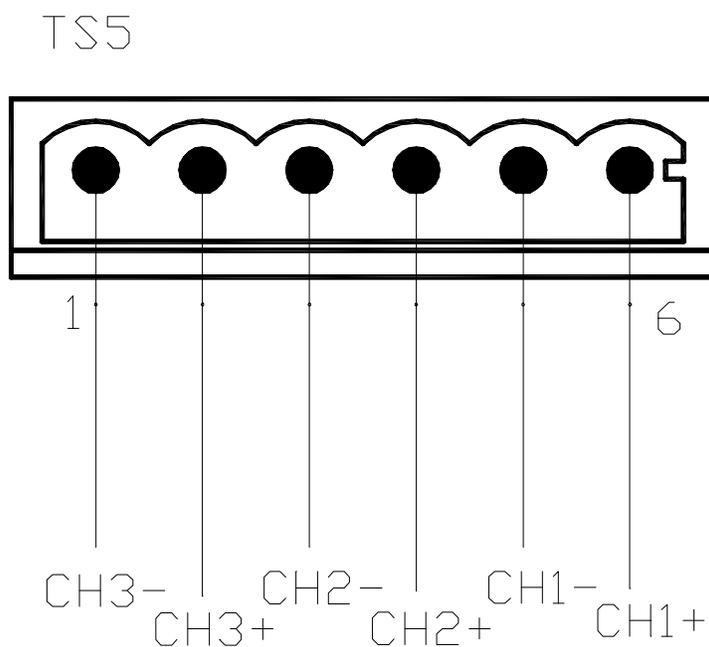
87MEG_tc

6. Output Options

HI-QMEGA outputs are determined by its part number. This number is located on the back side of the unit and should be used for reference.

6.1 Voltage Outputs

Output option 2 is the 0-5VDC ISOLATED output. The above diagram shows how to connect voltage outputs.
The minimum load allowed for this voltage output is 100K ohms. Most electronic voltmeters, chart recorders, valves and other devices have input impeadances greater than 1 Megohm.

```
          TS4
   1              4

 +LOOP OUT #2
 -LOOP OUT #2
 +LOOP OUT #1
 -LOOP OUT #1

   87MEG_DCVOUT
```
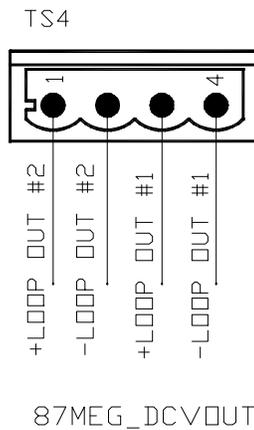
6.2 Current Outputs

The analog output, when used in the current mode, can be adjusted for 0-24mADC, 0-20mADC, 4-20mADC or 4-24mADC depending on the configuration and the dscale / doffset settings. This output option has a maximum allowable load of 1K ohm. The current output is of the source type and does not require and external power supply for operation. The source voltage is 30V maximum and 24V typical.
The Transducer power output provides +/-15VDC or +30VDC power for your 4-20mADC transmitters. The maximum available current is 30mADC.

4-20mADC output

```
          TS4
   1              4

 +LOOP OUT #2
 -LOOP OUT #2
 +LOOP OUT #1
 -LOOP OUT #1

   87MEG_DCVOUT
```

Transducer power output.
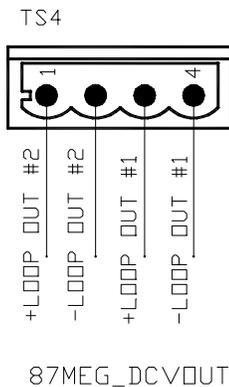
```
          TS3

   1         3

 +15VDC OUT
 RETURN
 -15VDC OUT

   87meg_powerout
```
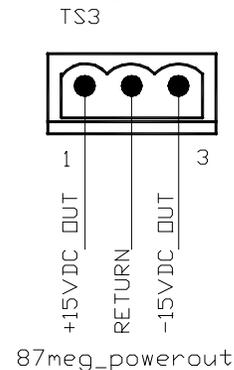
6.3 Relay Outputs

Relay output connections are shown on the right. The relays can be Connected as either Normally Open (N.O.) or Normally Closed (N.C.) And the software can also be configured as Normally energized or Normally De-energized. This allows for total system flexibility and Fail safe operation.

Open collector transistor

TS1

```
1                                              12
O.C.T. #2
  O.C.T. #1
    O.C.T. #3
      O.C.T. #5
        O.C.T. #4
          O.C.T. #6
            O.C.T. #8
              O.C.T. #7
                +5VDC OUT (50mA MAX)
                          GND (common emmitters)
```

87TEK_OCT

Relay contacts form C

TS1

```
1                                              12
K1 COM
  K1 N.C.
    K1 N.O.
      K2 COM
        K2 N.C.
          K2 N.O.
            K3 COM
              K3 N.C.
                K3 N.O.
                  K4 COM
                    K4 N.C.
                      K4 N.O.
```
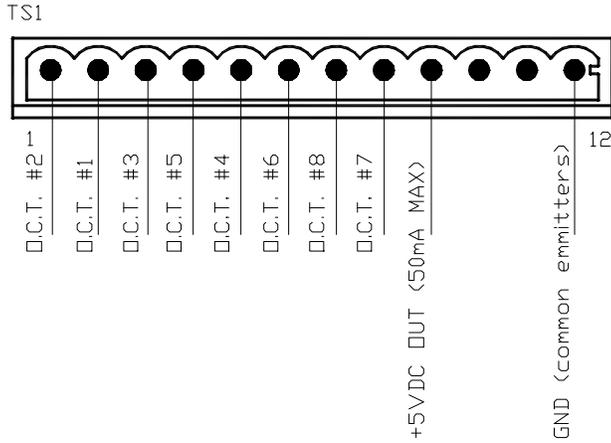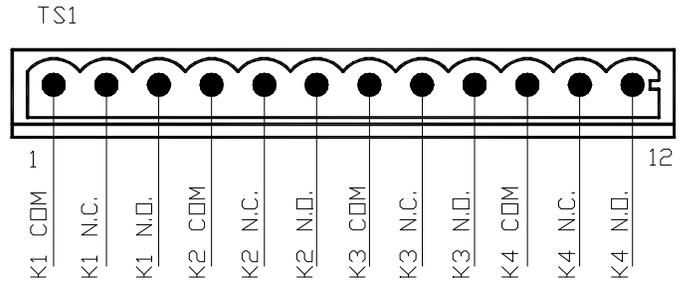
87MEG_RLY

7. Communication Options

The HI-QMEGA can be ordered with RS232, RS422 or RS485 serial communications. All the serial connections are made through the standard DB9 connector. When using RS232, any standard DB9 cable will work without modifications. The DB9 on the HI-QMEGA is a Female type. When using RS422 or RS485, a special cable must be made in order to achieve communications.

```
DB9 CONNECTIONS
     1. NC
     2. TXD
     3. RXD
     4. NC
     5. GND                          DB1
     6. TXB                    5        1
FOR RS422 AND                  9        6
RS485 ONLY.    7. TXA
     8. RXB
     9. RXA
```
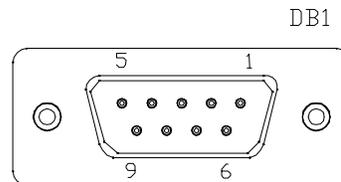
87MEG_DB9

7.   *Communication Options (continued)*

RS422

FROM MASTER
OR OTHER
RS422 DEVICES

TO OTHER
RS422
DEVICES
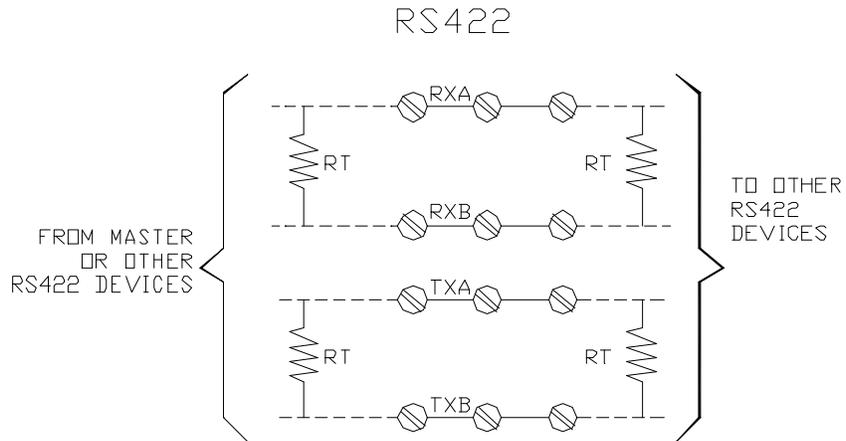
ADD TERMINATING RESISTORS (RT) TO FIRST AND
LAST UNIT (120Ω TYPICAL)

F# 87HQ_485

RS-232-C/422/485
CONCURRENT USE

(TXD)
(RXD)
(GND)
COMP.

RXD1
TXD1
GND1

NOTE:
1. ONLY CONNECTIONS TO FIRST UNIT ARE
   REQUIRED FOR RS-232C.

2. SINCE ALL HiQ's RS TRANSLATORS ARE
   ISOLATED FROM OTHER I/O ONLY CONNECT
   GND. TO THE COMPUTER END.

HiQ1   HiQ2   HiQ3   HiQN
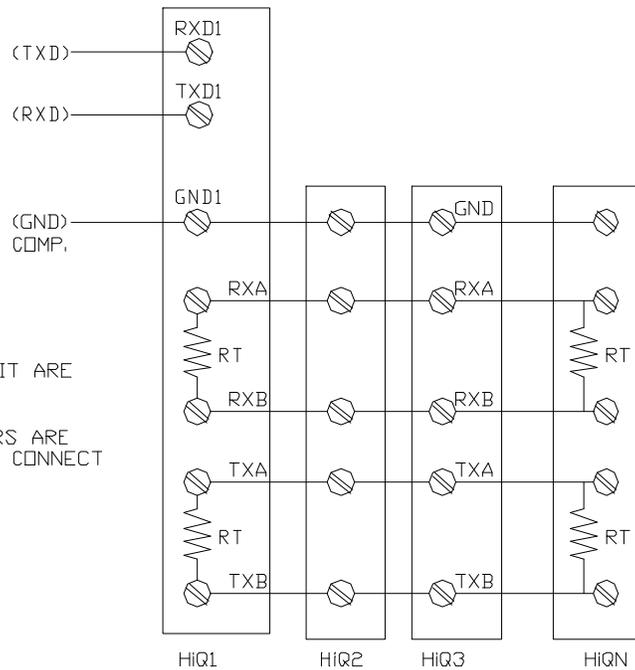
ADD TERMINATING RESISTORS TO FIRST AND
LAST UNIT (120Ω)

F# 87HQ_XLT

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8.   *Power Supply Options*

The HI-QMEGA power supply input range is either 24VDC or 90-265VAC and is determined by its part number. This number is located externally on the unit and should be used for reference. See *ordering information* on page 63 to determine the power supply option for a particular unit. The following diagram shows the different power supply connections to the HI-QMEGA. These connections on made on connector J3 located on the upper board.

J3

1   3

+VDC OR AC HOT

EARTH GROUND

-VDC OR AC NEUTRAL
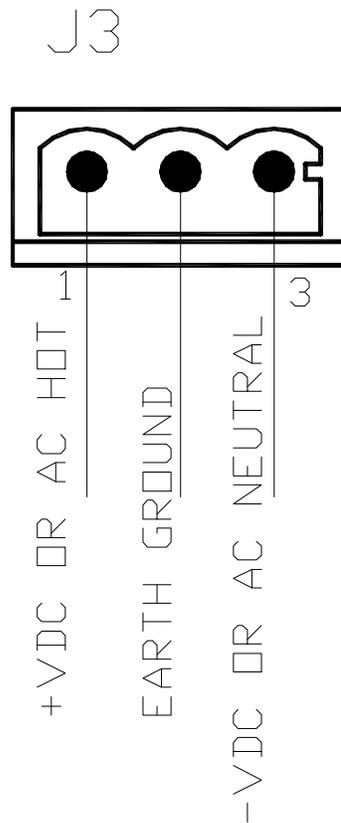
87MEG_powerin

General Operation

All data gathered by the HI-QMEGA must follow a path of operations before it can be displayed or used as an output. Like a product on an assembly line, the operations along the path refine the data and convert it to a more useful form. Understanding how this data path works makes using the HI-QMEGA a snap.

