TELEDYNE HASTINGS INSTRUMENTS
Everywhere**you**look™

THCD-401

INSTRUCTION MANUAL

TELEDYNE HASTINGS INSTRUMENTS
Everywhere**you**look™

ISO 9001
C E R T I F I E D

Manual Print History

The print history shown below lists the printing dates of all revisions created for this manual. The revision level letter increases alphabetically as the manual undergoes subsequent updates. Each new revision includes a revised copy of this print history page.

Visit www.teledyne-hi.com for WEEE disposal guidance.

Description of Symbols and Messages used in this manual

WARNING: indicates a hazardous situation, which, if not avoided, could result in death or serious injury. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood.

CAUTION: indicates a hazardous situation, which if not avoided, could result in minor or moderate injury. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

NOTICE: calls attention to a procedure or practice that if not correctly performed or adhered to, could result in equipment damage, loss of data, or inaccurate data.

NOTE: is used for tips and other digressions.

Hastings Instruments reserves the right to change or modify the design of its equipment without any obligation to provide notification of change or intent to change.

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1. Instrument Overview

The THCD-401 is a multi-featured process display controller, designed to be flexible, able to adapt for use in many processes. It is mainly based upon the THCD-101 signal channel display controller and shares most of its features, but for multiple channels. The THCD-401 has four main channels. These can be used to operate flow controllers or display the output from pressure transducers. The THCD-401 can also power these devices with either ±15 VDC or +24 VDC.

The THCD-401 features a graphical LCD display which allows viewing the process variables in relevant units. Any engineering units can be accommodated with a free text input. The display also allows for an easy-to-use menu structure for configuration.

Interfaces to the THCD-401 include Ethernet, RS232 (via USB) or it can be used with just analog signals.

NOTICE: The instruments described in this manual may be available with multiple pin-outs. Ensure that all electrical connections are correct.

NOTICE: The instruments described in this manual are designed for INDOOR use only.

NOTICE: The instruments described in this manual are designed for Class 2 installations in accordance with IPC standards.

WARNING: There are no operator serviceable parts or adjustments inside the product.

CAUTION: If this equipment is used in a manner other than that specified, the protection provided by the equipment may be impaired.

1.1. **Features**

- Fully integrated 4 channel, full color display and power supply for mass flowmeters, mass flow controllers, capacitance manometers and other pressure transducers

- USB, Ethernet and analog interfaces as standard

- Setpoint input for 'slaved' configurations

- ±15 volt and 24 Volt transducer supply

- 16-bit resolution

- Linearized data

- 0-5 / 0-10 Volt, 4-20 mA set point output controlled from front panel or digital comms

- Voltage or current sensor support

- Capacitance touch front panel for quick and reliable data input

- Programmable alarm output (mechanical volt free changeover contact)

1.2. **Accessories**

(a)   Cables

CB-12PCF-8-AM	8 Ft Cable; circular IP67 to THCD Pinout H	
CB-12PCF-XXX-AM	Custom length cable; circular IP67 to THCD Pinout H	
65-576	AF-4-AM	4 Ft Cable, Pinout H
65-149	AF-8-AM	8 Ft Cable, Pinout H
65-148	AF-25-AM	25 Ft Cable, Pinout H
65-160	AF-50-AM	50 Ft Cable, Pinout H
65-193	AF-100-AM	100 Ft Cable, Pinout H
65-576-Special	AF-XXX-AM	Custom Length Cable, Pinout H
65-791	AF-8-AMU	8 Ft Cable, Black Connector, H pinout THCD to U pinout MFC
65-791-99	AF-XX-AMU	Custom Length Cable, Pinout U
CB-AF-8-24VM	8 Ft Cable, Connects 9-Pin 200 or D-300B to THCD	
CB-AF-XXX-24VM	Custom Length Cable, Connects 9-Pin 200	
CB-DAVC-8-AM	8 Ft Cable, THCD Pinout H to DAVC	
CB-AF-8-HVG9M	Connects THCD (15-pin) to HVG-2020A or B (9-pin), 8 Ft	
CB-AF-XXX-HVG9M	Connects THCD (15-pin) to HVG-2020A or B (9-pin), Custom Length	
CB-USB-C	Type-A computer receptacle to the USB-C connector	

More information about the power supplies and cables can be found on the Hastings web site: http://www.teledyne-hi.com

2. Specifications

 WARNING: Do not operate instruments exceeding the specifications listed below. Failure to heed this warning could result in serious personal injury and/or damage to the equipment.

2.1. Power Supply

Line Voltage:	90 – 250 VAC
Line Frequency:	50 ~ 60 Hz
Consumption:	less than 150 VA
Protection:	1.6 A anti-surge fuse 20 x 5 mm
Mains connector:	IEC 320

2.2. Operating Conditions

Operating Temperature Range:	5°C to 60°C (41°F to 140°F)
Storage Temperature Range:	-20°C to 70°C (-4°F to 158°F)
Maximum Relative Humidity:	95 %RH at 50°C (non-condensing)
Warm-up Time to Full Accuracy:	20 minutes (assumes unit already stabilized at ambient and excludes transducer warm up time)

2.3. Measurement and Output

Power Supply Out:	± 15 VDC @ 300 mA max / channel + 24 VDC @ 350 mA max / channel (Total transducer load not to exceed 40W)
DC Input Signal:	±10 Volt (±10.8 Volt guaranteed) or 4-20 mA (3-21 mA guaranteed) factory option 16-bit ADC Impedance > 1 MΩ (Voltage input) Error: ± (0.02% of reading + 0.01% of full-scale) within ±10°C of calibration temperature
DC Setpoint Output:	0 – 10.0 VDC (10.8 Volt guaranteed) (into >10 kΩ) or 4-20 mA (3-21 mA guaranteed) factory option 16-bit DAC Error: ± (0.03% of reading + 0.02% of full-scale) within ±10°C of calibration temperature Override Close: -0.4 to -0.2 V, typ. -0.25 V Override Open: 6.5 V to 8 V, typ. 7.0 V @ 5 V full scale or >11.7 V, typ. 12.0V @10V FS

Signal Retransmission:	Buffered signal input
Alarm output:	Mechanical changeover relay (max 50 VDC)
Display range:	0 to 999999 (6 characters, decimal point counts as character)
Transducer connectors (4):	15 pin 'D' type (female on THCD-401)
Serial:	USB C (USB 2.0 over USB C connector)
Ethernet (TCP/IP):	Configurable static IP address and subnet mask. Single host stack. 100 Base T

2.4. **Mechanical**

Housing Dimensions:	3.23" H x 6.65" W x 8.14" D (82mm x 169mm x 206mm)
Weight:	1.85 kg
Panel cut out:	2U x ½ 19" Rack

3.   Installation and Interconnections

This section contains the necessary steps to assist in getting a controller into operation as quickly and easily as possible. Please read the following thoroughly before attempting to install the instrument.

3.1.   Receiving Inspection

Prior to opening, inspect for obvious signs of damage to the shipment. Immediately advise the carrier who delivered the shipment if any damage is suspected. If the shipment has arrived intact, carefully unpack the gauge and any accessories that have been ordered. Check each component shipped with the packing list. Ensure that all parts are present (i.e. gauge, power supply, cables, etc.). Optional equipment or accessories will be listed separately on the packing list.

3.2.   Mechanical Connections

The instrument is designed to be rack mounted. Note that the instrument must always be situated in such a way as to enable adequate air circulation about the unit.

If a transducer was supplied with the THCD-401 a suitable cable may have been included.

NOTICE: The controller should be installed in a clean and careful manner. Take care not to drop the product and avoid impacts to prevent damage.

3.3.   Transducer Socket Pinout – 15 pin 'D' Type (x4)

Pin #	Designation
1-4	Not Connected
5	Signal Common
6	Signal High
7	Earth / Chassis
8	Not Connected
9	-15 VDC
10	Not Connected
11	+15 VDC
12	Valve Return
13	Not Connected
14	Setpoint Out
15	Not Connected

If the transducer is being powered from another source (e.g., a main powered supply) it will only be necessary to connect to the two signal pins.

NOTE: The THCD-401 ties 0V Power (pin 5) and Signal Low (pin 12) together. But the separate pins allow large, power related currents to be routed separately from signal currents on long cables.

3.4. Interface Socket Pinout – Miniature 15 pin 'D' Type

Pin #	Designation
1	Ch1 Analog Output
2	Ch2 Analog Output
3	Ch3 Analog Output
4	Ch4 Analog Output
5	0 V (Signal Ground)
6	Ext. Setpoint 1 - *
7	Ext. Setpoint 2 - *
8	Ext. Setpoint 1 + *
9	Ext. Setpoint 2 + *
10	0v (Signal Ground)
11	TTL Input – Disable Menu
12	TTL Input – Disable Zero
13	Relay Com
14	Relay NO
15	Relay NC

