TELEDYNE
HASTINGS INSTRUMENTS
Everywhereyoulook™

INSTRUCTION MANUAL

THCD-400
POWER SUPPLY

TELEDYNE
TECHNOLOGIES
Everywhereyoulook™

CE

ISO 9001
CERTIFIED

Manual Print History

The print history shown below lists the printing dates of all revisions and addenda created for this manual. The revision level letter increases alphabetically as the manual undergoes subsequent updates. Addenda, which are released between revisions, contain important change information that the user should incorporate immediately into the manual. Addenda are numbered sequentially. When a new revision is created, all addenda associated with the previous revision of the manual are incorporated into the new revision of the manual. Each new revision includes a revised copy of this print history page.

Revision A (Document Number 178-032017) ..... March 2017

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

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

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

CAUTION: The instruments described in this manual are designed for Class 2 installations in accordance with IAW/IPC standards

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.

Table of Contents

1.0 Product Description

The 4-Channel MFC is a high performance, microprocessor-based 4-channel power

Supply/controller designed for use with Mass Flow Controllers (MFC). A linear regulator provides a low noise, foldback current limited, thermal overload protected +15Vdc and

-15Vdc power supply @ 250mA each for each of the (4) MFC's. The 4-Channel MFC accepts, user selectable 0-5Vdc, 0-10Vdc or 4-20mA input signals. It also supplies 0-5Vdc, 0-10Vdc or 4-20mA setpoint signals, for each channel, for flow control.

The firmware utilizes a Real Time Operating System (RTOS) for real time multitasking

Capabilities. This allows continuous monitoring of each channel's flow rates, total flow and setpoints regardless of the task being performed. A 16-bit multi-channel, high speed, sigma-delta analog-to-digital converter provides accurate flowrate data. A 32K x 8 battery backed RAM stores more than 90 Units of Measure and 190 Gas Identifiers selectable by the user. All pertinent data, required by the microprocessor at power-up to re-initialize the system, is also stored in the same RAM.

Ratio control is user selectable for master/slave operation. Channel 1 is always the master and any of the other 3 channels may be selected as slaves. This master/slave arrangement utilizes the actual flow of Channel 1 as the master signal.

The 4-Channel MFC utilizes a 4-line by 20 character back lighted LCD display. A built in Totalizer, for each channel automatically recognizes the units of measure selected and adjusts the time base for the integrator accordingly. The user can select either Flow or Total to be displayed for each channel. When selected, the setpoint signal is displayed and can be altered via the front panel switches. Override controls for opening or closing the MFC valves are also available for each channel. Annunciator LED's display the selected valve override conditions.

Both RS232 and RS485 serial communications are available. All functions selectable from the front panel switches are also accessible via the RS232/RS485 serial ports. Only one, either RS232 or RS485, serial port is active at any one time. Selection, including a baud rate of 9600 or 19.2K, is made via the front panel switches.

Each flow channel has a high and low user programmable alarm. The alarms activate an opto-isolated open collector transistor output capable of switching 25Vdc @ 10ma.

The unit can be rack mounted using standard half-rack hardware or can be bench mounted using the retractable stand provided. Input power is selectable, via the rear panel power selector for 100, 115 or 230 Vac, 50-400 Hz.

Comprised of a 316 stainless steel cylindrical shell concentrically located in the base that forms an annular flow channel of precise dimension. This flow channel creates laminar flow by the inboard sensor taps. The cylindrical shell encases a corrugated matrix of flow channels which serve as a shunt. The size and number of these channels is consistent with the sensor ΔP and flow range.

2.0 Specifications

Signal Input

Number of Channels 4
Signal Type ..... 0-5Vdc, 0-10Vdc, 4-20mA, user selectable
Accuracy ..... ± (0.1% of Reading + 1 Digit)
Input Resistance
Voltage ..... >1 Megohm
Current ..... 120 Ohms

Setpoint Output (Control Signal)

Signal Type ..... 0-5Vdc, 0-10Vdc, 4-20mA (user selectable)
Accuracy (typ) ..... +/-0.1% FS (Voltage), +/-0.2% FS (Current)
Source Resistance ..... 100 Ohms

Totalizer (Each Channel)

Accuracy (typ) ..... +/- 30ppm

Serial Communications

RS232 ..... 9600 / 19.2K baud
RS485 ..... Full–duplex, 9600 / 19.2K baud

Transducer Power Supply

Voltage ..... ± (15Vdc ± 0.75Vdc)
Total Supplied Current ..... 1.0 A (sum of all channels),
Single Channel Max Current ..... < 350 mA