There are three major portions of the HI-QMEGA data path: input channels, calculations, and stream outputs. All three sections can be seen in Figure 2. Each section takes the data it is given, modifies it if required, and passes it to the next section.

The input channels (analog and digital) read data from external inputs and sensors then perform the scale, offset, averaging, linearization, and tare functions. Inputs to this section can come from the serial port, analog inputs, or from a digital input function. The results of these operations are saved for use in the calculations section.
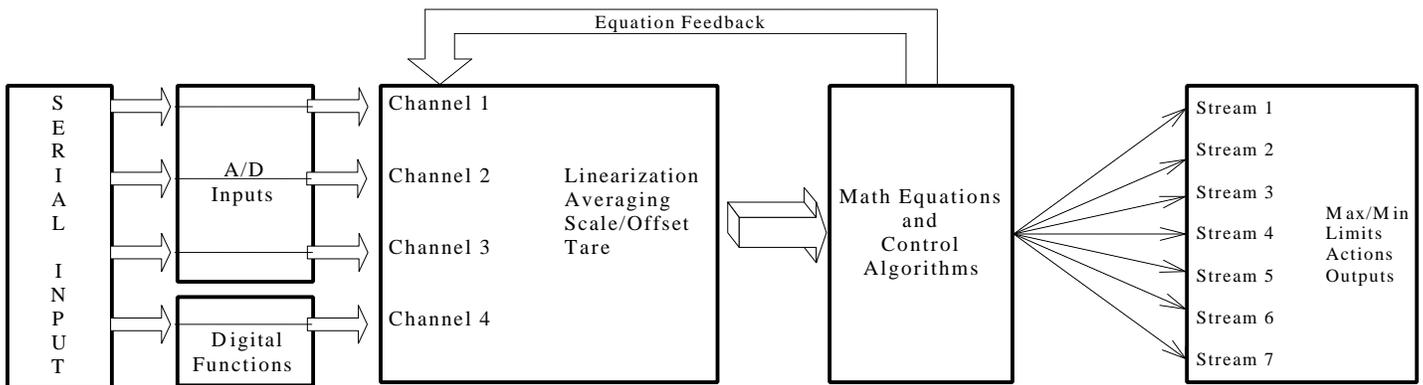
Figure 2: HI-QMEGA data flow organization

The calculations section combines data from the input channels with mathematical formulas and equations. It can also perform control algorithms. The results of these operations can be routed to seven different output areas known as streams.

The stream outputs take data from the calculations section and send it to the appropriate hardware. Data can be sent to the analog output, the serial output, or to the display. The stream outputs also take max/min readings, perform limit calculations, and execute any actions specified by alarm conditions.

The next four chapters explain in detail the operation of the HI-QMEGA data path. This knowledge is a ***crucial part*** of understanding how the HI-QMEGA operates. The concepts and terminology presented in these chapters will be used throughout the rest of this manual.

9.   Input Processing

All data gathered by a HI-QMEGA controller is placed into an input channel where it may be easily manipulated and processed. This chapter describes how the HI-QMEGA uses its four input channels to read and process data.

9.1   Input Channels

A channel is a path or sequence of operations data is passed through before it can be used in calculations or control algorithms. Data in a channel is processed to make it more suitable for display and manipulation. Figure 3 shows a block diagram of how the four input channels in a HI-QMEGA controller are arranged.
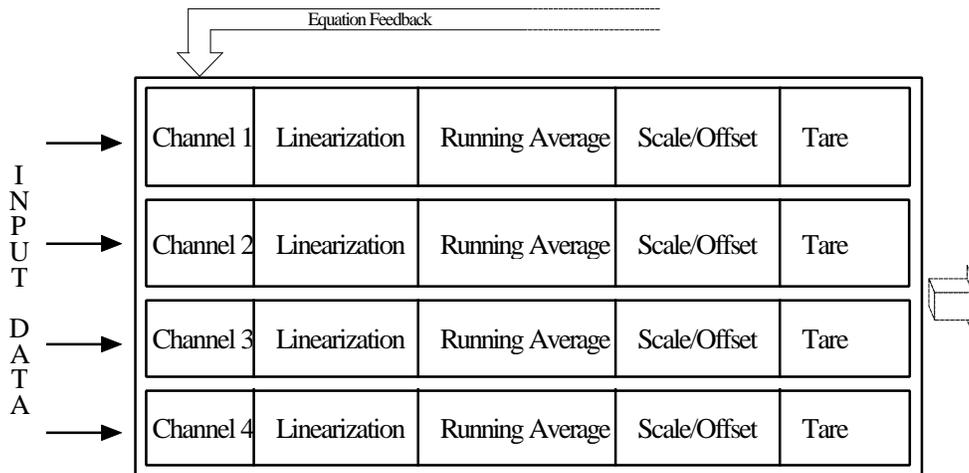
Figure 3: Input channel organization.

9.2   Input Channel Operations

Each input value is placed into its own channel for processing. The data in the channel is then linearized, averaged, scaled, offset, and tared as desired. If an operation is not needed for a specific input, it may be bypassed. The resulting data is then ready for use in calculations and control algorithms.

9.2.1   Channel Inputs

Data for input channels comes from analog, digital, and serial sources. Up to four serial and three analog inputs can be manipulated by the HI-QMEGA.

9.2.1.1 Analog Inputs

Analog measurements are placed into input channels with the **CH**<n>ON command:

CH<n>ON

      <n>= 1,2,3

      Example: S01 ch1on<cr> turns on channel #1. Currently, the HI-QMEGA allows for up to 3 analog input channels and 1 digital input channel (channel #4)

This command takes data from the corresponding A/D input and places it in the channel where it may be manipulated by input channel operations. A/D inputs can be turned off with the **CH**<n>OFF command:

CH<n>OFF

      <n>= 1,2,3

      Example: S01 ch1off <cr> turns off channel #1.

9.2.1.3 Serial Inputs

Data for input channels can be obtained from the serial port with the **CHN** command. This command takes data from the serial input and places it in the specified input channel.

CHN<n> [ffff]

      [ffff]= Value to place in channel <n>

      <n>= 1, 2, 3, 4

      Example: S01 chn1 5000 places the value 5000 on channel #1, which is then processed and sent to the display, dac and relays if desired.

9.2.2 Linearization

The first operation that can be performed on an input channel is linearization. Inputs from non-linear sources such as thermocouples, RTDs and horizontal cylindrical tanks can be manipulated to provide linear output values. HI-QMEGA controllers have two methods of providing linearization: lookup tables and polynomials.

Lookup tables compare input values to sets of desired input/output results and determine the output value through interpolation. Polynomials linearize data by passing each input value through the ninth order equation:

$$Y = A_9X^9 + A_8X^8 + A_7X^7 + A_6X^6 + A_5X^5 + A_4X^4 + A_3X^3 + A_2X^2 + A_1X + A_0$$

The coefficients A_0-A_9 are chosen to counteract the non-linear output characteristics of the sensor being used. The linearization method used by the HI-QMEGA is determined with the **LIN** command:

LIN<n> [OFF, PZ, TZ, sensor type]

       []=Show current linearization for channel <n>

       [OFF]= Turns linearization for channel <n> off

       [PZ]= Sets linearization to user polynomial

       [TZ]= Sets linearization to user table

       [sensor type]= Enables built-in linearization for [sensor type]

       <n>= 1,2,3,4

       Example: S01 LIN1TZ<cr> sets linearization of channel #1 to the user created table.

All built-in temperature linearization returns values in ?C. Fahrenheit readings are obtained by using a scale and offset. See *18.1*

       Temperature Control Using a Thermocouple on page 42 for a ?C to ?F conversion example. [sensor type] can be any one of:

JC	J type thermocouple
BC	B type thermocouple
KC	K type thermocouple
RC	R type thermocouple
SC	S type thermocouple
TC	T type thermocouple
EC	E type thermocouple
RTDC	European ? =0.00385? /? /?C
RTDC	ANSI ? =0.00392? /? /?C

Use the TEMPUNITS command to set the desired output to ?C, ?F or ?K. Example S01TEMPUNITS1F sets channel #1 to ?F.

9.2.2.1 Defining Polynomials

The user-defined polynomial (PZ) is a single segment, 9th order polynomial defined by its coefficients. The current values of these coefficients can be viewed with the **SHOWPOLY (S01 showpoly)**command. To change an individual coefficient, use the **SETA** command:

SETA<n> [ffff]

       Sets a single polynomial coefficient

       []= Shows current value of A<n>

       [ffff]= Sets A<n> value to [ffff]

       0 ? n ? 9

       Example: S01 seta1<cr> will show the value of coefficient A1. S01 seta1 10-3 12+4 will change the A1 coefficient to 10-3 12+4.

To enter or modify the entire polynomial, use the **SETP (S01 setp)** command. This command will display each polynomial coefficient (starting with A_0) and prompt for a new value. To keep the current value, simply press ENTER. To use a different value, type the new value and press ENTER. The HI-QMEGA will record any changes and move on to the next coefficient. After all coefficients have been viewed/modified, the HI-QMEGA will display the asterisk (*) prompt. Editing can be stopped at any point in the polynomial by pressing the ESCAPE (Esc)key.

9.2.2.2 Defining Tables

The user-defined table (TZ) is a set of 25 (X,Y) points which are used to interpolate input data for linearization. The current user table can be seen with the **SHOWTABLE (S01 showtable)** command. The X coordinates correspond to input values for the table, while the Y coordinates represent the HI-QMEGA output for each corresponding X input. To enter or modify a single table point, use the **SETX** and **SETY** commands.

SETX<n> [ffff]

       Sets a single user table X coordinate

       []= Shows current value of X<n>

       [ffff]= Sets X<n> value to [ffff]

       0 ? n ? 24 **Example: S01 setx1 10 sets the input value of X1 to 10.**

SETY<n> [ffff]

       Sets a single user table Y coordinate

       []= Shows current value of Y<n>[ffff]= Sets Y<n> value to [ffff]

       0 ? n ? 24**Example: S01 sety1 15 sets the output value of Y1 to 15.**

Setting X1 to 10 anf Y1 to 15 will change the channels value to 15 when 10 is reached.

In order to process inputs quickly, the HI-QMEGA requires the X coordinates to be in *ascending* order. The first X coordinate that is smaller than the previous X coordinate will mark the end of the table. This is useful for defining tables less than 25 points. For example, to use a 3 point table, the following coordinates could be entered:

Coordinate Number	X	Y
0	-25	0
1	-10	10
2	50	100
3	0	0

A **SHOWTABLE** command will display only the first three points. Since X3 is less than X2, the table ends at X2. To increase the length of the table by one point, enter a value for X3 that is larger than X2 and make sure X4 is less than X3.

To view and modify the entire table, use the **SETT** command. The HI-QMEGA will show each X and Y coordinate and prompt for a new value. To keep the current value, press ENTER. To use a different value, type the new value and press ENTER. After all table points have been viewed/modified, the HI-QMEGA will show the asterisk (*) prompt. To stop editing at any time, press the ESCAPE key.

9.2.3 Running Average

If an input signal is noisy or fluctuates between values rapidly, it can be smoothed out with averaging. The averaging prevents abrupt output changes during large input jumps or fluctuations. HI-QMEGA controllers use a weighted arithmetic running average to filter input signals. Figure 4 shows the effect averaging has on a square wave input.