* Not Yet implemented
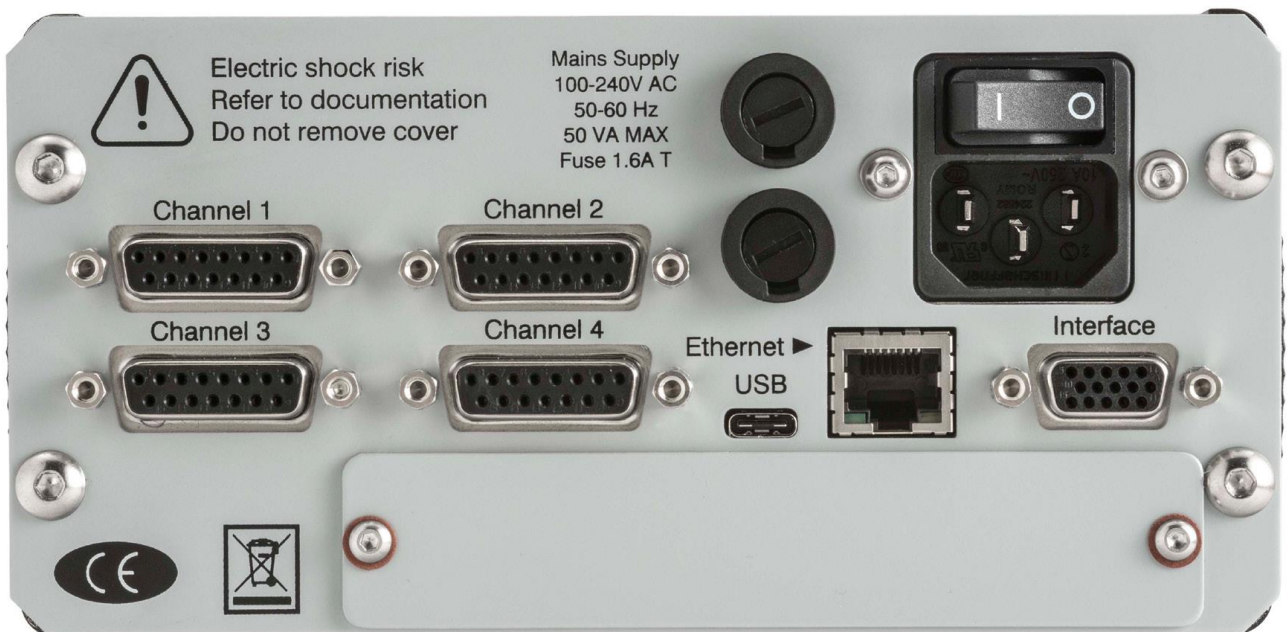
3.5. **USB Connector – USB Type-C**

The connector supports USB-C 2.0 cables without the SuperSpeed pairs. Therefore, connecting a fully featured USB-C 3.1 cable will not provide SuperSpeed functionality, although the cable will still work as per the USB 2.0 specification.

USB is provided for serial data comms and debugging purposes.

3.6. **Warnings**

WARNING: Care must be taken to avoid any high voltages that may be present when dealing with power supplies.

WARNING: Ensure correct mains supply rating and polarity. Failure to heed this warning could result in serious personal injury and/or damage to the equipment.

WARNING: Instrument must always be grounded/earthed. Failure to heed this warning could result in serious personal injury and/or damage to the equipment.

WARNING: Instrument must not be used when faulty, wet or near water. Failure to heed this warning could result in serious personal injury and/or damage to the equipment.

WARNING: The THCD-401 is intended for use in non-condensing environments only. Condensate or any other liquids which enter the gauge may destroy its electronic components and/or result in serious personal injury.

4. Front Panel Operation

4.1. Introduction

The front panel consists of a 480x272 TFT LCD color display with a capacitive touch membrane consisting of 11 'switches' and a 'scroll wheel'. Each switch has legends on it (and in some cases above it) to indicate the function of the switch. Most switches have some commonality between different screens, as detailed below.

For the purpose of the following sub-sections, the switches shall be referred to using the legends on the membrane.

4.2. Common Switch Functions

The switches on certain types of screens and in certain modes, have the same functionality as detailed here:

(a) Menu screens

On all menu screens, the scroll wheel is used to navigate through the menu options. The '**Func**' switch is used to go back to the parent menu, except on the Main Menu screen where it goes back to the main screen. The '**Enter**' switch actions the chosen menu selection to an editable or information screen (see HMI breakdown for more details).

(b) Editable screens

On any screen that has editable fields, the scroll wheel will move the selection between the possible editable fields. '**Func**' goes back to the parent screen which is usually the menu that was used to get to the screen in question. '**Enter**' activates edit mode (see below).

(c) Edit mode

When in edit mode, the edit cursor appears on the first character in the editable field (the cursor is an inverted box over the character being edited). If the field is bigger than 1 character, then switches '◄' & '►' are used to move left and right across the field. If the field is only one character (e.g. a Yes/No selection) or has a rolling selection (e.g. for selection of a percentage) then '◄' & '►' do nothing.

The wheel is used to change the character being edited within the valid range (field position dependent). '**Func**' cancels edit mode and returns the field to its previous value. '**Enter**' accepts any changes to the field and comes out of edit mode.

4.3. **HMI breakdown**

Here follows a complete breakdown of all screens that appear whilst using the THCD-401:

(a) Main Screen

The main screen shows the currently enabled input data (with range, full-scale and calibration applied). Each channel can be assigned a label ('Chx' above) and a units string. These are fully configurable in the Configuration sub-menu screens (see later). If an input is over range (more than 15% above full-scale voltage) then the data value is replaced with the over range error – "RANGE". Also shown is the current mode of the setpoint, if it's not in AUTO mode (i.e. OPEN or CLOSED). If the relay has been tripped (i.e. the input has gone above the configurable threshold) then a small bar is shown on the far left of the screen next to the channel label.

When a channel is selected, its associated label is highlighted (as shown above on channel 4). This selection is cleared automatically when a valid function is selected (e.g setpoint mode change), or after 5 seconds have passed if no function is selected.

If a setpoint value is being changed, the channel selected splits into two lines, the bottom showing the input data and the top showing the setpoint as it is being altered (as shown above on channel 4). The caret above the Setpoint value is moved through the decades by the '◄' or the '►' switches.

<u>Switch Functions:</u>

Func	No function
◄	No function (in normal operation) Moves decade caret left (when changing setpoint) Rezero selected channel(s) (if held)
►	Select all 4 channels (in normal operation) Moves caret right (when changing setpoint)
'Wheel'	Change setpoint value of selected channel
Ch1 to Ch4	Select Channel 1 to 4 (only one channel at a time)
Open, Auto, Close	Change setpoint mode of selected channel(s) to OPEN, AUTO or CLOSE
Enter	Enter the menu system

(b)   Main Menu Screen
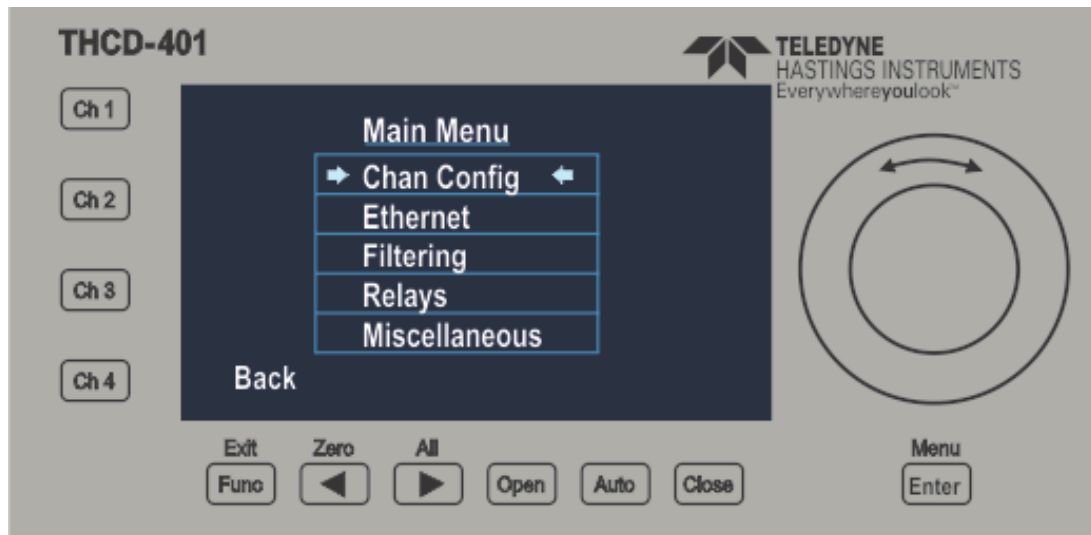
The Main Menu screen provides access to the configuration sections of the THCD-401.

<u>Switch Functions:</u>

Func   Go back to Main screen

◄   No function

►   No function

'Wheel'   Move menu selection up and down

Ch1 to **Ch4**   No function

Open, Auto, Close   No function

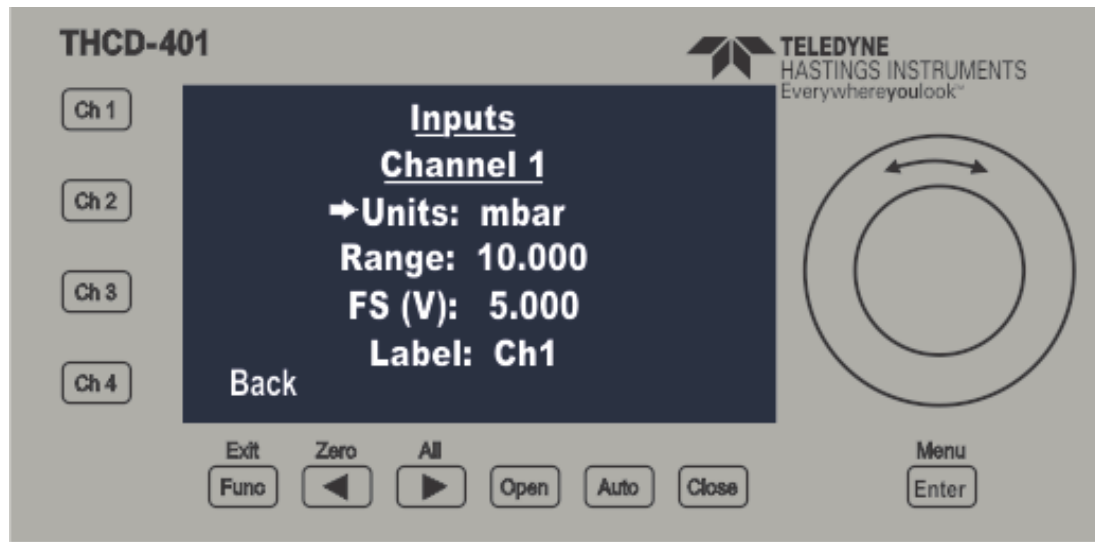**Enter**   Go to selected menu item page

(c)   Inputs Screen

The Inputs screen contains all user configuration items for each of the input channels. The screen shows the items for one channel at a time and the Title on the 2nd from top row of the screen indicates which channel's information is selected. The 'Chx' buttons on the front panel select the input channel to configure. **You should, therefore, make sure you have selected the correct channel before editing anything else.**

This screen allows you to assign a channel label to the input channel (up to 5 characters).
From this screen you can also configure the input for the transducer connected to it – you can set up a unit's label (up to 7 characters) and change the channels input range and full-scale voltage (see the Principles section 7.2 for more information on this).

The number of decimal places selected on the range field dictates the number of decimal places shown for the input data for the channel on the Main screen. To reduce the number of decimal places, change the number under the edit cursor to a decimal point and the system will auto format the field when the **Enter** switch is pressed.

Switch Functions:

Func	Go back to Main Menu screen (in normal operation)
	Undo changes (in edit mode)
◄	Move edit cursor left (in edit mode)
►	Move edit cursor right (in edit mode)
'Wheel'	Move edit field selection (in normal operation)
	Change char under cursor (in edit mode)
Ch1 to Ch4	Select input configuration for channels 1 to 4, respectively.
Open, Auto, Close	No function
Enter	Go to edit mode for selected field (in normal operation)
	Accept changes (in edit mode)

(d)   Setpoint Screen

The setpoint screen allows for changing of the initial setpoint settings that the unit will use for each channel's setpoint on power up. As with the Inputs screen above, the screen shows the items for one setpoint channel at a time and the Title on the 2nd from top row of the screen indicates which channel's information is selected. The 'Chx' buttons on the front panel select the input channel to configure. **You should, therefore, make sure you have selected the correct channel before editing anything else.**
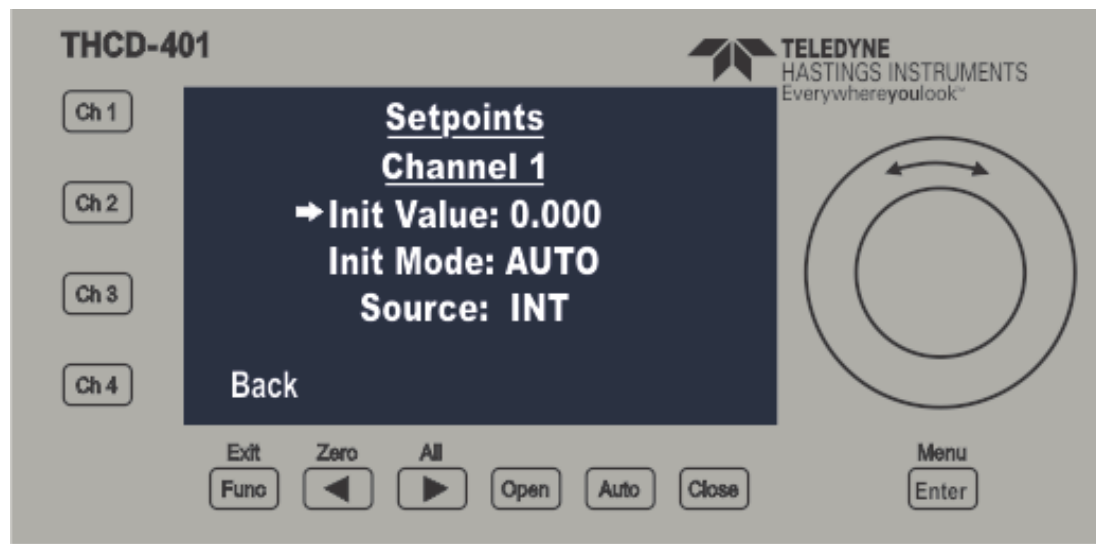
From this screen the initial settings that can be configured are the setpoint value (anything between 0 and full scale) and setpoint mode (AUTO, OPEN, CLOSE). The source of a setpoint can also be changed, cycling between INT, SLV1, SLV2, SLV3 & SLV4. For more information on setpoints, see the Principles section - 7.4.

<u>Switch Functions:</u>

Func	Go back to Main Menu screen (in normal operation)
	Undo changes (in edit mode)
◄	Move edit cursor left (in edit mode)
►	Move edit cursor right (in edit mode)
'Wheel'	Move edit field selection (in normal operation)
	Change char under cursor (in edit mode)
Ch1 to Ch4	Select setpoint settings for channels 1 to 4, respectively.
Open, Auto, Close	No function
Enter	Go to edit mode for selected field (in normal operation)
	Accept changes (in edit mode)

(e) Ethernet Screen
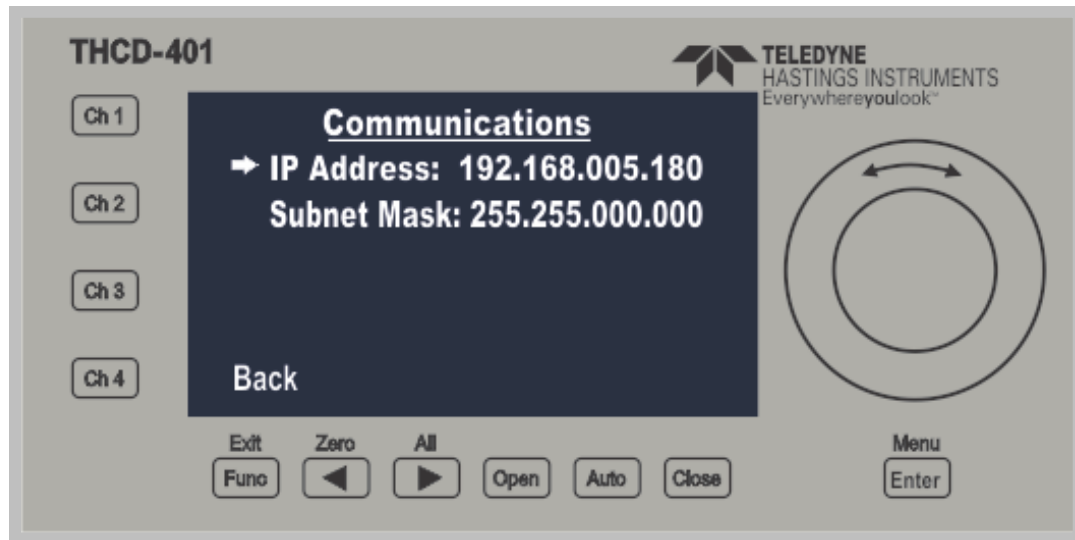
The Communications screen allows you to edit the various Ethernet settings for remote communications with the THCD-401.

For Ethernet comms, the IP address and subnet mask can be changed. Although any number can be cycled to during edit mode, the THCD-401 will cap at 255.

Switch Functions:

Func	Go back to Main Menu screen (in normal operation)
	Undo changes (in edit mode)
◄	Move edit cursor left (in edit mode)
►	Move edit cursor right (in edit mode)
'Wheel'	Move edit field selection (in normal operation)
	Change char under cursor (in edit mode)
Ch1 to Ch4	No function
Open, Auto, Close	No function
Enter	Go to edit mode for selected field (in normal operation)
	Accept changes (in edit mode)

(f) Filtering Screen
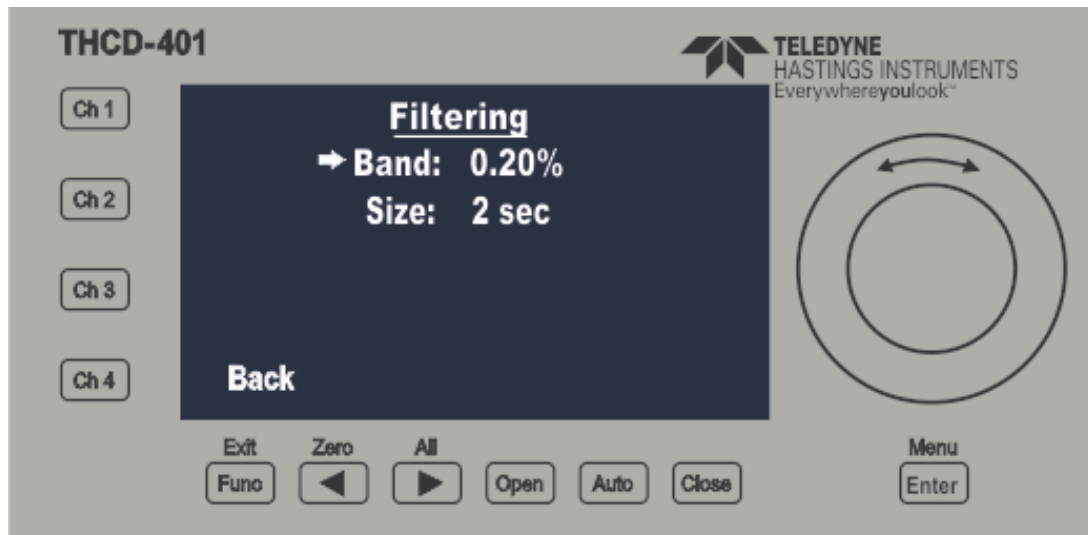
This screen allows the user to modify the band and buffer size of the adaptive filter.

The filter only applies to the display and comms output readings. The band is represented as a percentage of FS and can be set between 0.00% (OFF) and 1.00% and to ON. The buffer size allows settings between 0 and 6 seconds of filtering.