The effect of averaging can be adjusted by changing the weight of the average. The larger the weighting factor, the quieter the output and the slower the output response to input variations. The weighting factor is specified with the **AVG** command:

AVG<n> [dddd]
       [ ]= Shows current average weight for channel <n>
       [dddd]= Sets channel <n> average weight to [dddd]
       dddd = 0,1 disables channel <n> averaging
       <n>= 1,2,3,4
       0 ? [dddd] ? 255
       Example: S01 avg1 8 sets the averaging of channel #1 to 8. Since the HI-QMEGA's standard read rate is 16/second with one channel on, the average of 8 will take approximately ½ second to settle to the actual value.
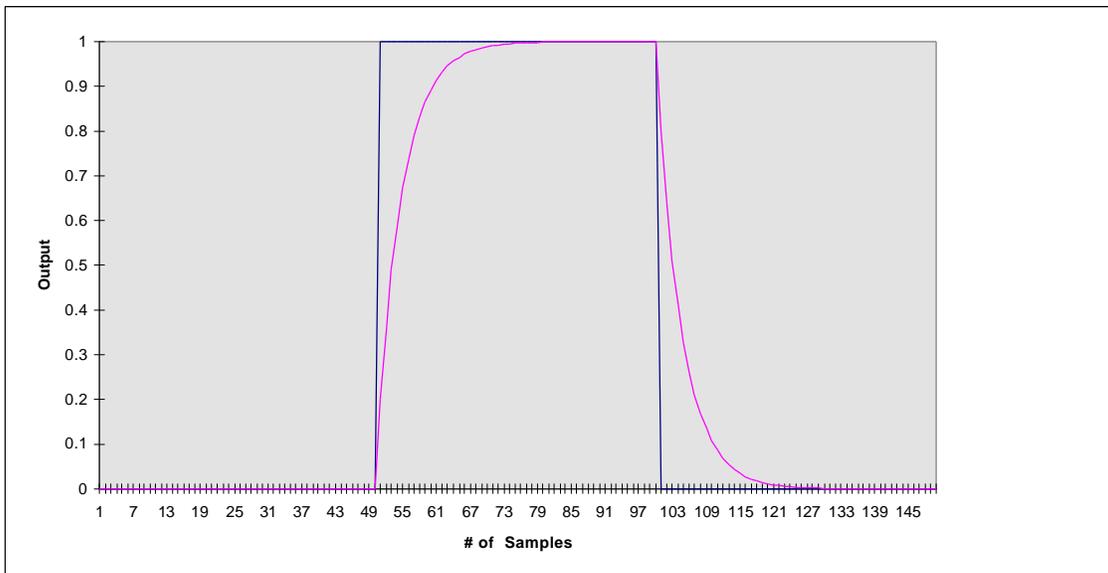
Figure 4: The effect of averaging a square wave

9.2.4   Scaling to Engineering Units

After averaging, each channel undergoes a scale and offset. These operations are used to transform the filtered input data to the desired units for display. Data is scaled according to the linear equation:

y=mx+b with "y" the output and "x" the input.

Example for 4-20mADC:

The 4-20mADc is by far the most common input signals used. Converting the 4-20mADc signal to engineering units would be per the following.

X=Required reading at 4mA;

Y= Required reading at 20mA;

Then   SCALE = (Y-X) / (20mA-4mA)

OFFSET = X – (4mA x SCALE)

With a desired reading of 5000 at 20mA and 0 at 4mA then;

Scale = (5000 - 0) / 16 = 312.5

Offset = 0 – (4 x 312.5) = -1250

Then enter the scale value of 312.5 and the offset value of –1250.0. The HI-QMEGA will read 5000 at 20mADC and 0 at 4mADC.

SCALE<n> [ffff]
    []= Shows current scale for channel <n>
    [ffff]= Sets channel <n> scale to [ffff]
    <n>= 1, 2, 3, 4
    Example: S01 scale1 6.25<cr>

OFFSET<n> [ffff]
    []= Shows current offset for channel <n>
    [ffff]= Sets channel <n> offset to [ffff]
    <n>= 1, 2, 3, 4
    Example: S01 offset1 -25

9.2.5   Using Tare Values

Subtraction of a tare value is the last operation performed on each input channel. The tare function subtracts a previously recorded input value from all subsequent readings.

TARE<n> [ON, OFF, NEW, ffff]
    []= Shows current tare value for channel <n>
    [ON]= Turns channel <n> tare on
    [OFF]= Turns channel <n> tare off
    [NEW]= Reads a new tare value from channel <n>
    [ffff]= Set channel <n> tare to [ffff]
    <n>= 1,2,3,4

Tare is most often used to take measurements relative to a base reading. For example, if a weight reading of 350Lbs. is recorded as a tare value, a 15000Lb. input will be displayed as 14650Lb. after the tare is subtracted.

10. Calculations and Control Algorithms

Once data gathered by a HI-QMEGA controller has passed through an input channel, it can be used in mathematical equations and control algorithms. These functions are used to generate values for the output streams, which update the display, serial output, digital outputs, and analog outputs.

10.1 Performing Calculations on Channel Data

After all inputs are measured and conditioned, the resulting data goes through a series of calculations. Here, output values are generated by using the data in up to seven separate equations. These equations can include the addition (+), subtraction (-), multiplication (*), and division (/) operators as well as the square root (SQRT) function.

The HI-QMEGA evaluates equations from left to right with no operator precedence. Parentheses must be used to change the order of evaluation. Numerical constants, previous controller outputs, tare values, Max/Min values and limit values can also be used in equations, allowing calculation of almost any desired output parameter. The HI-QMEGA evaluates equation 1 first, followed by equations 2, 3, etc.

EQN<n>[equation]

    []= Erases equation <n>

    [equation]= Equation to use in calculations

    <n>= 1, 2, 3, 4, 5, 6, 7

    Example: S01 eqn1 s1=c1 places the channel #1 data into stream 1.

        S01 eqn1 s1=max1 places the max recorded value into stream 1.

        S01 eqn1 s1=c2-c1 places the result of channel #2 minus channel #1 into stream 1.

    Valid equation format: RESULT= OPERATOR(s) and OPERAND(s)

    RESULT= can be:

    OPERATOR(s) can be

S<n>=	Stream <n>		*	Multiplication
C<m>=	Channel<m>		/	Division
HH<m>=	HH limit <m>		+	Addition
H<m>=	H limit <m>		-	Subtraction
L<m>=	L limit <m>		(	Opening parenthesis
LL<m>=	LL limit <m>		)	Closing parenthesis
HYST<m>=	Hysteresis <m>		SQRT	Square root function
A<m>=	Scale <m>			
B<m>=	Offset <m>			
DH<p>=	DAC H limit <p>			
DL<p>=	DAC L limit <p>			

OPERAND(s) can be:

S<n>	Current value of stream <n>	A<m>	Scale <m>
R<n>	Rate of change of stream <n>	B<m>	Offset <m>
MAX<n>	Max. value of stream <n>	T<m>	Tare <m>
MIN<n>	Min. value of stream <n>	1 ?n ? 7	
C<m>	Current value of channel <m>	1 ?m ? 4	
O<m>	Last value of channel <m>	1 ? p ? 2	

    A maximum of 4 nested parenthesis can be used. Equations with invalid expressions will be evaluated until an error is reached, with an undefined result and a warning on the serial output. The following are examples of valid equations: All examples below must be preceeded by the equation number (EQNn).

S1= C1*12 - C2
C2= S1+S2*(C1-C2)
HH3= SQRT(C3-MAX1)*A1-O4
A4= C4*(MIN2-(MAX1+C1-(S3*S1)))+1.8
S5= S1+T1*KP2-B2
C1= (SP3-C2)/21.9 - (C2-SP2)*3.14159E-3

11. Streams and Outputs

Data from calculations and control algorithms is sent to output hardware via the streams. The streams provide the flexibility of allowing any calculated value to be sent to any combination of outputs, including the serial output, analog output and display.

11.1 Stream Operation

A stream is a list that indicates to which outputs a piece of data should be sent. Figure 5 shows how the streams in the HI-QMEGA are organized. Placing data in a stream routes that data to every output on the stream list. The analog and display outputs can receive data from only one stream at a time, while the serial output can process data simultaneously from all seven HI-QMEGA streams.

Stream Computations				Stream Outputs							
Stream 1	Max/Min	Limits		Serial	PCMCIA						
Stream 2	Max/Min	Limits		Serial	PCMCIA						
Stream 3	Max/Min	Limits	ACTIONS	Serial	PCMCIA	Display #1	Display #2	Display #3	Display #4	DAC #1	DAC #2
Stream 4	Max/Min	Limits		Serial	PCMCIA						
Stream 5	Max/Min			Serial	PCMCIA						
Stream 6	Max/Min			Serial	PCMCIA						
Stream 7	Max/Min			Serial	PCMCIA						
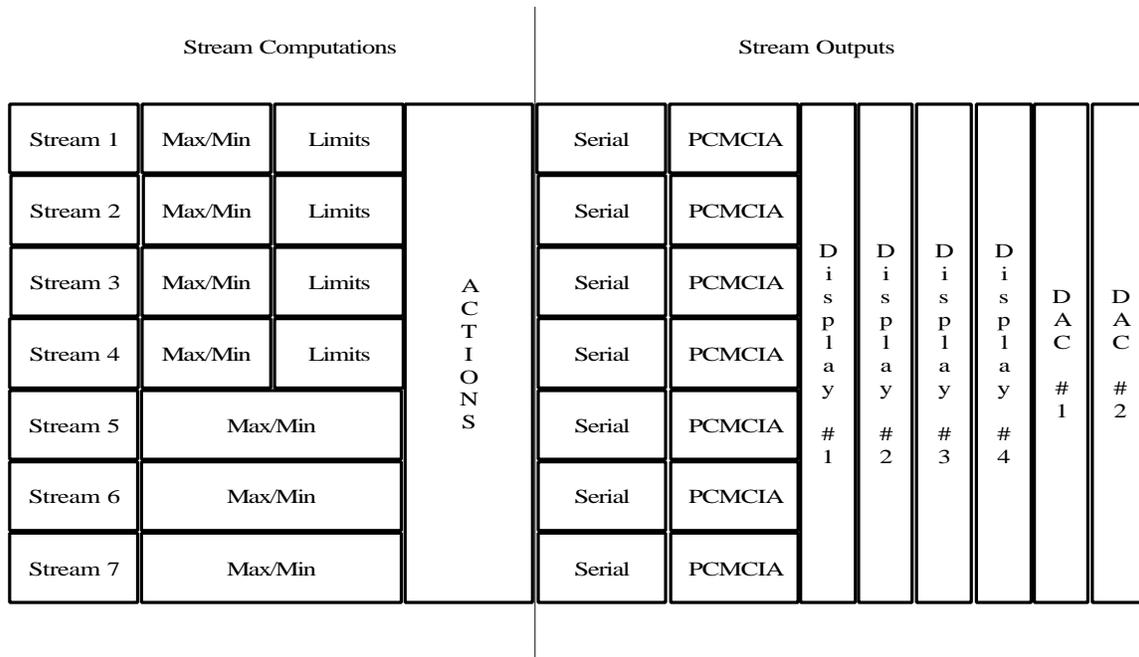
Figure 5: Stream organization

11.2 Stream Values

Individual stream values can be set manually with the **STREAM** command:

STREAM<n> [ffff]
>   [ffff]= Value to place in stream <n>
>   <n>= 1,2,3,4,5,6,7
>   Example: S01 stream1=disp1 disp2 dac1 serial will send the data in stream #1 to both displays 1 and 2 as well as the analog output and the serial port.

This command places the value [ffff] in stream <n>. If the HI-QMEGA is in the RUN mode, this value will be sent to all outputs associated with stream <n>. Any limits and actions resulting from a stream value of [ffff] will also be executed. Refer to *Section 12. Alarms and* Actions for information on defining actions.

11.3 Max/Min Stream Values

The HI-QMEGA controller automatically records the maximum and minimum input values from each stream. The **SHOWMAX** command recalls these values and can be used to determine the range of input values encountered since the Max/Min values were last cleared. Max/Min values are also available for use in mathematical equations as described in *section 10 (page 31)*

The **NEWMAX** and **NEWMIN** commands reset the Max and Min values for all seven streams. The **NEWMAXMIN** command resets both the Max and Min stream values for all seven streams. A Max value that is reset becomes the smallest number the HI-QMEGA can represent ($-1.7014*10^{-38}$) while a Min value resets to the largest number the HI-QMEGA can represent ($1.7014*10^{38}$).

11.4 Stream Limits

Limits allow the HI-QMEGA controller to take actions such as turning relays on and off, disabling analog outputs, and executing commands if a stream value exceeds or drops below a specified value. Streams 1-4 have *High-High, High, Low, Low-Low,* and *Rate* limits associated with them. Limits are enabled with the **LIMON** command and can be disabled with the **LIMOFF** command.

High-High and *High* limits are activated when a stream value is larger than the limit value. *Low-Low* and *Low* limits are activated when a stream value is smaller than the limit value.[4] There are two *Rate* limits, the Rate Increasing (*RI*) and Rate Decreasing *(RD)* limits. The *RI* limit is activated when a stream value is increasing at a rate higher than the *RI* limit for that stream. The *RD* limit is activated when a stream value is decreasing at a rate higher than the *RD* limit for that stream.

11.4.1 Setting Limits

Limits for streams 1-4 can be set with the following commands:

HH<n> [ffff]
>   []= Show current limit value
>   [ffff]= New stream<n> *High High* limit
>   <n>= 1,2,3,4
>   Example: S01 hh1 90 sets the high-high limit of channel #1
>   to 90.

H<n> [ffff]
>   []= Show current limit value
>   [ffff]= New stream <n> *High* limit
>   <n>= 1,2,3,4
>   Example: S01 h2 75 sets the high limit of channel #2 to 75.

---

[4] Due to the way limits are processed, a channel's *High-High* limit must be larger than its *High* limit, which must be larger than its *Low* limit, which must be larger than its *Low-Low* limit. If this order is not followed, the limits for that channel will not operate properly.

L<n> [ffff]
    []= Show current limit value
    [ff.]= New stream <n> *Low* limit
    <n>= 1,2,3,4
    Example: S01 l3 300 sets the low limit of channel #3 to 300

LL<n> [ffff]
    []= Show current limit value
    [ffff]= New stream <n> *Low Low* limit
    <n>= 1,2,3,4
    Example: S01 ll1 10 sets the low-low limit of channel #1 to 10.

RI<n> [ffff]
    []= Show current limit value
    [ffff]= New stream <n> *RI* limit
    <n>= 1,2,3,4
    Example: S01 ri1 5 sets the rate of increase value of channel #1 to 5 per second.

RD<n> [ffff]
    []= Show current limit value
    [ffff]= New stream <n> *RD* limit
    <n>= 1,2,3,4
    Example: S01 rd1 10 sets the rate of decrease value of channel #1 to 10 per sec.

11.4.2 Limit Hysteresis

The limits for each stream are calculated relative to a hysteresis value. Hysteresis creates a "dead band" around a limit, preventing it from activating and deactivating rapidly if the stream value fluctuates slightly above and below the limit value. This can be important if the limit controls a pump, motor, or other piece of equipment that will wear out quickly if turned on and off several times a second. Figure 6 demonstrates how hysteresis affects limit activation.

HYST<n> [ffff]
    []= Show current hysteresis value for stream <n> limits
    [ffff]= Set stream <n> hysteresis to [ffff]
    <n>= 1,2,3,4
    Example: S01hyst1 0.2 places a dead band of 0.2 around all the relays on stream1.
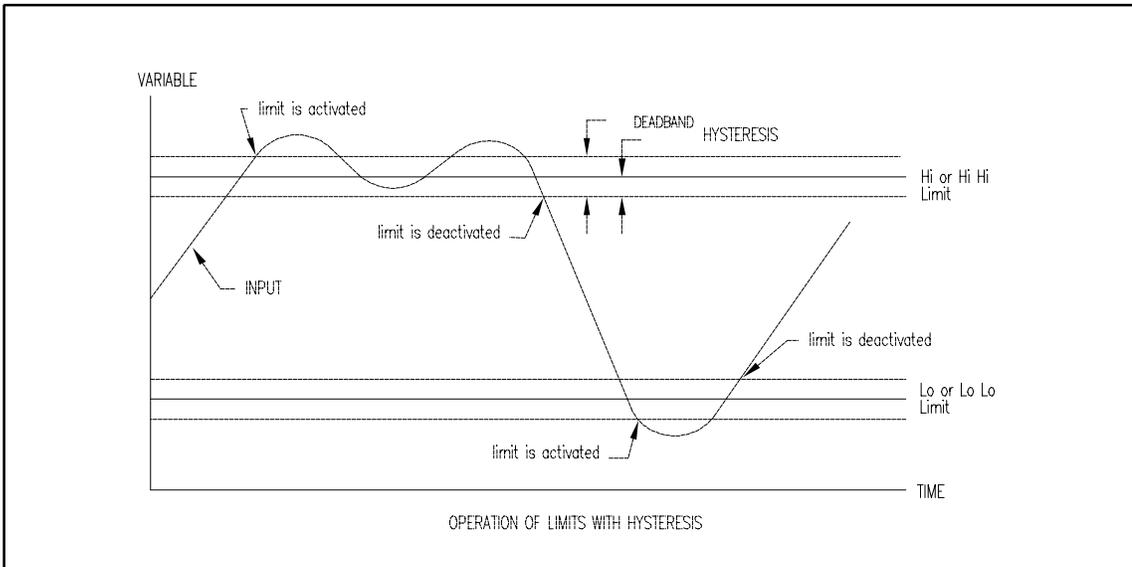
Figure 6: How hysteresis affects limit activation/deactivation

11.5 Output Options

There are five outputs that may be associated with a stream. These are the serial, display1, display2, DAC1 and DAC2. Each output receives data from the appropriate stream(s) and processes it according to the particular hardware shipped with the HI-QMEGA.

STREAM<n>= [off, +,-: serial disp1 disp2 disp3 dac1]

[]=	Shows current stream <n> outputs		[disp1]=	Stream <n> data to display #1(bargraph)
<n>=	1,2,3,4,5,6,7		[disp2]=	Stream <n> data to display #2 (numeric)
[off]=	Removes all stream <n> outputs		[dac1]=	Stream <n> data to DAC #1
[serial]=	Stream <n> data to serial output		[dac2]=	Stream <n> data to DAC #2

11.5.1   Serial Output

The serial output is the most versatile of all outputs. It can display all seven stream values, stream units, and limit messages. Because all seven streams can send data to the serial output simultaneously, data from each stream is preceded by the stream number generating the data (STR1: 25.0567)

Hardware and software problems will also send messages to the serial output. An A/D failure, non-volatile memory failure, divide by zero error, bad equation, or other problem detected by the HI-QMEGA will send an error message to the serial output.

11.5.1.1   Unit Messages

If desired, a message describing the units of each stream can be added to the serial output. Each message will be displayed after the appropriate stream data and can be up to 15 characters long.

UNITS<n><message>
> <message>= Any ASCII message up to 15 characters long
> <n>= 1,2,3,4,5,6,7
> Example: S01 units1 PSIG attaches the units PSIG to stream 1. When sent through the serial port the data displayed on the CRT would look like this STR1 25.3056 PSIG.

11.5.1.2   Limit Messages

Messages describing the status of stream limits, up to 15 characters long, can be added to stream outputs. For example, if stream1 receives data outside of its assigned limits, the appropriate limit message can be added to the serial output of stream1.

MHH<n><msg>
> <msg>= Channel <n> *High High* limit message
> <n>= 1, 2, 3, 4
> Example: S01 mhh1 overflow

MH<n><msg>
> <msg>= Channel <n> *High* limit message
> <n>= 1, 2, 3, 4
> Example: S01 mh1 warning

ML<n><msg>
> <msg>= Channel <n> *Low* limit message
> <n>= 1, 2, 3, 4
> Example: S01 ml1 tank 3 low

MLL<n><msg>
> <msg>= Channel <n> *Low Low* limit message
> <n>= 1, 2, 3, 4
> Example: S01 mll1 tank 1 empty

MRI<n><msg>
> <msg>= Channel <n> *RI* limit message
> <n>= 1, 2, 3, 4
> Example: S01 mri1 change coolant

MRD<n><msg>
> <msg>= Channel <n> *RD* limit message
> <n>= 1, 2, 3, 4
> Example: S01 mrd1 pump 3 bad

11.5.1.3   Numeric Notation

The serial output values can be displayed in a scientific or fixed decimal format. Scientific notation is selected with the **SCI (S01 sci)** command and displays numbers like this:

| 1.234567E3 | 4.567890E-3 | -1.200000E4 | -1.001423E-4 |

The fixed decimal format displays the integer portion of a number with a fixed number of digits after the decimal point.

DFIX[n]
> [n]= # digits after the decimal point. (Serial port use)
> N = 0 to 6

After a FIX3 command (S01 Dfix3), the above numbers would be shown as:

| 1234.567 | 0.005 | -12000.000 | -0.000 |

11.5.1.4   Serial Output Rate

The rate at which the serial output is updated can be controlled through the use of timer T1.

T1[n]
> []= Shows current value of T1
> [n]= # of seconds between serial transmissions.
> 0 ? n ? 16,777,215
> n = 0 allows continuous serial transmission.
> Example: S01 t1 5 will send the serial data out once every five seconds.

When the HI-QMEGA is running, T1 updates the serial output once every [n] seconds. All other outputs are updated normally. If [n] = 0, the serial output is updated continuously.

11.5.2 Display Outputs

Assigning display1, display2 or display3 to a stream will send the stream data to the corresponding display. Refer to the *Error! Reference source not found.* on page **Error! Bookmark not defined.** to determine how display outputs correspond to the physical display. On the HI-QMEGA the bargraph is disp1, the numeric is disp2.

11.5.2.1   Numeric Displays

Numeric displays show stream data in a fixed notation according to their setup parameters. Each numeric display can be configured individually using the **Dfix** command. Refer to section *0*

17.3   Numerical Displays.

11.5.2.2   *Bargraph Displays*

Bargraph displays use stream data to light up a number of display elements. The number of elements lit is determined by the full scale and zero parameters assigned to each bargraph. Bargraphs can also operate in one of several modes. Refer to *0 17.2 Bargraph* Display for more information.

11.5.3 DAC output

DAC1 output converts stream data into a 0-5Vdc or 4-20mA analog output. In addition, the DAC output has its own set of limits, scale, and offset. The limits allow the user to set clamps around the output so that it will not exceed the clamped range.

11.5.3.1   *Output Scaling*

DAC outputs scale the engineering units used by the serial and display outputs to a range appropriate for the analog output signal:

Analog output = (Stream value * DAC scale) + DAC offset

For instance, stream values representing 15-25?C may be scaled to get an analog output of 4-20mA. Scale and offset values are calculated from simple mathematical relations:

scale value = (20mA-4mA)/(25?C -15?C) = 1.6

offset value = 4mA - (scale value) * 15?C = -20

Then, a 15?C stream value will generate an analog output of 15*1.6-20= 4mA and a 25?C stream value will generate a 25*1.6-20= 20mA output.

DSCALE1 [ffff]
      []= Show current DAC scale
      [ffff]= Set DAC scale to [ffff]
      Example: S01 dscale1 1.6

DOFFSET1 [ffff]
      []= Show current DAC offset
      [ffff]= Set DAC offset to [ffff]
      Example: S01 doffset1 -20

11.5.3.2   *Output Limits*

The DAC output has a *DAC-High* and *DAC-Low* limit. Like stream limits, DAC limits allow the HI-QMEGA to perform actions when a limit value is reached. In addition, a DAC output cannot exceed its *DAC-High* limit or fall below its *DAC-Low* limit.

DH1 [ffff]
      []= Show current DAC1 *High* limit
      [ffff]= Set DAC *High* limit to [ffff]
      Example: S01 dh1 22 will not allow the analog output to exceed 22mADC.

DL1 [ffff]
      []= Show current DAC1 *Low* limit
      [ffff]= Set DAC *Low* limit to [ffff]
      Example: S01 dl1 3 will not allow the analog output to fall below 3mADC.

12. Alarms and Actions

The HI-QMEGA can be programmed to perform specific actions when it encounters an alarm. Alarms include activated limits and digital input values. Actions that may take place when an alarm occurs include setting relays, changing digital outputs, resetting analog outputs, and executing commands.

12.1 *Alarm Uses*

Alarms are a way of telling the HI-QMEGA that something needs to be done. If a pressure sensor input reaches a *High* limit because a tank is full, the *High* limit alarm can be used to turn off a pump or close the fill valve on the tank. Later, when the tank pressure falls below the *Low* limit, the *Low* limit alarm can refill the tank by turning on the pump or opening the fill valve again. If the valve or pump do not respond properly, the *High High* and *Low Low* limits can be used to alert an operator and shut the system down.

SA <alarm> [actions]

[]= Shows current [actions] assigned to <alarm>	[D1L]= Set DAC1 to its low limit
[R<p>H]= Turn relay/BiMOS output <p> on	[D1Z]= Set DAC1 output to zero
[R<p>L]= Turn relay/BiMOS output <p> off	[CMD<m>]= Execute CMD<m> command
[R<p>T]= Toggle state of relay/BiMOS output <n>	[STOP]= Open the execution loop
[D1H]= Set DAC1 to its high limit	[RUN]= Keep the execution loop closed
	[NONE]= Remove all [actions] from <alarm>

<alarm> is one of:

NORM	Normal operating status	RI<p>	Stream <p> RI limit
HH<p>	Stream <p> HiHi limit	RD<p>	Stream <p> RD limit
H<p>	Stream <p> Hi limit	DH1	Dac1 Hi limit
L<p>	Stream <p> Lo limit	DL1	Dac1 Lo limit
LL<p>	Stream <p> LoLo limit		

1 ? m ? 3
1 ? p ? 4

SA+ [alarm] [actions]	Same as SA, but adds [actions] to [alarm].
SA- [alarm] [actions]	Same as SA, but removes [actions] from [alarm].