For more information on the adaptive filter, see the Principles section (7.6)

<u>Switch Functions:</u>

Func	Go back to Main Menu screen (in normal operation)
	Undo changes (in edit mode)
◄	Move edit cursor left (in edit mode)
►	Move edit cursor right (in edit mode)
'Wheel'	Move edit field selection (in normal operation)
	Change char under cursor (in edit mode)
Ch1 to Ch4	No function
Open, Auto, Close	No function
Enter	Go to edit mode for selected field (in normal operation)
	Accept changes (in edit mode)

(g)   Relay screen
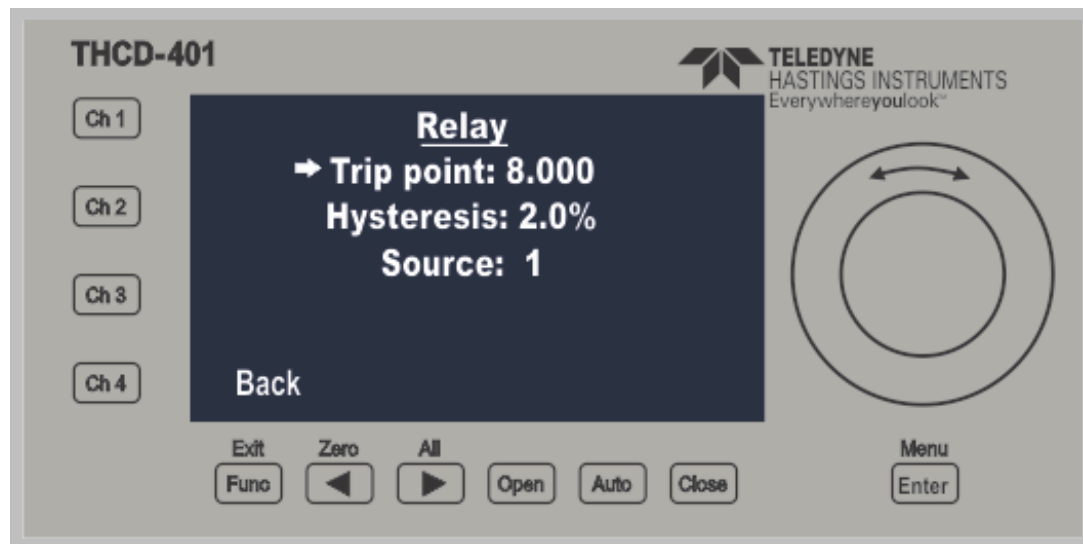
The Relay screen allows you to set the trip point for when the relay switches and set the source channel that is used to check if the trip point has been reached. The relay also contains some hysteresis to stop the relay 'chattering'. This is configurable from this screen as well and is represented as a percentage of full scale of the source channel, with limits of 0.0% (i.e. no hysteresis) to 10.0%.

<u>Switch Functions:</u>

Func	Go back to Main Menu screen (in normal operation)
	Undo changes (in edit mode)
◄	Move edit cursor left (in edit mode)
►	Move edit cursor right (in edit mode)
'Wheel'	Move edit field selection (in normal operation)
	Change char under cursor (in edit mode)
Ch1 to Ch4	No function
Open, Auto, Close	No function
Enter	Go to edit mode for selected field (in normal operation)
	Accept changes (in edit mode)

(h)   Factory Defaults Confirm Screen
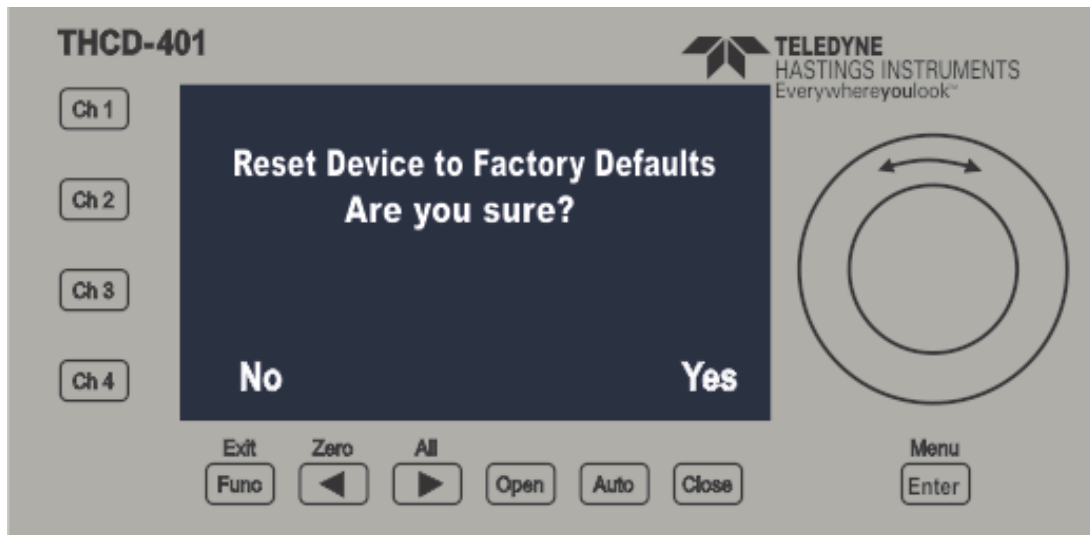
This screen appears when selecting the Factory Default item from the Configuration Menu screen to provide an extra user interaction check before performing the default. If actioned, all settings are returned to their factory defaults (see Table 2 in Appendix B). Once completed, a message appears on screen to tell the user to restart the device, this is necessary to apply the defaults.

Switch Functions:

Func   Go back to Main Menu screen

Close   Confirm factory default function

All other switches   No function

(i) Menu Lock out screens
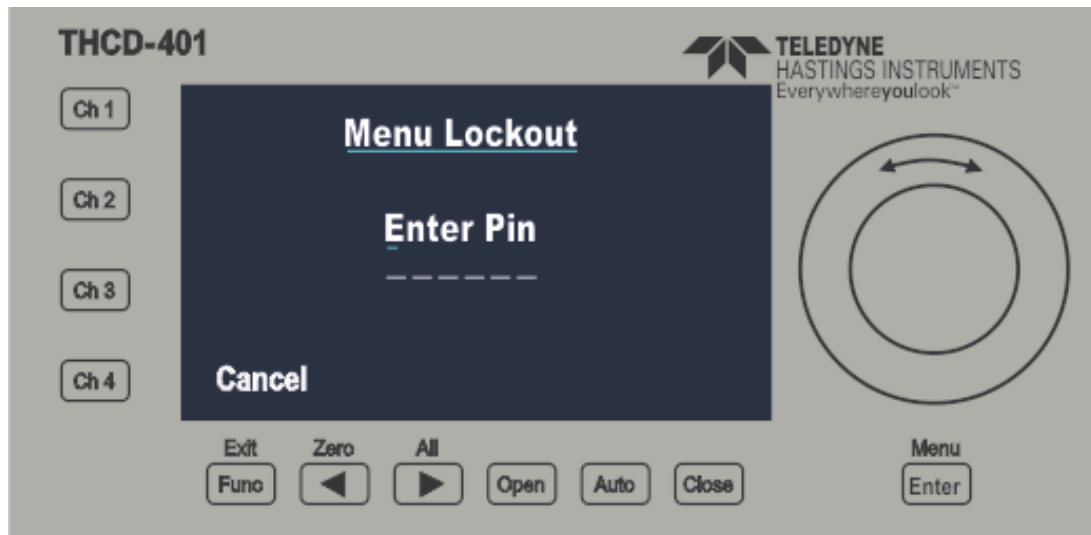
This screen is displayed when the "Menu" button is pressed and there has been a Menu Lock Out pin set, the main menu cannot be accessed unless this pin has been correctly entered. When a pin is incorrectly entered, a message will display as shown below.

Switch Functions:

Func	Go back to Main Menu screen (in normal operation)
	Undo changes (in edit mode)
◄	Move edit cursor left (in edit mode)
►	Move edit cursor right (in edit mode)
'Wheel'	Move edit field selection (in normal operation)
	Change char under cursor (in edit mode)
Ch1 to Ch4	No function
Open, Auto, Close	No function
Enter	Accept changes (in edit mode)

(j) Miscellaneous Screen
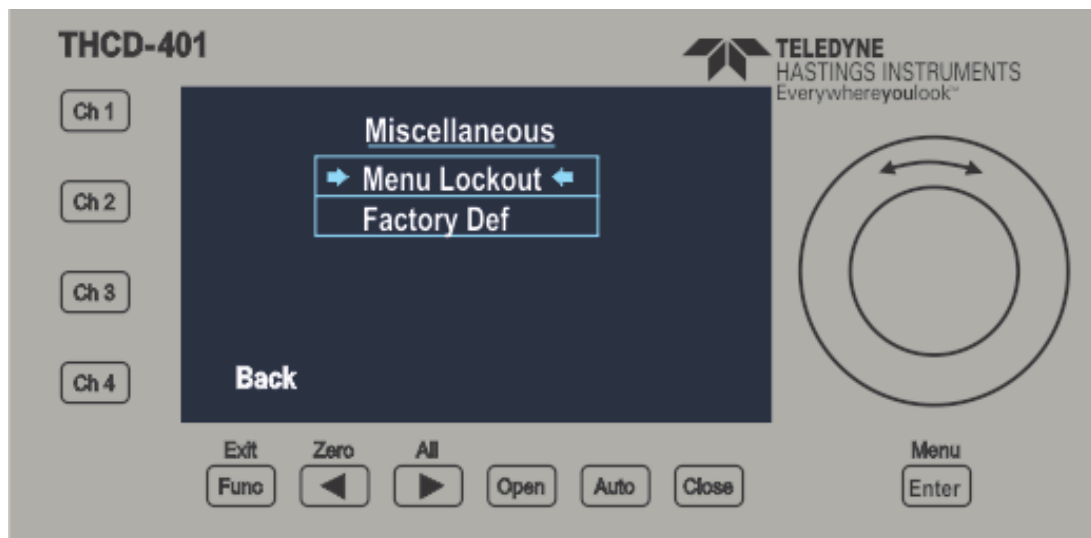
The Miscellaneous screen provides access to the factory settings and the menu lockout configuration screen