The tank example above could be implemented with:

    Relay 1 = High limit bell/buzzer
    Relay 2 = Operator alert switch
    Relay 3 = Power to fill valve (Should normally be ON)
    Relay 4 = Fill valve (ON fills tank, OFF closes valve)

using the following commands:

`SA NORM R1L R2L R3H`	Relay positions for normal operation
`SA H1 R1H R4L`	At *high* limit, turn Relay 1 ON to sound bell, Relay 4 OFF to stop fill valve
`SA L1 R4H`	At *low* limit, turn Relay 4 ON to activate fill valve
`SA HH1 R2H R3L`	At *high high* limit, turn Relay 2 ON to alert operator and Relay 3 OFF to cut power
`SA LL1 R2H R3L`	At *low low* limit, turn Relay 2 ON to alert operator and Relay 3 OFF to cut power

12.1.1 Smart alarming

When alarms are used to indicate an input, output, or process parameter that is out of range, the HI-QMEGA is performing what is known as smart alarming. With its mathematical capabilities the HI-QMEGA can detect many complex alarm conditions. For example, an alarm can be set off if the difference between two inputs exceeds a specified limit for more than ten seconds.

```
S01 EQN1 S3=S1-S2  (Stream 3 = difference between streams 1 and 2)
S01 HH3 25         (Alarm when stream 3 exceeds 25)
S01 DELAY HH3 100(Limit must be exceed for 100*100 milliseconds before taking action)
S01 SA HH3 R1H     (Turn relay1 ON when alarm is activated)
```

12.1.2 On/Off control

When alarms are used to turn relays and devices on and off, the HI-QMEGA is performing on/off or "bang-bang" control. This is the type of control commonly used in refrigerators. When the temperature inside the refrigerator reaches an upper limit, the cooling unit turns off. When the temperature falls below the lower limit, the cooling unit turns back on.

```
S01 H1 50          (Start cooling when temperature is 50 degrees)
S01 L1 25          (Turn cooling off when temperature is below 25 degrees)
S01 SA H1 R1H      (At High limit #1, relay 1 turns ON)
S01 SA L1 R1L      (At Low limit #1, relay 1 turns OFF)
```

12.2 Trigger delays

Most alarms may be assigned a delay time that must elapse before an action is taken. This is beneficial for actions that are needed only if an alarm lasts longer than a specified time. For instance, a motor might be allowed to run at high speed for short periods of time. The HI-QMEGA can monitor motor speed, and shut the motor down if it is operated for too long at high speed.

DELAY <alarm> [time]

 []= Shows time <alarm> must be on before actions are taken
 [time]= Sets time in 100ms increments <alarm> must be on before actions can be taken
 0 ? time ? 255
 <alarm>=

HH<n>	Stream <n> HH limit	RI<n>	Stream <n> RI limit
H<n>	Stream <n> H limit	RD<n>	Stream <n> RD limit
L<n>	Stream <n> L limit	DH1	DAC 1 H limit
LL<n>	Stream <n> LL limit	DL1	DAC 1 L limit

 For example, the command DELAY HH2 10 would require the Stream 2 *High High* limit to be active for 1 second (10 * 100ms) before any actions associated with it could be taken.

Note: The accuracy of the delay function is proportional to the number of A/D channels turned on. If the unit is receiving data through the serial port its accuracy is +/- 1 second. If the unit is receiving analog signals to the A/D converter use one of the following formulas.

Single channel unit	Programmed Delay = ((desired delay) / (1.255)) * (10)
Two channel unit	Programmed Delay = ((desired delay) / (1.9294)) * (10)
Three channel unit	Programmed Delay = ((desired delay) / (2.705)) * (10)

Hint, if a delay of more than 25.5 seconds is desired, turn on the additional channels that are not being used.

12.3 Actions

After an alarm occurs, the HI-QMEGA performs all of the actions assigned to that alarm. If more than one alarm occurs, the actions associated with all activated alarms will be performed.

12.3.1 Action Conflicts

Because it is possible for actions from two alarms to conflict, alarms are assigned a priority. If an action conflict occurs, the alarm with highest priority will control the action. Alarm priority is listed in Table 1.

Alarm	Priority
Stream 1 limits	Highest
Stream 2 limits	
Stream 3 limits	
Stream 4 limits	
DAC 1 limits	
TTL1 input	
TTL2 input	Lowest

Table 1: Alarm priorities

In addition, the *High High, High, Low,* and *Low Low* limits have priority over the *RI* and *RD* limits. For example, if the *High* limits for streams 1 and 3 are activated and both try to control the same relay, the stream1 *High* limit action will operate the relay since it has the higher priority.

12.3.2 Relays and BiMOS outputs

All four (4) relays and eight (8) BiMOS outputs can be turned on, off, toggled, or left alone by an alarm. If left alone, a relay or BiMOS output may be controlled by an alarm with lower priority.

12.3.4 DAC output

The DAC output can be set to its *High* limit, *Low* limit, zero, or can be left alone by an alarm. Alarms that set the DAC to zero cause the analog output to become 0Vdc or 0mA.

12.3.5 Command execution

Actions can also be used to execute one of three user selected commands. Any valid command can be selected with the **CMD** command. The commands are executed as if they had been sent directly to the serial input. If more than one alarm tries to execute a command, only the highest priority alarm will have its command executed.

CMD<n> [command]
      Defines command <n>
      <command>= Any valid command (<u>without</u> 'S' + the device address)
      <n>= 1,2,3
      Example: S01 cmd1 stream1-disp1 causes stream1 data to be removed from disp1 after cmd1 is activated by an alarm.

12.3.6 Run/stop control

The last action that an alarm can perform is to stop the HI-QMEGA from running. This action is equivalent to entering the **STOP** command from the serial port. All streams and analog outputs will remain at their current values and the HI-QMEGA will stop reading and processing inputs.

Additional Functions

This section describes the remaining functions available on the HI-QMEGA. These include digital I/O, emergency shutdown, and manual control of outputs. Commands that show current HI-QMEGA parameters and variables are also presented.

14. Manual Control of Outputs

All relay/BiMOS outputs, digital outputs, analog outputs, streams, and channels can be set manually with commands from the serial port or with the keypad. To control an output that is currently being updated by the HI-QMEGA, the **STOP** command must first be issued. Otherwise, any manually assigned output values will be overwritten the next time the HI-QMEGA updates its outputs.

14.1 Emergency Shutdown

In the event of an emergency, all HI-QMEGA outputs can be quickly set to a predetermined value with the **PANIC** command. The outputs will remain at the predetermined values until a **RUN** command is given or the outputs are changed manually. The **SETPANIC** command is used to set emergency output conditions. Current emergency output conditions can be seen with the **SHOWPANIC** command.

SETPANIC [DAC1<ffff>, R<n> <H, L>]
      []= Show current emergency shutdown outputs
      [DAC1<ffff>]= Set DAC1 output to <ffff>
      [R<n><H, L>]= Set relay/BiMOS output <n> High or Low
      1 ? n ? 8

14.2 Relays and Discrete Outputs

All relays and BiMOS outputs can be set with the **R** command:

R<n>[H, L, T]
      []= Shows current state of relay/BiMOS output <n>
      [H]= Turn relay/BiMOS output <n> on
      [L]= Turn relay/BiMOS output <n> off
      [T]= Toggle relay/BiMOS output <n>
      <n>= Relay/BiMOS output to control
      1 ? n ? 8

The state of the selected relay/BiMOS output will change as soon as the command is entered and will remain in that state until changed with another **R** command, updated by the HI-QMEGA, or until power is disconnected.

14.4 Analog output

Manual control of the analog output is accomplished with the **DAC1** command:

DAC1 [ffff]
>   []= Show most recent DAC1 output
>   [ffff]= Valid output value

The output value used with the **DAC1** command should be in the same engineering units as the display and serial output. This value will then be scaled to the appropriate value of mA or Vdc with the DAC scale and offset values. See section 11.5.3.1 for information on scaling DAC outputs.

The DAC *High* and *Low* limits also affect manually specified output values. Attempting to set a DAC output to a value outside its *Low* and *High* limits will result in the output being set to the *High* or *Low* limit value. See *11.5.3.2   Output* Limits for more information on DAC limits.

15. Computer Operating Properly Timer

In addition to software operational checks, the HI-QMEGA contains a Computer Operating Properly (COP) or watchdog timer. This timer can determine if the HI-QMEGA has stopped operating properly due to software problems or hardware failure. If a failure is detected, the COP timer resets the HI-QMEGA, which will try to recover from the error.

15.1 Enabling the COP Timer

The **WDON (S01 wdon)** command enables the COP timer, while the **WDOFF (S01 wdoff)** command disables it. ***Once the state of the COP timer is changed, the HI-QMEGA must be turned off and back on for the change to take effect***. The **SHOWSTAT** command will display the current state of the COP timer, and the state it will be in after a hardware reset.

15.2 Testing the COP Timer

The **WDTEST (S01 wdtest)** command tests the COP timer. It places the HI-QMEGA in an infinite software loop, which the COP timer will detect. When the COP detects the software loop, it causes the HI-QMEGA to reset.

16. Showing System Status

Often it is desired to see the current value of many HI-QMEGA parameters. While most commands will show the current value of a parameter if a new value is not specified, it can be time consuming to check multiple parameters. Therefore, several SHOW commands are available that will display related groups of HI-QMEGA parameters in an easy-to-read format. Issuing the **SHOW** or **HELP** commands will send a list of available SHOW commands to the serial port along with a short description of what they display.

16.1 Input Parameters

Input parameters such as scale, offset, linearization method, tare, and limits can be viewed with the **SHOWIN** command. Information regarding all four channel inputs and stream limits is displayed.

16.2 Output Parameters

The **SHOWOUT** command will display the analog output scale, offset, and limit values. These values determine the values of analog outputs for a given input. This command will also show the current state of all relay/BiMOS outputs.

16.3 Other Parameters

For a list of all SHOW commands and what they display, refer to the SHOW section of *The HI-QMEGA Command Set*.

16.4 System Diagnostics

The **DIAG** command can be used to test basic HI-QMEGA hardware operation. After the command is given, the HI-QMEGA will perform various internal diagnostics and report any problems. Due to the complexity of the system, not all hardware problems can be detected by this command.

17. Display Configuration

There are several commands which alter the way a HI-QMEGA display looks. Display colors, flashing, bargraph mode, limit colors, and numeric notation can all be customized to suit a particular application. This chapter discusses the various commands that affect how each display operates.

17.1 General Setup

Some commands affect all displays on the HI-QMEGA. These are the **DEMO**, **SETD**, **CLRD**, **LAMP**, **INT**, **DLFLASH**, and **DLNFLASH** commands.

DEMO
> Places the display in a demo mode

SETD<n>
> Causes all segments/bars of display <n> to turn on

CLRD<n>
> Causes all segments/bars of display<n> to turn off

LAMP
> Initiates a lamp test to ensure all display elements are working properly

DINT [0, 1, 2, 3]
> [0-3]= Sets the display intensity from 0 (off) to 3 (brightest)

DLFLASH<n>
> Causes entire display to flash when display <n> reaches a limit. *Hi* and *Lo* limits flash at a slow speed, while *Hi Hi* and *Lo Lo* limits flash at a faster speed.

DLNFLASH<n>
> Turns off flashing when display <n> reaches a limit.

17.2 Bargraph Display

A bargraph display can be set to a specific mode, scale, and color. It can also display limit marks in various colors and change color when a limit is reached.

17.2.1 Bargraph Mode

A bargraph display can be configured to operate clockwise, counter clockwise or bi-directionally from the center or specified starting point. The **DMODE** command is used to select how a bargraph operates:

DMODE2 [top, bot, bi]
> [bot]= Fill bargraph in a left-to-right direction
> [top]= Fill bargraph in a right-to-left direction
> [bi]= Bargraph operates bi-directionally from the center
> Example: S01 dmode2 bi places the bargraph in bi-directional mode. Sending the command S01 dmode2 bot will return it to a left-to-right mode of operation.

17.2.2 Bargraph Scale

The range of values displayed on a bargraph is determined by its 'bars full scale' (BFS) and 'bars zero' (BZ) parameters. BFS determines the maximum number a bargraph can display before it tops out by having all its bars lit. BZ sets the value at which bars start to light. For example, having BFS=200 and BZ=100 would cause the displayed reading to start at 100 and top off at 200. An input of 150 would light half of the bargraph's bars.