Switch Functions:

Func	Go back to Main screen
◄	No function
►	No function
'Wheel'	Move menu selection up and down
Ch1 to Ch4	No function
Open, Auto, Close	No function
Enter	Go to selected menu item page

(k)   Menu Lock-out Configuration screen
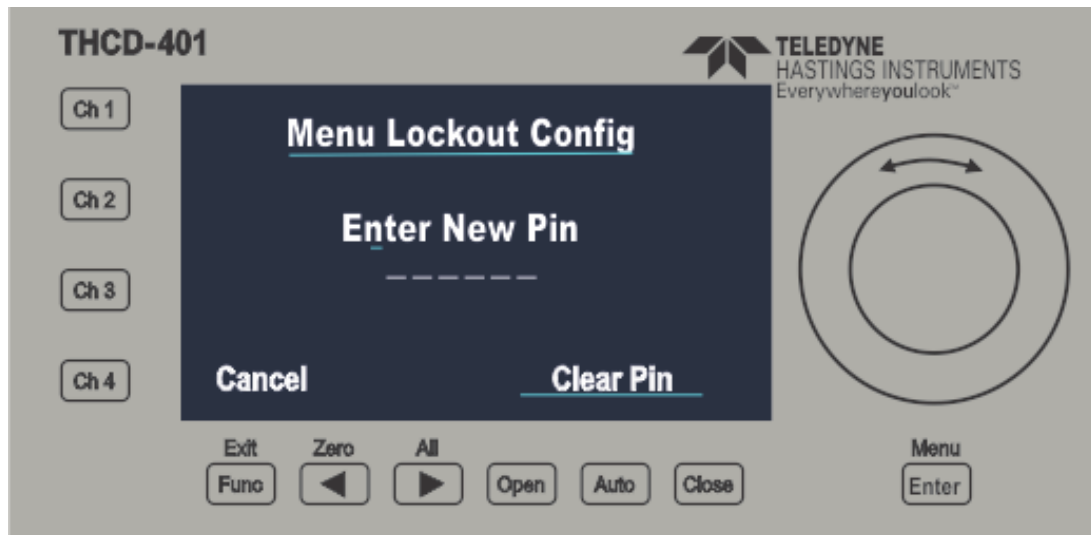
This screen appears when selecting the Menu Lockout item from the Miscellaneous menu screen, from this screen you can set a pin of up to 6 digits which will then be required to be entered when the THCD-401 main menu wishes to be accessed or clear the pin so that no pin is required to access the THCD-401 main menu.

Switch Functions:

Func	Go back to Main Menu screen (in normal operation)
	Undo changes (in edit mode)
◄	Move edit cursor left (in edit mode)
►	Move edit cursor right (in edit mode)
'Wheel'	Move edit field selection (in normal operation)
	Change char under cursor (in edit mode)
Ch1 to Ch4	No function
Open, Auto, Close	Clears the menu-lockout pin, (No pin-required)
Enter	Go to edit mode for selected field (in normal operation)
	Accept changes (in edit mode)

(l) Totalizer Configuration
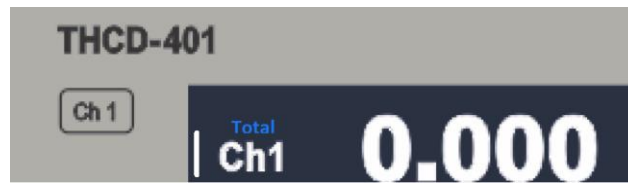
From the main screen, the totalizer function can be enabled by holding the desired channel button for four seconds. The word "Total" should appear in blue above the channel label after this feature is enabled. The totalizer for each channel <u>will not</u> start counting until the user commands it. To start the totalizer, select the channel button and then press the "Open" button. The value on the channel display should begin to increase (assuming the meter/controller is actually flowing). To stop the totalizer, select the channel button and press the "Close" button. To zero the totalizer, select the channel button and press the "Zero" button. The zero button also happens to be the ◄ button.
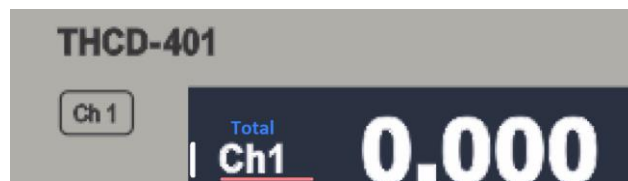
<u>Summary:</u>

Enable/Disable	Hold Channel button for 4 seconds (blue "Total" appears)
Start Totalizer	Select Channel button and press "Open" button
Stop Totalizer	Select Channel button and press "Close" button
Zero Totalizer	Select Channel button and press "Zero" button (◄ button, red bar appears)

5. Webserver Operation

The webserver is an easy way for the user to change the device settings and to access channel data. The webserver can be accessed by entering the device IP Address into a browser URL bar. The webserver is divided into multiple sections (Pages) that control different aspects of the device.

5.1. Main screen

The main screen is the first page the user will see upon opening the webserver. Along the top the tabs are always visible and allows the user to navigate between pages. The sidebar is also always visible, allowing the user to start and stop streaming and control streaming settings, it is also possible to rezero all channels and control setpoints on all channels.

☞ Note: for TCP streaming to work a TCP connection on port 101 must be pre-established (the unit does not data stream over the HTTP port (80)).

5.2. 'Live Data' Page

The main section when the page first loads up is the 'Live Data' page, this page allows the user to monitor the current live data of each channel, as well as channel specific setpoint control.

The 'Live Data' page allows the user to rezero each channel individually by using the zero buttons underneath the channel label. The right side of the screen holds the live setpoint control for each channel. The channels are all separate, so the user will need to apply the setpoint individually for each channel (via the Apply buttons). The setpoints are limited by what is configured for that channel in the range field and whether the channel is in internal or slave mode, as setup in the 'Channel cfg' page.

5.3. 'Channel cfg' Page

Below is the channel configuration for just one channel. When the user navigates to the channel configuration page, there are 4 of these sections in a column so that user can change the settings for each channel.

- Units string allows for 7 characters so that the user can note what units are being measured
- Range is the Engineering units range of the device. The number of decimal places set for the range
- dictates its display precision
- Fullscale is the Voltage input from the device.
- Channel label is a 5 character string to more easily describe the channel.
- Source is the setpoint source; the source can be 'Internal', 'Slave 1', 'Slave 2', 'Slave 3' and 'Slave 4'.
- Init value is the Initial setpoint value that will be set at startup.
- Init mode is the valve position set at startup. Auto is the normal setpoint mode, Open will set the
- output above maximum range voltage and closed sets below 0V.
- The clear rezero button allows the user to clear any previous rezero offset that may be stored.

5.4. 'Control cfg' page

The control configuration page is made of multiple sections that allow the user to change various settings of the device itself.

(a)   'Communication' section

The communication section allows the user to change the device IP Address and Subnet mask.
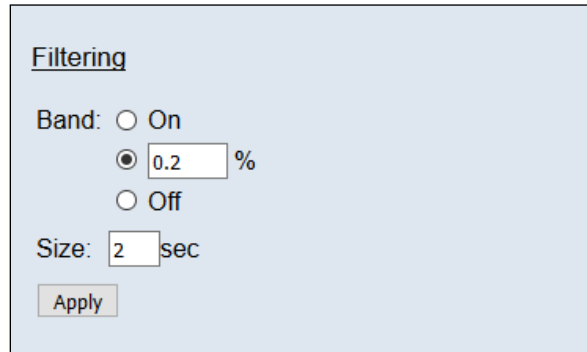
To apply a settings change from this page the device must be reset, the device will start this process automatically and on the webserver a message will popup telling the user to wait 10 seconds then go to new address. Note: clicking Ok will take the user to the new address.

(b)   'Filtering' page

The filtering page is a way of controlling the active filtering facility of the device to help reduce noise in the data.
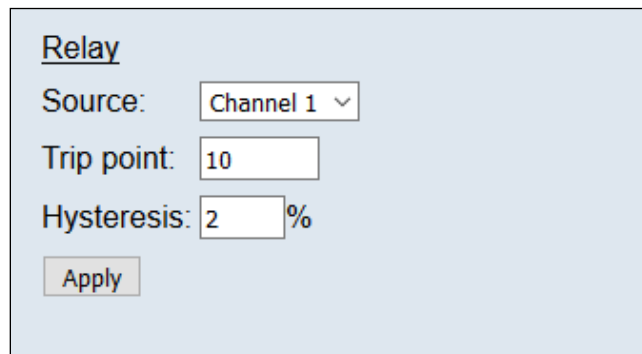
```
Filtering

Band: ○ On
      ◉ 0.2      %
      ○ Off

Size: 2    sec

Apply
```

- Band relates to the filtering limits. The setting is percentage of full-scale and can be set between 0.01% and 1.00%. Other settings are On so that the filtering will be fully active, filtering all data all the time, and Off where there is no filtering.
- The size is the time the data is filtered over, a time greater than 5 will turn the filtering band to on automatically.

For more information on how the adaptive filter works, see the Principles section (7.6).

(c)   'Relay' Page

The relays page allows the user to control when the relay will trigger.

```
Relay

Source:       Channel 1 ⌄

Trip point:   10

Hysteresis: 2      %

Apply
```

- The Source is the channel on which the relay trip point is checked against.
- The Hysteresis is a window around the trip point at which the relays will trigger, so to trigger the relay in the image above the input must get to Trip point + 2% (of fullscale) and the relay will not switch off until the input drops to Trip point – 2% (of fullscale).
- The Trip point is the Engineering unit at which the Relay will trip

5.5. 'Linearization' page

The linearization page is a way for the user to apply a linear calibration to the data to correct any non-linearity's that may exist in a connected transducer. The user can store up to 11 points. The Links at the top of the page allow the user to switch between each channel's linearization data.