BFS1 [n]   **BZ1** [n]
    [n]= Set BFS to [n]   [n]= Set BZ to [n]

17.2.3 Bargraph Color

The colors on a bargraph can be changed with the **DCOLOR1** command. This command has no effect on displays without color capability.

DCOLOR1 [R, G, A]
    [R]= Set the normal operating color of the bargraph to RED
    [G]= Set the normal operating color of the bargraph to GREEN
    [A]= Set the normal operating color of the bargraph to AMBER
    Example: S01 dcolor1 G.

17.2.4 Bargraph Limits

Limit marks for all bargraph displays are turned off with the **DLIMOFF** command. The display will still change colors and flash, but no limit marks will show. The **DLIMON** command turns limit marks back on. If stream limits are not enabled (limoff), no limit marks will show. The color of the limit marks on the bargraph can be set with the following commands:

HHD1 [R, G, A]   Set High High limit color
HD1 [R, G, A]   Set High limit color
LD1 [R, G, A]   Set Low limit color
LLD1 [R, G, A]   Set Low Low limit color
    [R]= Set limit color to RED
    [G]= Set limit color to GREEN
    [A]= Set limit color to AMBER
    Example: S01 hhd1r Sets the high high limit color to red.
        S01 hd1a set the high limit color to amber.
        S01 ld1a sets the low limit color to amber
        S01 lld1a sets the low low limit color to red.
    With the above settings and the dcolor command set to G (green) the bargraph will be normally green with low and high limits being amber and low low and high high limits being red.

When the bargraph reaches a limit, all bars can change to the limit color or only the bars beyond the limit can change color. The **DSYMOFF** command causes only the bars beyond a limit to change colors while the **DSYMON** command causes all bars to change to the color of the activated limit.

17.3 Numerical Displays

The values shown in a numerical display can be modified with the **DFIX2** command:

DFIX 2n (n= 0, 1, 2, 3, 4, 5, or 6)
>   [0-6]= Number of digits to display after the decimal point
>   [AUTO]= Automatic setting of the decimal point
>   Example: S01 dfix2 3 will display 45.001. 3 digits to the right of the decimal point on display #2.

Numerical displays will also display any alpha-numerical message sent with the **DISP**<n> command:

DISP<n> <message>
>   Displays alpha-numerical <message> on display <n>
>   Example: S01 disp2 alarm <cr> will show the word alarm on display#2

18. HI-QMEGA Applications

This chapter presents some typical applications of the HI-QMEGA programmable intelligent controllers. Its purpose is to demonstrate how to set up and configure the HI-QMEGA for use. The applications presented can be used as shown or can be modified to fit your particular requirements.

18.1 Temperature Control Using a Thermocouple

This example shows how to control temperature using the HI-QMEGA using simple *on/off or bang-bang control*. A thermocouple input will be measured, linearized, scaled to appropriate display values. To demonstrate the flexibility of the HI-QMEGA, an example of relay operation will be presented. This example will turn a relay ON when the temperature exceeds a high limit and will turn a second relay ON when the temperature drops below a low limit. Both relays will be OFF when the temperature is between the high and low limits. The other two relays will be set as an operator warning to sound an external alarm at over / under temperature limits.

18.1.1 Control Specifications

Thermocouple input type: J
High temperature limit: 350 ?C
Low temperature limit: 300 ?C
Display1 (Bargraph): Current temperature with 1% resolution
Display2 (numeric): Current temperature with 0.1 degree resolution
Bargraph display should read 0 bars @ 0?C and 100 bars @ 400?C

18.1.2 Connections

The thermocouple is connected to the channel 1 analog input.
Relay 1 is the control relay.

18.1.3 Configuration

To begin configuration apply power to the HI-QMEGA meter. It will start up in USER MODE as discussed in *0 Operating Modes*.

```
HI-Q by OTEK
Version 2.75  1996
Address: '01'
Warming-Up..
*
```

Start configuration by setting the channel input parameters. Since no tare is needed, the factory values (tare off) will be used. First, the type of linearization needed is used. For a J-type thermocouple, the JC linearization is needed.

```
Example: S01 LIN1 JC
```

The linearization converts the thermocouple millivolt output into a temperature, eliminating the need for setting the scale1 or offset1 values. The next values to set are the limits.

```
*S01 HH1 400 Sets high high limit of channel #1 to 400
*S01 H1 350  Sets the high limit of channel#1 to 350 (control temp.)
*S01 L1 300  Sets the low limit of channel#1 to 300 (control temp.)
*S01 LL1 250 Sets the low low limit of channel#1 to 250
```

At this point, the input parameters should be verified with the **SHOWIN** (S01 showin) command. Once verified, set the stream outputs to update the display, and set the scale on the Bargraph to show the correct number of bars.

```
*S01 STREAM1= DISP1 DISP2
*S01 BFS1  400 (Turn on all 100 bars (bargraph elements) at a reading of 400)
```

Now the HI-QMEGA will correctly display its input values. Next we will use the limit alarms to make the relay operate properly.

```
*S01 SA NORM R1LR2LR3LR4L (Sets normal status of relays 1-4 to low)
*S01 SA HH1 R1H (Relay 1 turns ON at High High limit)
*S01 SA H1 R2H (Relay 2 turns ON at High limit)
*S01 SA L1 R3H (Relay 3 turns ON at Low limit)
*S01 SA LL1 R4H (Relay 4 turns ON at Low Low limit)
*S01 HYST1 1.2 (sets the hysterisis around all relays of channel#1 to 1.2 degrees)
*S01 limon (turns the limit control on)
```

Finally save all parameters in non-volatile memory.

```
*S01 WRITE
Writing EEPROM..............Done!
```

The HI-QMEGA is now configured for use as a simple temperature controller. Disconnect power and re apply to verify all data was saved. When power is reapplied, the HI-QMEGA will start in USER mode with the newly programmed parameters. It will automatically start taking temperature measurements and control the relays.

18.1.4 Alternate Relay Control

Since the HI-QMEGA's relays can be configured as normally open (n.o.) or normally closed (n.c.) and the relays have both poles available at the screw terminal connector, it can be configured so that the relays are normally energized and they turn off at the limits. This is also know as a fail safe configuration so that in the event of a power failure, the relays will deactivate and the temperature will not increase

First we need to reset the relay logic for fail safe operation.

```
*S01 SA NORM R1HR2HR3HR4H (set relays 1-4 to an activated state while within  normal operating
conditions)
```

Once the unit receives this command, all relays will change their current state of logic. Your connections can then be made to the N.C. contact. When the limit is reached or power is removed, the relays will inherently deactivate and these contacts will be closed.

Troubleshooting

The following table lists solutions to typical problems associated with setting up a HI-QMEGA controller. The most probable solution for each symptom is listed. If a problem persists or is not listed, contact OTEK technical support at (520) 748-7900. Normal business hours are M-F, 8AM-4PM MST. Be sure to have the HI-QMEGA model number, a detailed description of the problem, and an explanation of the intended application. This information is necessary to ensure fast and efficient technical support.

SYMPTOM	SOLUTION
No startup message on serial port	**Check power connections. Make sure the TXD, RXD, DO, and DI lines are wired properly. Verify communications protocol for baud rate, parity, number of start/data/stop bits.**
Garbage appears instead of a startup message	**Check communications protocol for proper baud rate, parity, number of start/data/stop bits**
Characters sent to the unit appear twice on the terminal	**Set communication software to FULL DUPLEX communications, or turn off LOCAL ECHO.**
After the startup message, the unit does not respond to commands	**Make sure the RXD or DI line is properly connected. Check communications software for proper settings.** **Be sure to use 'S' + the unit's *address* when sending commands.** **This situation can occur if the unit is in NET mode or has a long T0 setting. Use the LOC command to place the unit into local mode.**
Analog input always reads zero	**Turn the analog input channel on. Make sure the scale for that channel is not zero. Check all equations for proper operation.**
DAC1 output does not work	**Check the wiring connections to the HI-QMEGA. Be sure the DAC1 output is listed in an output stream. Make sure the dscale1 value is not zero.**
Relays/BiMOS outputs do not work	**Use the SHOWACT1 and SHOWACT2 commands to make sure the relay/BiMOS output is listed in an action. When in the STOP mode, use the R\<n\> [H, L, T] command to manually switch a relay/BiMOS output.**
Limits do not work properly	**Make sure the limit values are in the proper order. The HI-QMEGA requires *High-High* ? *High* ? *Low* ? *Low-Low* limit.** **Make sure limits are enabled with the LIMON command.**
The actions turn relay/BiMOS outputs on and then off.	**Check the SA NORM actions. It can override relay control from a CMD or TTL action.**

DEFAULT Parameters

COMMUNICATIONS

Parameters: 9600 baud, 1 start bit, 8 data bits, 1 stop bit, no parity, no flow control
(hardware flow control is simulated by the wiring connections)

Address: '01'

CHANNELS

Value:	0.0000	Lin:	none
Scale:	1.0000	Average:	0
Offset:	0.0000	Tare:	OFF

EQUATIONS

S1=C1	S3=C3
S2=C2	S4=C4

STREAMS

Unit messages: <none>
Limit messages: <none>

DISPLAYS

Notation: DFIX2=Auto (automatically shift decimal point as required to display MSD)
Bargraph color: DCOLOR1=Grn (green)
Bargraph mode: DMODE1=BOT (illuminate in a left-to-right direction)
Bargraph full scale: BFS1=1
Bar zero: BZ1=0 (the starting point of the bargraph)

LIMITS

Disabled

HH:	0.0000	LL:	0.0000
H:	0.0000	RI:	0.0000
L:	0.0000	RD:	0.0000

ACTIONS

All actions OFF.

GENERAL

Notation:	SCI
IDELAY:	0
T0:	0
T1:	0
LOCAL mode	
STOP mode	
COP timer:	OFF

Power Supply Notes

Care should be taken when making all connections to the HI-QMEGA instrument. Since this unit is available with either 24VDC power input or 90-265VAC power input, the units model number should be compared to the part numbering matrix located at the end of this manual. If the unit is powered from 24VDC, its power input should be well filtered and regulated to +/- 5%. If the unit is to be powered from 90-265VAC, the frequency must be 50 to 60Hz.

ASCII Codes

Decimal	Hexa-decimal	ASCII	Decimal	Hexa-decimal	ASCII	Decimal	Hexa-decimal	ASCII	Decimal	Hexa-decimal	ASCII
0	0	NUL	32	20	SP	64	40	@	96	60	'
1	1	SOH	33	21	!	65	41	A	97	61	a
2	2	STX	34	22	"	66	42	B	98	62	b
3	3	ETX	35	23	#	67	43	C	99	63	c
4	4	EOT	36	24	$	68	44	D	100	64	d
5	5	ENQ	37	25	%	69	45	E	101	65	e
6	6	ACK	38	26	&	70	46	F	102	66	f
7	7	BEL	39	27	'	71	47	G	103	67	g
8	8	BS	40	28	(	72	48	H	104	68	h
9	9	HT	41	29	)	73	49	I	105	69	i
10	A	NL	42	2A	*	74	4A	J	106	6A	j
11	B	VT	43	2B	+	75	4B	K	107	6B	k
12	C	NP	44	2C	,	76	4C	L	108	6C	l
13	D	CR	45	2D	-	77	4D	M	109	6D	m
14	E	SO	46	2E	.	78	4E	N	110	6E	n
15	F	SI	47	2F	/	79	4F	O	111	6F	o
16	10	DLE	48	30	0	80	50	P	112	70	p
17	11	DC 1	49	31	1	81	51	Q	113	71	q
18	12	DC 2	50	32	2	82	52	R	114	72	r
19	13	DC 3	51	33	3	83	53	S	115	73	s
20	14	DC 4	52	34	4	84	54	T	116	74	t
21	15	NAK	53	35	5	85	55	U	117	75	u
22	16	SYN	54	36	6	86	56	V	118	76	v
23	17	ETB	55	37	7	87	57	W	119	77	w
24	18	CAN	56	38	8	88	58	X	120	78	x
25	19	EM	57	39	9	89	59	Y	121	79	y
26	1A	SUB	58	3A	:	90	5A	Z	122	7A	z
27	1B	ESC	59	3B	;	91	5B	[	123	7B	{
28	1C	FS	60	3C	<	92	5C	\	124	7C		
29	1D	GS	61	3D	=	93	5D	]	125	7D	}
30	1E	RS	62	3E	>	94	5E	^	126	7E	~
31	1F	US	63	3F	?	95	5F	_	127	7F	DEL

The HI-QMEGA Command Set

The following is an alphabetical list of all HI-QMEGA commands. Examples are included for the more complex commands. Details of how each command works can be found in the appropriate chapter.

ADBAND\<n\> \<value\>
> \<n\> = channel # (1, 2 or 3)
> \<value\> = number of counts to set band at
> This command places an intelligent moving band around the signal input. If the next incoming reading is within this band, the unit continues the current averaging. If the reading is outside of the band, the unit will disable the averaging and then enable it again once the signal stabalizes within the band value. This is useful when noise may be present on the signal lines and a steady reading is desired while still maintaining a quick step response to an actual signal change.
> **Example:** S01ADBAND1 .005 set the band for channel 1 to 0.005 counts. To disable set the band to 0.

ADDR [address]
> Changes the device address. If no new address is specified, only an 'S' must precede commands
> [address] = ASCII address of up to 6 characters
> **Example**: S01addr02 changes the address of unit 01 to 02. The unit will only respond to commands starting with S02 from this point on.

AVG\<n\> [dddd]
> []= Shows current number of samples being averaged for channel \<n\>
> [dddd]= Sets # of samples to [dddd]
> \<n\>= 1,2,3,4
> 0 ? [dddd] ? 255
> **Example**: S01avg1 4 sets the number of samples to be averaged on channel 1 to 4.

BAUD [baudrate]
> []= Shows current baud rate
> [baudrate]= 19.2K, 9600, 4800, 2400, 1200
> **Example**: S01baud4800 sets the meter's serial baud rate to 4800bps

BFS1 [ffff]
> [ffff]= Set BFS1 value to [ffff]
> **Example**: S01BFS1 20 sets the bargraph#1 full scale value to 20. On the HI-QMEGA series the bargraph is always #1.

BZ1 [ffff]
> [ffff]= Set display \<n\> BZ value to [ffff]
> **Example**: S01BZ1 20 sets the starting value of the bargraph to 20. The bargraph will begin illuminating with a value of 20 on the appropriate stream. If the BFS is set to 100 then the bargraph will illuminate from 20 to 100.

CH\<n\> \<ON, OFF\>
> \<ON\>= Turn channel \<n\> A/D inputs ON
> \<OFF\>= Turn channel \<n\> A/D inputs OFF
> \<n\>= 1,2,3
> **Example**: S01CH1on initializes the A/D converter for channel #1.

CHN\<n\> [ffff]
> [ffff]= Value to place in channel \<n\>
> \<n\>= 1,2,3,4
> **Example**: S01CHN1 20 will display the number 20 on the digital display and turn on the appropriate number of bargraph segments.

CLRD\<n\>
> Turn all display \<n\> elements OFF
> \<n\>= 1,2,3,4

CMD<n> [command]

    Defines the command to be executed when CMD<n> is found in an action list

    <command>= Any valid command (without the device address)

    <n>= 1,2,3

    Example: S01cmd1 bfs1 250 will automatically change the bargraph full scale value to 250 when cmd1 is activated. Cmd1 can be activated from an alarm using the set action command. S01sahh1cmd1 sets the action so that when the hh1 value is reached cmd1 is executed.

DCOLOR1 [R, G, A]

    [R]= Set bargraph to RED

    [G]= Set bargraph to GREEN

    [A]= Set bargraph to AMBER

    Example: S01dcolor1R changes the bargraph normal color from green to red.

DELAY <action list> [time]

    [time]= Time to delay in 100ms increments before <action list> can occur on an alarm condition

    0 ? time ? 255

    <action list>=

HH<n>	Stream <n> HH limit	RI<n>	Stream <n> RI limit
H<n>	Stream <n> H limit	RD<n>	Stream <n> RD limit
L<n>	Stream <n> L limit	DH1	DAC 1 H limit
LL<n>	Stream <n> LL limit	DL1	DAC 1 L limit

DFIX<n> [ddddd]

    [ddddd]= Set numerical display <n> to [ddddd] fixed decimal places

    n=1, 2, 3, or 4 depending on the unit. For the HI-QMEGA the numeric display is #2.

    Example: S01dfix2 3 will show a maximum reading of 999.999 on the display and a minimum reading of 0.001

DH1 [ffff]

    Set DAC*Hi* limit

    []= Shows current DAC1 *Hi* limit

    [ffff]= Sets DAC1 *Hi* limit to [ffff]

    Example: S01dh1 22 sets the analog output high limit to 22mADC when the 4-20out is ordered.

DIAG

    Performs internal diagnostics

    Example: S01diag will start the individual segment test of the display and main microprocessor.

DINT [0, 1, 9]

    Set display intensity

    [0]= Display OFF

    [1]= Lowest intensity

    [9]= Highest intensity

    Example: S01dint1 changes the display intensity to low brightness. Mainly used for night time use onboard ocean going ships.

DL1 [ffff]

    []= Shows current DAC1 *Lo*limit

    [ffff]= Sets DAC1 *Lo* limit to [ffff]

    Example: S01dl1 3 sets the analog output low limit to 3mADC when the 4-20out is ordered.

DLFLASH

    Causes entire bargraph to flash when display reaches a limit. *Hi* and *Lo* limits flash at a slow speed, while *Hi Hi* and *Lo Lo* limits flash at a faster speed.

    Example: S01dlflash

DLIMOFF

Turns off limit marks for all bargraph displays. Bargraphs will still change color and/or flash when reaching a limit, but the limit marks will not show.
Example: S01dlimoff

DLIMON
Turns limit marks on for all bargraph displays
Example: S01dlimon

DLNFLASH
Turns off flashing when display reaches a limit

DMODE1 [BOT, BI]
[BOT]= Set bargraph to illuminate in a left-to-right direction.
[BI]= Set bargraph to illuminate in a bi-direction mode. Used mainly to display positive and negative values such as charge / discharge rate of batteries in power plants.

DOFFSET1 [ffff]
[]= Show current DAC1 output offset
[ffff]= Set DAC1 output offset to [ffff]

DSCALE1 [ffff]
[]= Show current DAC1 output scale
[ffff]= Set DAC1 output scale to [ffff]

DSYM
Causes all bargraph bars to change to the limit color when a limit is reached

DSYMOFF
Allows only the bargraph bars beyond a limit to change to the limit color

EQN<n>[equation]
[]= Changes equation <n> to its original factory setting
[equation]= Defines an equation to use in calculations.

Valid equation format: RESULT= OPERATOR(s) and OPERAND(s)

RESULT= can be:

S<n>=	Stream <n>	RI<m>=	RI limit <m>
C<m>=	Channel<m>	RD<m>=	RD limit <m>
HH<m>=	HH limit <m>	HYST<m>=	Hysteresis <m>
H<m>=	H limit <m>	A<m>=	Scale <m>
L<m>=	L limit <m>	B<m>=	Offset <m>
LL<m>=	LL limit <m>	DH1=	DAC1 High limit
		DL1=	DAC1 Low limit

OPERATOR(s) can be:

*	Multiplication		(	Opening parenthesis
/	Division		)	Closing parenthesis
+	Addition		SQRT	Square root function
-	Subtraction			

OPERAND(s) can be:

S<n>	Current stream <n> value		O<m>	Last value of channel <m>
R<n>	Rate of change of stream <n>		A<m>	Scale <m>
MAX<n>	Max. value of stream <n>		B<m>	Offset <m>
MIN<n>	Min. value of stream <n>		T<m>	Tare <m>
C<m>	Current channel <m> value			

1 ?n ? 7
1 ?m ? 4

A maximum of 4 nested parenthesis can be used. Equations with invalid expressions will be evaluated until an error is reached, with an undefined result. The following are examples of valid equations:

S1= C1*12 - C2	A4= C4*(MIN2-(MAX1+C1-(S3*S1)))+1.8
C2= S1+S2*(C1-C2)	S5= S1+T1*KP2-B2
HH3= SQRT(C3-MAX1)*A1-O4	C1= (SP3-C2)/21.9 - (C2-SP2)*3.14159E-3

FIX[n]
> Formats numbers on the serial port to have a fixed number of digits to the right of the decimal point
> [n]= # digits after the decimal point
> n=0 to 6
> Numbers too big to be printed without E+nn will have the exponential portion truncated.
> **Example**: S01fix3 will allow serial transmission of data to 3 decimal places (125.592)

H<n> [ffff]
> []= Show current stream <n> *Hi* limit
> [ffff]= Set stream <n> *Hi* limit to [ffff]
> <n>= 1,2,3,4
> **Example**: S01h1 15 sets the high limit for channel#1 to 15

HD1 [R, G, A]
> [R]= Set bargraph *Hi* limit color to RED
> [G]= Set bargraph *Hi* limit color to GREEN
> [A]= Set bargraph *Hi* limit color to AMBER
> **Example**: S01hd1a sets the high limit color to amber on the bargraph.

HELP
> Shows a list of all available SHOW commands.

HH<n> [ffff]
> []= Show current stream <n> *Hi Hi* limit
> [ffff]= Set stream <n> *Hi Hi* limit to [ffff]
> <n>= 1,2,3,4
> **Example**: S01hh1 35 sets the high high limit on channel #1 to 35.

HHD1 [R, G, A]
> [R]= Set bargraph *Hi Hi* limit color to RED
> [G]= Set bargraph *Hi Hi* limit color to GREEN
> [A]= Set bargraph *Hi Hi* limit color to AMBER
> **Example**: S01hhd1r sets the high high limit to red on the bargraph.

HYST<n> [ffff]

    []= Shows current stream <n> limit hysteresis
    [ffff]= Set stream <n> limit hysteresis to [ffff]
    <n>= 1,2,3,4
    Example: S01hyst1 .25 sets the hysteresis for channel #1 to +/- 0.25. Mainly used with the relay output option on noisy signals or fluctuating processes.

IDELAY [n]

    Sets an initial delay to take place after every RUN command.
    []= Shows current value of idelay
    [n]= # of seconds to delay
    0 ? n ? 255
    Example: S01idelay 5 will cause the unit to not take any analog input readings for 5 seconds after power up or receiving the run command.

L<n> [ffff]

    Set stream <n> *Lo* limit
    []= Show current stream <n> *Lo* limit
    [ffff]= Set stream <n> *Lo* limit to [ffff]
    <n>= 1,2,3,4
    Example: S01L1 5 sets the low limit for channel #1 to 5.

LAMP

    Perform a display lamp test
    Example: S01lamp

LD1 [R, G, A]

    [R]= Set bargraph *Lo* limit color to RED
    [G]= Set bargraph *Lo* limit color to GREEN
    [A]= Set bargraph *Lo* limit color to AMBER
    Example: S01LD1a sets the low limit color to amber on the bargraph.

LIMOFF

    Turns limit checking for all streams off and turns off limit marks on all bargraph displays
    Example: S01limoff

LIMON

    Turns limit checking for all streams on and turns on limit marks for all bargraph displays
    Example: S01limon

LIN<n> [OFF, sensor type]

    [OFF]= Turns linearization for channel <n> off.
    <n>= 1,2,3,4
    [sensor type]= user polynomial, user table, or type of thermocouple/RTD

RTDC	European RTD	SC	S type
JC	J type	TC	T type
BC	B type	EC	E type
KC	K type	TZ	User table
RC	R type	PZ	User polynomial

    All thermocouples equations and tables are calibrated for ?C.
    Example: S01lin1jc turns on the linearization for channel #1 for type J thermocouple in degrees C. For degrees F you must set the equation to perform the conversion.

LL<n> [ffff]

    []= Show current stream <n> *Lo Lo* limit
    [ffff]= Set stream <n> *Lo Lo* limit to [ffff]
    <n>= 1,2,3,4
    Example: S01ll1 3 sets the low low limit for channel #1 to 3

LLD1 [R, G, A]

> [R]= Set bargraph *Lo Lo* limit color to RED
> [G]= Set bargraph *Lo Lo* limit color to GREEN
> [A]= Set bargraph *Lo Lo* limit color to AMBER
> **Example**: S01lld1r sets the low low limit to red on the bargraph.