Once all required points are entered, Apply should be clicked. Because the device will need to be reset (to build the new linearization tables), the device will check with the user to ensure this is what they wish to do.

If the User clicks Yes then the webpage will show the below message.

6. Serial & TCP Communication

6.1. Introduction

The THCD-401 allows full control and feedback via TCP/IP and RS232 (via USB) communications protocols. All controls via HMI are also available via comms and all calibration is also performed via comms commands.

Please note that the RS232 serial port is not configurable. The fixed baud rate is 57600 with other settings as follows: 8 data bits, 1 stop bit, No parity, No handshaking.

TCP/IP comms requires an IP address and subnet mask to be configured for the THCD. This can be set via the HMI, webserver or via serial comms. Note that on changing the IP address or subnet mask, the THCD must be re-initialized by performing a system reset. This is done automatically if setting from comms (the THCD waits a second and then resets itself) or from the webserver, but if setting from the HMI, you must power off & on for the new TCP/IP settings to come into effect.

Note for the host connection, the TCP port of the THCD-401 is port 101.

6.2. Command/Query format

The format of the commands and queries is common between all available comms protocols for ease of use and understanding when switching between comms methods:

> Format: accc[?] [p][,p][,p] ↵

… where 'a' = address, 'ccc' = command/query, '?' = query identification; 'p' = parameter (separated by commas if more than one)

The first letter to be entered on the command line, before any command or query, is the address identifier. The is a legacy character left in to provide some level of backwards compatibility and familiarity with Chell's remote comms protocol from earlier display models. It can no longer be configured and is now fixed to the character 'a'. On TCP/IP this address doesn't really mean anything because TCP/IP uses an IP address per unit for identification.

Most commands are identified by three letters (although this is not always the case) and a query is identified by following the command letters with a '?' character. For all commands with parameters, you must separate the command from its parameters with a space, and separate multiple parameters with commas.

Table 1 in Appendix A summarizes all commands and queries available. Note that where a command is also a query, you do not enter any parameters for the query 'version' unless explicitly stated in the table.

For everything sent on the comms port, the THCD will reply by informing of the command/query it has just received, along with any parameters identified, any data requested (if it was a valid command/query) and a line indicating whether the command was accepted. This reply block is the same for anything sent to the THCD and is as follows.

('↵' indicates a carriage return/line feed pair):

> For a command:
>
> > *<a>*:<cmd>;<params>↵
> >
> > !<a>!<response>!↵
>
> For a query:
>
> > *<a>*:<cmd>;<params>↵
> >
> > <data>↵
> >
> > !<a>!<response>!↵

where:

<a> is the address letter

<cmd> is the command/query (query identified by a '?' after the three chars)

<params> is the comma separated parameter list, if any

<response> is the acceptance indicator.

<data> is the data requested if a query was sent. Note the data usually consists of some identification string, in CAPS, followed by a colon (:) and then the actual data. Some queries return multiple lines of information. See individual commands for details as appropriate.

The acceptance indicator is a single character as follows:

- 'o' = OK: if the command/query was recognized and accepted;
- 'b' = BADCMD: if the command/query was not recognized or has incorrect/invalid parameters
- 'e' = ERROR: if there was some internal comms error.
- 'w' = BUSY: if the comms is currently busy.

6.3. **Main commands**

(a)   Output current readings – 'r'

This command tells the THCD to get the current readings of the input channels and output them to the comms. Note that only data for channels that are marked as being shown is output (see the 'dis' command (Error! Reference source not found.), later). If the input voltage for a channel is more than 15% over the full-scale voltage set for the channel, the <reading> below will be replaced with the over range error – "RANGE!".

The readings output format is in CSV format with the channel data comma separated on one line, followed by a setpoint mode indication, as follows:

READ:<ch1 reading>,<ch2 reading>,<ch3 reading>,<ch4 reading>;<setpoint modes>↵

The <setpoint modes> is a single number that represents the current mode of all four setpoints as indicated by the following bit table:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Decimal	Setpt 1	Setpt 2	Setpt 3	Setpt 4
0	0	0	0	0	0	0	0	0	Auto	Auto	Auto	Auto
0	0	0	0	0	0	0	1	1	Open	Auto	Auto	Auto
0	0	0	0	0	0	1	0	2	Close	Auto	Auto	Auto
0	0	0	0	0	1	0	0	4	Auto	Open	Auto	Auto
0	0	0	0	1	0	0	0	8	Auto	Close	Auto	Auto
0	0	0	1	0	0	0	0	16	Auto	Auto	Open	Auto
0	0	1	0	0	0	0	0	32	Auto	Auto	Close	Auto
0	1	0	0	0	0	0	0	64	Auto	Auto	Auto	Open
1	0	0	0	0	0	0	0	128	Auto	Auto	Auto	Close

This number is mainly included for use with front-end software and is mainly useful when outputting repeated readings, where it effectively provides a constant update of the current mode of each setpoint.

(b)   Output current readings repeatedly – 'rp'

The THCD is also able to report the current readings repeatedly, at a given interval. This command starts and stops this repeat activity by setting the parameter accordingly:

0 = Repeat off

1 = Repeat every 100ms

2 = Repeat every 500ms

3 = Repeat every second

4 = Repeat every minute

The timing commences from the point at which the 'rp' command is entered.

NOTE for 100ms repeat readings: The data output is effectively lots of small data packets. On TCP networks this can cause problems when communicating with front end software running on MS Windows. It has been found that the Winsock control commonly used in TCP comms development on Windows does not handle lots of small data packets very well, coming in at speeds of around 10Hz or faster. As such it has been decided that when 100ms repeated output is used, the data will be taken every 100ms and buffered up, to be sent out every 500ms in blocks of 5 readings. This has proven to be a more robust output method. For consistency, the output from serial comms also works in the same way.

(c)   Setpoint value – 'spv'

This command is used to set the value of a particular setpoint. The command takes two parameters – the first is the setpoint to set (1-4) and the second is the actual value to set.

The current values of all setpoints can be retrieved by using the query 'spv?'. Returned data is:

SP1 VALUE: <setpoint 1 value>

SP2 VALUE: <setpoint 2 value>

SP3 VALUE: <setpoint 3 value>

SP4 VALUE: <setpoint 4 value>

(d)   Setpoint mode – 'spm'

This command sets the mode for a particular setpoint. The command takes two parameters – the first is the setpoint to set and the second is a number between 0 & 2, identifying the mode, as follows:

0 = Auto mode

1 = Open mode

2 = Closed mode

(For more information on setpoint modes, see the Principles section – 7.4(a)).

The current modes of all setpoints can be retrieved by using the query 'spm?'. The returned data is:

SP1 MODE: (<x>) <mode string>

SP2 MODE: (<x>) <mode string>

SP3 MODE: (<x>) <mode string>

SP4 MODE: (<x>) <mode string>

… where …

<x> = 0, 1, or 2 and <mode string> = AUTO, OPEN, or CLOSE respectively.

(e)   Setpoint source – 'sps'

The setpoint source can be an internally set value (using, for example, the 'spv' command) or a percentage (slave ratio) of one of the THCDs inputs. This source is set using this command and as with the other setpoint commands, it takes two parameters. The first is the setpoint to set and the second is a number between 0 & 4, identifying the source, as follows:

0 = Internal

1 = A percentage of input channel 1

2 = A percentage of input channel 2

3 = A percentage of input channel 3

4 = A percentage of input channel 4

Remember to use the 'spv' command or the front panel HMI to set the percentage value if the chosen source is 1-4.

(For more information on setpoint sources, see the Principles section – 7.4(b)).

The current sources of all setpoints can be retrieved by using the query 'sps?'. The returned data is:

SP1 SOURCE: (<x>) <source identifier>

SP2 SOURCE: (<x>) <source identifier>

SP3 SOURCE: (<x>) <source identifier>

SP4 SOURCE: (<x>) <source identifier>

…where…

<x> = 0 to 4 (same as the second parameter above)

<source identifier> = string identifier for <x> : INT or SLVn where n is the input channel number. (You will see these designations are used on the front panel HMI as well).

(f) Setpoint initial value – 'siv'

The setpoint value set with the 'spv' command (above) is not non-volatile. This command can be used to set an initial setpoint value on system startup. It takes two parameters which are the setpoint to set and the initial setpoint value.

The initial values of all setpoints can be retrieved using the query 'siv?'. Returned data is:

SP1 INIT VAL: <initial setpoint 1 value>

SP2 INIT VAL: <initial setpoint 2value>

SP3 INIT VAL: <initial setpoint 3 value>

SP4 INIT VAL: <initial setpoint 4 value>

(g)   Setpoint initial mode – 'sim'

As with the value, the setpoint mode set using the 'spm' command (above) is a volatile setting. Again this command provides a way of setting an initial startup mode for any of the setpoints on power up of the THCD. Again, it takes two parameters which are the setpoint to set and a number between 0 & 2, identifying the initial mode, as follows:

0 = Auto mode

1 = Open mode

2 = Close mode

The initial modes of all setpoints can be retrieved using the query 'sim?'. Returned data is:

SP1 INIT MODE: (<x>) <mode string>

SP2 INIT MODE: (<x>) <mode string>

SP3 INIT MODE: (<x>) <mode string>

SP4 INIT MODE: (<x>) <mode string>

… where …

<x> = 0, 1, or 2 and <mode string> = AUTO, OPEN, or CLOSE respectively.

6.4. **Comms commands**

(a)   Ethernet IP address – 'eip'

This command changes the IP address used to communicate over TCP/IP comms. The parameter should be entered as a standard 4 octet IP address. e.g. 192.168.1.180. The max octet value is 255. If a greater value is entered, that value will be capped to 255. Once the THCD has responded to the command, it will display the following and should restart.

UNIT SHOULD AUTO RESTART↵

IF NOT, RESTART TO APPLY CHANGES↵

This is necessary to re-initialise the internal TCP socket with the newly set IP address.

To retrieve the current IP address, use the query 'eip?'. The returned data is:

IP ADDRESS: <xxx>.<xxx>.<xxx>.<xxx> …where <xxx> is always 3 digits.

(b)   Ethernet subnet mask – 'esm'

This command changes the Subnet mask used as part of the TCP/IP communication. As with the IP address, the parameter should be entered as a standard 4 octet mask. e.g. 255.255.255.0. Each octet value is again capped if a value greater than 255 is entered.

Again, the THCD will respond and display the following before restarting the system.

UNIT SHOULD AUTO RESTART↵

IF NOT, RESTART TO APPLY CHANGES↵

The current subnet mask can be retrieved using the query 'esm?'. The returned data is:

SUBNET MASK: <xxx>.<xxx>.<xxx>.<xxx> …where <xxx> is always 3 digits.

6.5. **Channel Setup commands**

(a)   Input channel display label – 'dil'

Each input channel can be assigned a label which is shown on the Main screen. This command is used to set that label and it takes two parameters - the first is the input channel number (1-4) and the second is a max of 5 characters for the label.

The currently set labels for all input channels can be retrieved using the query 'dil?'. The data returned is one line for each input channel and is as follows:

CH<x> LABEL: "<label>"

… where…

<x> = the channel number

= channel label padded with spaces to 5 characters

(Note the "" just indicate the start and end of the label to identify space chars in the label).

(b)   Input channel units string – 'uiu'

Each input channel has an associated free-form text field that can be used to identify the units being used on the channel. This command is used to set this and it takes two parameters – the first is the input channel number (1-4) and the second is a max of 7 characters for the units string.

The current units strings for all input channels can be retrieved using the query 'uiu?'. The data returned is one line for each input channel and is as follows:

CH<x> UNITS STR: <units>

… where…

<x> = the channel number

<units> = the exact units string as displayed on the front panel

(c)   Input channel range – 'uir'

Use this command to set the range of an input channel. As with all other channel setup commands, this takes two parameters – the first is the input channel number (1-4) and the second is the actual value for the range. The number of decimal places passed in the range value dictates the number of decimal places shown for the main data output (up to a max of 4 decimal places – any more will get chopped off)

The current range of all input channels is retrieved using the query 'uir?'. The data returned is one line for each input channel and is as follows:

CH<x> INPUT RANGE: <range>

… where…

<x> = the channel number

<range> = the range of the channel (engineering units)

(d)   Input channel full scale – 'uif'

This command is used to set the full scale voltage for an input channel. It takes two parameters – the first is the input channel number (1-4), the second is the actual full scale value.

The full scale voltage setting for all input channels is retrieved using the query 'uif?'. The data returned is one line for each input channel and is as follows:

CH<x> INPUT FS: <fs>

… where…

<x> = the channel number

<fs> = the full scale voltage of the channel

For more information on the use of input range and full scale, see the Principles section - 7.2.

6.6. Filtering commands

(a) Filter band – 'flb'

This command is used to set the point at which the adaptive filtering kicks in. It takes one parameter which is the percentage of full scale of the input. Valid values are between 0.01% and 1.00%. Additionally, the parameter can be OFF which will mean the filtering will never kick in, or ON which means the filtering is always used. For more information on this see the Principles section (7.6).

To retrieve the current filter band, use the query 'flb?'. The returned data is:

FILTERING BAND: <band>%

(b) Filter size – 'fls'

Use this command to set the size of the adaptive filtering buffer. The one parameter this command takes is the buffer size in seconds, between 0 and 6 seconds. (0 can be used to effectively turn the adaptive filtering off).

To retrieve the current filter size, use the query 'fls?'. The returned data is:

FILTERING SIZE: <x> sec

… where <x> = number of seconds of filtering

(Note if current size is 0 then returned data is: FILTERING SIZE: 0 (NO FILTER)).

6.7. Relay control commands

(a) Relay trip point – 'rlt'

This command sets the point at which the relay switches from one state to the other. When the source data is below this point then the relay is closed, so therefore when the source data rises above this point then the relay is open. The command takes one parameter which is the trip point in engineering units, as configured with the Input Channel range command (see 6.5(c)).

The current trip point value can be retrieved using the query 'rlt?'. The returned data is:

RELAY TRIP POINT: <trip point, in engineering units>

(b) Relay source – 'rls'

This command sets the input channel to use as the source data for the check to see if the relay threshold value has been crossed. The single parameter used here is the input channel number (1-4).

The current source channel can be retrieved using the query 'rls?'. The returned data is:

RELAY SOURCE: <input channel number>

(c) Relay hysteresis – 'rlh'

This command configures the hysteresis setting of the relay. It takes one parameter which is the percentage hysteresis, represented as a percentage of full scale of the source channel, with limits of 0.0% (i.e. no hysteresis) to 10.0%.

The current hysteresis setting can be retrieved using the query 'rlh?'. The returned data is:

RELAY HYSTERESIS: <hysteresis percentage>

6.8. Other commands

(a) Date of last factory calibration – 'dlc?'

This query is used to retrieve the date of the last factory calibration run. The data is returned as follows:

LAST CAL DATE: <yymmdd>

…where yy = year, mm = month & dd = day.

E.g. 051201 means the last calibration run was 1st December 2005.

(b) User input rezero – 'irz'

To perform a user input rezero function, use this command. The command can take two parameters, although only one is required to perform the function and that is the input channel number (1-4). The optional second parameter is '0' and this clears any value already generated by a previous rezero for a specific input channel.

To find the current user rezero values for all input channels. use the query 'irz?'. The data returned is one line for each input channel and is as follows:

CH<x> REZERO: <rezero>

…where…

<x> = the input channel number

<rezero> = the current rezero value

(c) Retrieve all settings – 'ras'

As well as issuing some of the above commands as queries to retrieve individual settings, this command has been provided which will return a comma separated list of most of the settings for all channels, setpoints, etc.

The exact settings provided by this command are detailed in Table 3 in Appendix C.

7.   Principles

7.1. Introduction

This section describes the principles used in the THCD-401. It details the various settings for the inputs and the outputs including setpoint control. It does not detail any servicing or calibration procedures.

7.2. Analog Inputs

The THCD-401 has four analog voltage input channels that can be configured to accept any input voltage from 0V to a full scale of up to 10V. This input is calibrated using a straight-line fit method and then can be displayed on the THCD with an applied range.

Each input channel has several associated setup parameters:

(a)   Label

An input channel can have a label associated with it to better describe its use (e.g. FC1, XTSP, etc.). This label can be a maximum of 5 characters and is shown on the far left of each channel line on the Main screen.

(b)   Range

Each device attached to the THCD will be outputting a voltage that represents some form of units and the range is used with the full scale to determine what the user sees on the screen for any input voltage.

(c)   Full Scale Voltage

Each device attached to the THCD will have a full-scale voltage which is the maximum voltage the device should output under normal operating conditions. Typical values are 10V, 5V and 1V. The full scale is used with the range to determine what the user sees on the screen for any input voltage. The THCD will show the over range error ("RANGE") for any channel whose voltage input is more than 15% over the full-scale voltage set for that channel.

(d)   Units String

To inform the user of what units are being dealt with, each channel has an associated units string. This is a free form text field (maximum 7 characters) that is displayed on the far right of each channel line on the Main screen.

Example

A device has a full-scale voltage of 10V and a range of 100 mbar. If the device now outputs 10V, the THCD-401 display will nominally show 100 (pending input calibration). If the device outputs 5V, the CMD100 will show 50, and so on.

7.3. Analog Outputs

There is a total of 8 analog outputs on the THCD-401. There are four voltage outputs for setpoint control, each with their own setup parameters (see next section) and four voltage outputs that simply retransmit the main input voltage (before it is manipulated by the ADC and microprocessor). Typically, these outputs can be used for data logging or debugging purposes.

7.4. **Setpoint Control**

As mentioned previously, there are 4 analog voltage outputs for setpoint control. These allow a mass flow controller to be operated. Each setpoint command output has a voltage full scale that matches its associated input channel configuration.

Example

If a channel is setup for a 100 slpm 5V full scale device, and the setpoint value is 10.0 (assuming setpoint is in Auto mode and not a slave source), then the output voltage of the setpoint would be 0.5V.

The setpoints do have some configuration parameters that can be used to alter the function of the setpoint control, and they are detailed as follows:

(a) Setpoint Mode

Each setpoint can be configured in one of three modes – Auto, Open and Close.

- In Auto mode the setpoint output is dependent on the setpoint source and value settings (see below).
- In Open mode the setpoint outputs a voltage greater than the full scale of the device. For a setpoint command full scale of 5V or less, the output in this mode is nominally 7V. For any other setpoint command full scale (e.g. 10V), the output in this mode is nominally 12V.
- In Close mode the setpoint outputs a voltage less than the minimum output voltage of most devices, the setpoint output voltage is nominally –0.25V.

(b) Setpoint Source

The setpoint source dictates where the setpoint value comes from, assuming the mode is set to Auto (see above). This can be one of two possibilities – Internal or Slave.

- Internal source – the setpoint uses the value set internally via the '▲' & '▼' switches or via the remote comms.
- Slave source – in this case the setpoint uses a percentage of an externally produced value. The percentage is set via the '▲' & '▼' switches and the external value comes from one of the other input channels.