LOC

> Enables serial output from the HI-QMEGA
> **Example**: S01loc

MHH<n><message>

> Assigns a message to channel <n> HH limit
> <message>= Any ASCII message up to 15 characters long
> <n>= 1,2,3,4
> **Example**: S01mhh1 pump failure. Sending this command will cause the HI-QMEGA to transmit the message "pump failure" through the serial after the data is sent when the value is greater than the high high limit setting. (STR1: 165.3 pump failure)

MH<n><message>

> Assigns a message to channel <n> H limit
> <message>= Any ASCII message up to 15 characters long
> <n>= 1,2,3,4
> **Example**: S01mh1 pump failure. Sending this command will cause the HI-QMEGA to transmit the message "pump failure" through the serial after the data is sent when the value is greater than the high limit setting. (STR1: 165.3 pump failure)

ML<n><message>

> Assigns a message to channel <n> L limit
> <message>= Any ASCII message up to 15 characters long
> <n>= 1,2,3,4
> **Example**: S01ml1 pump failure. Sending this command will cause the HI-QMEGA to transmit the message "pump failure" through the serial after the data is sent when the value is less than the low limit setting. (STR1: 165.3 pump failure)

MLL<n><message>

> Assigns a message to channel <n> LL limit
> <message>= Any ASCII message up to 15 characters long
> <n>= 1,2,3,4
> **Example**: S01mll1 pump failure. Sending this command will cause the HI-QMEGA to transmit the message "pump failure" through the serial after the data is sent when the value is less than the low low limit setting. (STR1: 165.3 pump failure)

MRD<n><message>

> Assigns a message to channel <n> RD limit
> <message>= Any ASCII message up to 15 characters long
> <n>= 1,2,3,4
> **Example**: S01MRD1 coolant level   The message coolant level will be transmitted through the serial port whenever the rate of decrease value of stream #1 is exceeded.

MRI<n><message>

> Assigns a message to channel <n> RI limit
> <message>= Any ASCII message up to 15 characters long
> <n>= 1,2,3,4
> **Example:** S01MRI1 coolant level   The message "coolant level" will be transmitted through the serial port whenever the rate of increase value of stream #1 is exceeded.

NET

> Disables all serial output from the HI-QMEGA unless a SEND command or the T1 timer is used

NEWMAX

> Resets all maximum stream readings to –1.701413 E+38

NEWMAXMIN

> Resets all maximum and minimum stream readings.

NEWMIN
>   Resets all minimum stream readings to 1.701413 E+38

OFFSET<n> [ffff]
>   []= Show current channel <n> offset
>   [ffff]= Set channel <n> offset to [ffff]
>   <n>= 1,2,3,4

PANIC
>   Enters emergency shutdown mode and set HI-QMEGA outputs to the values specified by the **SETPANIC** command
>   **Example**: The keys on the front of the HI-QMEGA can be programmed so that when pressed the HI-QMEGA executes the panic settings for a safe recovery of the process. This is essential in critical processes that can cause catastrophic failure or death when not properly controlled.

R<n> [H, L, T]
>   []= Show current state of relay/BiMOS output <n>
>   [H]= Turns relay/BiMOS output <n> on.
>   [L]= Turns relay/BiMOS output <n> off.
>   [T]= Toggles the state of relay/BiMOS output <n>.
>   1?n?8
>   **Example**: S01r3h sets relay or bimos #3 to its high state. If in the run mode, the relay / bimos will be toggled momentarily. If in the stop mode the relay / bimos will remain in the high state until commanded to change.

RD<n> [ffff]
>   []= Show current stream <n> *RD* limit
>   [ffff]= Set stream <n> *RD* limit to [ffff]
>   <n>= 1,2,3,4

RESET
>   Performs a software reset of the HI-QMEGA. Startup mode will be determined by the current state of the default jumper.

RI<n> [ffff]
>   []= Show current stream <n> *RI* limit
>   [ffff]= Set stream <n> *RI* limit to [ffff]
>   <n>= 1,2,3,4

RUN
>   Makes the HI-QMEGA read its inputs, perform calculations, and update its outputs continuously

SA <action list> [actions]
>   []= Shows current [actions]
>   [actions]= [actions] to assign to <action list>
>
>   [actions] include:

[R<n>H]= Turns relay/BiMOS <n> on.	[D1Z]= Sets DAC1 to zero.
[R<n>L]= Turns relay/BiMOS <n> off.	[CMD<m>]= Execute CMD<m> command.
[R<n>T]= Toggles state of relay/BiMOS <n>.	[STOP]= Open the execution loop.
[D1H]= Sets DAC1 to its high limit.	[RUN]= Keep the execution loop closed.
[D1L]= Sets DAC1 to its low limit.	[NONE]=Remove all[actions]from<action list>.

>   <action list> is one of:

NORM	Normal operating status	RI<n>	Stream <n> RI limit
HH<n>	Stream <n> HiHi limit	RD<n>	Stream <n> RD limit
H<n>	Stream <n> Hi limit	DH1	Dac1 Hi limit
L<n>	Stream <n> Lo limit	DL1	Dac1 Lo limit
LL<n>	Stream <n> LoLo limit		

>   1 ? n ? 2
>   1 ? m ? 4
>   **Example**: S01sanorm R1LR2LR3LR4L sets the normal state of relays 1-4 to low.
>
>   S01sahh1r4h   causes relay#4 to change state when the high high #1 limit is reached.
>   S01sah1r3h   Causes relay#3 to change state when the high#1 limit is reached

SA+

      Same as SA, but adds [actions] to an existing list

SA-

      Same as SA, but removes [actions] from an existing list

SCALE<n> [ffff]

      []= Shows current channel <n> scale value
      [ffff]= Sets channel <n> scale to [ffff]
      <n>= 1,2,3,4

SCI

      Formats numbers on the serial port to have scientific notation

SEND[n] MEGA must be put on stop.

      S01STOP<R>
      S01SEND(N)<R>
      Makes the HI-QMEGA read its inputs and update its outputs
      []= Reads and updates once
      [n]= Read and updates [n] times
      1 ? n ? 255

SETA<n> [ffff]

      Sets user polynomial coefficients
      []= Shows current value of A<n>
      [ffff]= Sets A<n> value to [ffff]
      0 ? n ? 24

SETD<n>

      Turn all elements of display <n> ON

SETP[n]

      Prompts for user polynomial entries starting from A[n]. The current value of each table point is displayed and a prompt for a new value appears. Pressing ENTER at the prompt keeps the old value. Entering a new value replaces the old value. Pressing ESCAPE exits the command and keeps any changed values.
      0 ? n ? 24

SETPANIC DAC1<ffff>, R<n> <H, L>]

      Set the output values for an emergency shutdown
      []= Show current emergency shutdown outputs
      [DAC1<ffff>]= Set DAC1 output to <ffff>
      [R<n><H, L>]= Set relay/BiMOS output <n> High or Low
      1 ? n ? 8

SETT[n]

      Prompts for user table entries starting from X[n]. The current value of each table point is displayed and a prompt for a new value appears. Pressing ENTER at the prompt keeps the old value. Entering a new value replaces the old value. Pressing ESCAPE exits the command and keeps any changed values.
      0 ? n ? 24

SETX<n> [ffff]

      Sets user table X coordinates
      []= Shows current value of X<n>
      [ffff]= Sets X<n> value to [ffff]
      0 ? n ? 24

SETY<n> [ffff]
> Sets user table Y coordinates
> []= Shows current value of Y<n>
> [ffff]= Sets Y<n> value to [ffff]
> 0 ? n ? 24

SHOW
> Shows a list of all available SHOW commands

SHOWACT1
> Shows the action lists for channel inputs

SHOWACT2
> Shows the action lists for all other alarm conditions

SHOWCAL
> Shows calibration scale and offset values

SHOWCMD
> Shows the current commands saved with the **CMD**<n> command

SHOWDELAY
> Shows the delays associated with alarms and actions

SHOWEQN
> Shows current equations being used

SHOWIN
> Shows scale, offset, averaging, linearization, tare and limits for input channels

SHOWLIM
> Shows the limit messages for the three analog input channels and one digital input channel

SHOWMAX
> Shows the max/min values for all streams

SHOWMIN
> Shows the max/min values for all streams

SHOWOUT
> Shows scale and offset values for DAC outputs

SHOWPANIC
> Shows the current emergency shutdown output values

SHOWPOLY
> Shows user-defined polynomial

SHOWRAMP
> Shows the current ramp + soak parameters

SHOWREL
> Shows the current state of all relay/BiMOS outputs

SHOWSTAT
> Shows the status of the COP, FIX/SCI, etc

SHOWSTR
> Shows output assignments for all streams

SHOWTABLE

      Shows user-defined linearization table

SHOWUNIT

      Shows the units assigned to all streams

STOP   **Stops all functions except for Serial I/O.**

      Bargraph display will full scale orange, digital display will retain last reading.

      Stops the HI-QMEGA from reading inputs and updating outputs

STR$<n>$ [ffff]

      []= Show the current value of stream $<n>$

      $<n>= 1,2,3,4,5,6,7$

STREAM$<n>=$ [off, + , - serial disp1 disp2 dac1 dac2]

      Determines which outputs are affected by stream $<n>$

      []= Shows current outputs affected by stream $<n>$

      $<n>= 1,2,3,4,5,6,7$

[off]= Removes all outputs from stream $<n>$	[disp2]= Sends stream $<n>$ data to display #2 (numeric)
[serial]= Sends stream $<n>$ data to serial output	[dac1]= Sends stream $<n>$ data to DAC #1
[disp1]= Sends stream $<n>$ data to display #1 (bargraph)	[dac2]= Sends stream $<n>$ data to DAC #2

      A '+' before an argument adds that argument to the existing output list for stream $<n>$.

      A '-' before an argument removes that argument from the existing output list for stream $<n>$.

      Example:S01Stream1= serial disp1 disp2 dac1   (Sends stream 1 data to serial port, display#1, display#2 and analog output 1) Spaces are

           required between serial and disp1 and disp2 etc…

      Stream1 -serial   (Removes serial output from previous list)

      Stream1 +dac1   (Adds analog output 1 from the output list)

TARE$<n>$ [ON, OFF, NEW, ffff]

      []= Shows current tare value for channel $<n>$

      [ON]= Turns the tare for channel $<n>$ on

      [OFF]= Turns the tare for channel $<n>$ off

      [NEW]= Takes a new tare reading from channel $<n>$

      [ffff]= Sets channel $<n>$ tare to [ffff]

      $<n>= 1,2,3,4$

      Example: S01tare1on turns on the tare feature for channel #1

           S01tare1new tares the current reading on the display to zero. Can be activated with the keypad if so desired by setting the

           alternate keypad functions.

TEMPUNIT$<n><degrees>$

      $<n>=$channel #(1, 2 or 3)

      $<degrees>=$desired temperature units in degrees C, F or K

      Example: S01 TEMPUNIT1F sets channel 1 to read in degrees F. Must have the Linearization enabled for proper operation.

UNITS$<n><message>$

      Assigns a unit message to stream $<n>$

      $<message>=$ Any ASCII message up to 15 characters long

      $<n>= 1,2,3,4$

      send UNITS$<n>$ too disable units transmission from channel n

      Example: S01units1 RPM will send the text RPM with the channel 1 data through the serial port.

USER

      Performs a software reset and loads USER parameters into memory

WDON

      Turns the internal watchdog/Computer Operating Properly timer on. The timer will be enabled only after a hardware or power-on reset.

WDOFF

Turns the internal watchdog/Computer Operating Properly timer off. The timer will be disabled only after a hardware or power-on reset.

WDTEST

If the watchdog/Computer Operating Properly timer is enabled, this command will place the internal processor into an infinite loop. If working properly, the watchdog/COP will reset the HI-QMEGA and normal device operation will resume.

WRITE

Saves current HI-QMEGA configuration to non-volatile memory. Send this command only when you are certain the unit is configured properly. Additional writes can be made at a later time if changes are required.

WINDOW AREA
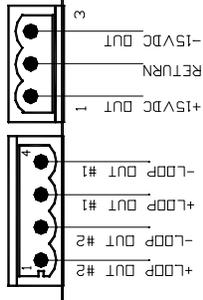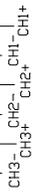
NOTES:
1. All mounting holes are 0.375: diameter for 1/4-20 screws.
2. Conduit knock out 1.05" diameter for 3/4"NPT

MODEL	MEG15	MEG30	MEG40	MEG50	MEG70
A	3.00	6.00	7.50	8.50	11.00
B	3.80	7.00	8.00	9.50	13.00
C	4.55	7.75	8.75	10.25	13.75
D	5.30	7.50	9.00	10.00	12.50
E	3.50	3.50	3.50	3.50	3.50
F	1.75	1.75	1.75	1.75	1.75
G	9.20	17.00	23.00	27.00	44.00
H	10.00	18.00	24.00	28.00	45.00
I	NONE	18.75	24.75	28.75	45.75
J	NONE	19.50	25.50	29.50	46.50

1.125 1.125 1.125 2.250 3.00" 2.0