Setpoints are volatile, in that when power is removed from the THCD-401, the current setting of each setpoint value and mode is NOT remembered. However, there are some initial power-up settings for the value and mode of each setpoint channel that can be set via the front panel HMI, webserver or remote comms (see appropriate sections above, for more information).

7.5. **User Rezero**

Over time it is possible that an input may 'drift' slightly due to various conditions (temperature changes, etc.). As such it may be necessary for the channel to be rezeroed by the user.

The user rezero function is provided for this task. It simply takes the current reading and uses that as an additional offset for the channel in question, subtracting the value from all subsequent readings. Ensure any process value to be zeroed, is in fact truly zero before performing this function. This would mean isolating flow devices or fully pumping a pressure device.

Note that the user rezero via comms or webserver also provides the facility for clearing any user rezero value that may have already been set. This should be used before any input calibration is performed to ensure that the calculated calibration points are not distorted by the user zero offset.

7.6. **Adaptive Filtering**

The THCD-401 includes an adaptive averaging filter on the display and comms readings output to aid in 'smoothing out' unwanted 'noise' on the displayed readings. The filter is not channel specific – if enabled it filters all readings for all displayed channels.

(a)   Operational band

The filter can be configured to only operate within a certain band, meaning that excursions between subsequent readings that fall outside that band are shown as real (and not filtered) readings. The band is configurable between 0.01% and 1.00% of the full-scale range of the channels. It can also be set to OFF, which means that no filtering is performed (i.e. every reading is a 'real' one) and can also be set to ON which means that filtering is always shown no matter how big of an excursion occurs.

(b)   Filter size

The size of the filter is currently configurable between 0 and 6 seconds and simply indicates the amount of readings that are taken and buffered to calculate and show the averaged reading. A filter size of 0 will naturally turn the filtering off, irrespective of the band setting.

NOTE: this type of adaptive filtering can cause readings to be displayed abnormally, particularly if the buffer size is one of the larger available settings, where the displayed readings seem to 'jump about' as the filter is disabled and then re-enabled when the data excursions fall into the pre-set band. This is because outside of the band, the display will show the 'real' unfiltered readings (whilst constantly taking an average in the background). When the excursions fall into the band then the display will switch to showing the filtered data. If this data is quite significantly slowed (due to a large buffer size) then the display will appear to nearly reach the new data value (due to 'real' values being shown) and then jump back to the filtered data which could be several seconds behind. Because of this, the setting of a buffer size greater than 5 seconds will automatically change the band to ON, meaning that filtered data will always be shown.

Selecting different filter band/size combinations will reduce these anomalies, turning the band OFF and ON will stop this anomaly.

8. Service and Calibration

8.1. Service

WARNING: The presence of lethal voltages within the instrument means that the user is strictly forbidden from removing the covers. There are no user-serviceable parts inside the instruments.

NOTICE: Should any difficulties be encountered in the use of the THCD-401, it is recommended that you contact Teledyne Hastings Instruments for advice and instructions. Entry into the instrument or tampering with the printed circuit board will void the warranty.

8.2. Calibration

There is no user calibration for the THCD-401. It is recommended that the instrument be returned periodically to Teledyne Hastings Instruments for a 'factory calibration'. This will ensure optimum performance throughout the life of the product.

8.3. Adjustment

WARNING: The presence of lethal voltages within the instrument means that the user is strictly forbidden from removing the covers. There are no user adjustments in the instrument.

8.4. Cleaning

A dirty instrument may be wiped clean with a damp cloth, then wiped dry immediately.

WARNING: Under no circumstances should the instrument be wetted directly or left damp.

8.5. End of Life

Teledyne Hastings Instruments complies with the WEEE legislation as a manufacturer of Electrical and Electronic Equipment. Once this equipment reaches its end of life or is no longer required, it may be returned to Teledyne Hastings Instruments to be reused or recycled. Please contact Teledyne Hastings Instruments for full details. Terms and conditions apply.

8.6. Warranty Policy

See the company website for warranty information at:

http://www.teledyne-hi.com/terms&conditions.htm

8.7. **Return Policy**

See the company website for return information at:

http://www.teledyne-hi.com/terms&conditions.htm

Any product returned for either warranty or non-warranty repair must have been issued a Return Material Authorization (RMA) form.

RMA Forms may be obtained from the Information section of the Hastings Instruments website:

http://www.teledyne-hi.com/inforeq.htm

WARNING: Contaminated parts can be detrimental to health and environment. Ensure instruments are free of hazardous contamination prior to shipment.

Company contact information

TELEDYNE HASTINGS INSTRUMENTS

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ATTENTION: REPAIR DEPARTMENT

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9. Appendicies

9.1. Appendix A - THCD-401 Command Set Summary

Purpose	Cmd	Qry	Params	Notes
Output current readings	r	---	---	
Output current readings repeatedly	rp	---	0-4	P1: 0 = Repeat off 1 = Repeat every 100ms 2 = Repeat every 500ms 3 = Repeat every second 4 = Repeat every minute
Setpoint value	spv	spv?	1-4,#	P1: Setpoint number P2: Real value to set Query returns values of all setpoints
Setpoint mode	spm	spm?	1-4,0-2	P1: Setpoint number P2: 0 = Auto mode 1 = Open mode 2 = Close mode Query returns mode of all setpoints
Setpoint source	sps	sps?	1-4,0-4	P1: Setpoint number P2: 0 = Internal source 1-4 = Ratio source (1-4) Query returns source of all setpoints
Setpoint initial value	siv	siv?	1-4,#	P1: Setpoint number P2: Real value to set Query returns initial value of all setpoints
Setpoint initial mode	sim	sim?	1-4,0-2	P1: Setpoint number P2: 0 = Auto mode 1 = Open mode 2 = Closed mode Query returns initial mode of all setpoints
Input channel display label	dil	dil?	1-4,cccc	P1: Input channel number P2: Max length 5 chars Query returns channel labels for all input channels
Input channel units string	uiu	uiu?	1-4,ccccccc	P1: Input channel number P2: Max length 7 chars Query returns units strings for all input channels

Input channel range	uir	uir?	1-4,#	P1: Input channel number P2: Real value for range to set Query returns channel range for all input channels
Input channel full scale	uif	uif?	1-4,#	P1: Input channel number P2: Real value for full scale to set. Query returns channel full scale for all input channels
User input rezero function	irz	irz?	1-4[,0]	P1: Input channel number P2 (optional): clears current user input rezero setting
Adaptive filter band	flb	flb?	#	P1: Band % (0.01-1.00), OFF, ON
Adaptive filter size	fls	fls?	0-6	P1: Buffer size in seconds
Relay switch threshold	rlt	rlt?	#	P1: Real number for switching point
Relay source	rls	rls?	1-4	P1: Input channel number
Relay hysteresis	rlh	rlh?	0.0-10.0	P1: Hysteresis percentage value
Ethernet IP address	eip	eip?	IP octets	P1: xxx.xxx.xxx.xxx
Ethernet subnet mask	esm	esm?	IP octets	P1: xxx.xxx.xxx.xxx
Retrieve all settings	ras	---	---	Comma separated string returned See Table 3 for actual settings
Date of last calibration	---	dlc?		Returned date format: yymmdd

9.2. **Appendix B - Factory Defaults**

Setting	Default Value	Additional Information
Repeat Rate (for output readings)	0	Repeat off
Ethernet IP Address	192.168.1.180	
Ethernet Subnet Mask	255.255.255.0	
Input Channel Label (for all channels)	"ChX "	X = input channel number (1 to 4)
Input Channel Show Flag (for all channels)	Y	
Input Channel Units String (for all channels)	""	No units strings set
Input Channel Range (for all channels)	10.000	Sets display precision to 3 decimal places
Input Channel Full Scale (for all channels)	10.0	
Input Channel User Rezero (for all channels)	0.0	No rezero set
Setpoint Source (for all setpoints)	0	Internal source
Setpoint Initial Value (for all setpoints)	0.0	
Setpoint Initial Mode (for all setpoints)	2	Close mode
Date of Last Factory Calibration	10101	
Adaptive Filter Band	0.2%	
Adaptive Filter Buffer Size	2	2 seconds
Relay Trip Point	10.0	
Relay Source Channel	1	Input channel 1
Relay Hysteresis	2.0%	

9.3. Appendix C - Settings in 'ras' command string

Description	Type and size
Channel 1 input label	5 char string
show flag	1 char (currently fixed at 'Y')
units string	7 char string
range	8 char string representation of a float
full scale	8 char string representation of a float
Channel 2 input label	5 char string
show flag	1 char (currently fixed at 'Y')
units string	7 char string
range	8 char string representation of a float
full scale	8 char string representation of a float
Channel 3 input label	5 char string
show flag	1 char (currently fixed at 'Y')
units string	7 char string
range	8 char string representation of a float
full scale	8 char string representation of a float
Channel 4 input label	5 char string
show flag	1 char (currently fixed at 'Y')
units string	7 char string
range	8 char string representation of a float
full scale	8 char string representation of a float
Setpoint 1 value	8 char string representation of a float
mode	1 byte (0-2 as for spm? query)
source	1 byte (0-4 as for sps? query)
Setpoint 2 value	8 char string representation of a float
mode	1 byte (0-2 as for spm? query)
source	1 byte (0-4 as for sps? query)
Setpoint 3 value	8 char string representation of a float
mode	1 byte (0-2 as for spm? query)

source	1 byte (0-4 as for sps? query)
Setpoint 4 value	8 char string representation of a float
mode	1 byte (0-2 as for spm? query)
source	1 byte (0-4 as for sps? query)
Last factory calibration date	6 char string (format as for dlc? query)
Adaptive filter band	4 char string representation of a float
size	1 byte (0-6 as for fls? query)
Relay trip point	8 char string representation of a float
hysteresis value	4 char string representation of a float
source	1 byte (0-3)