Input Power

Voltage ..... 100 / 115 / 230 VAC, +/-10% (user selectable)
Frequency ..... 50 – 400 Hz
Fuse (type) ..... Slow Blo (Time Delay), 250 VAC rating
Fuse 110 / 115 / 230 VAC ..... 0.7 / 0.6 / 0.315 amp dependent on AC supply

Environmental

Operating Temperature ..... 20 – 50 °C
RoHS ..... Compliant

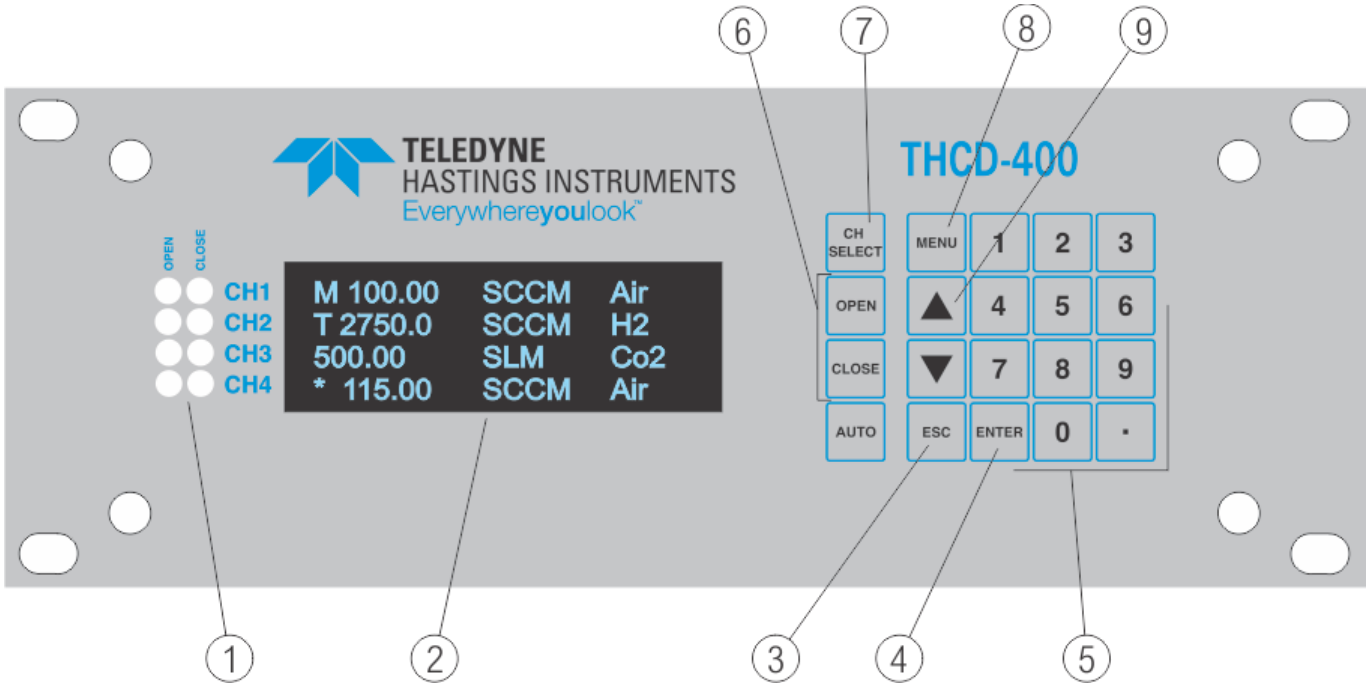
Regulatory

Safety ..... EN 61326
Emissions / Immunity / ESD ..... EN 61010

Mechanical

Rack Mounting ..... 2U (EIA-310) half rack wide

3.0 Front Panel



1. **ANNUNCIATORS**: Displays OVERRIDE signal status of each channel. If annunciators are not illuminated, the Setpoint (Control) voltage is active.

2. **DISPLAY AREA:**

Column 1:	Reserved for displaying (*) Active Channel, (M) Master Channel, (S) Slave Channel or (T) Totalizer.
Column 2:	Reserved for polarity indicator (minus sign for negative signal, none for positive).
Col's 3 - 8:	Actual scaled value of input signal. Displays FLOW or TOTAL in normal display mode. Displays the Setpoint (Control) value when CH SEL is depressed.
Column 9:	Space
Col's 10-14:	Units of Measure
Column 15:	Space
Col's 16-20:	Gas Identifier

3. **ESC:** Escape key used to exit MENU sequence without updating current settings.

4. **ENTER:** Key used to enter new settings.

5. **KEYPAD:** Used to quickly enter new settings.

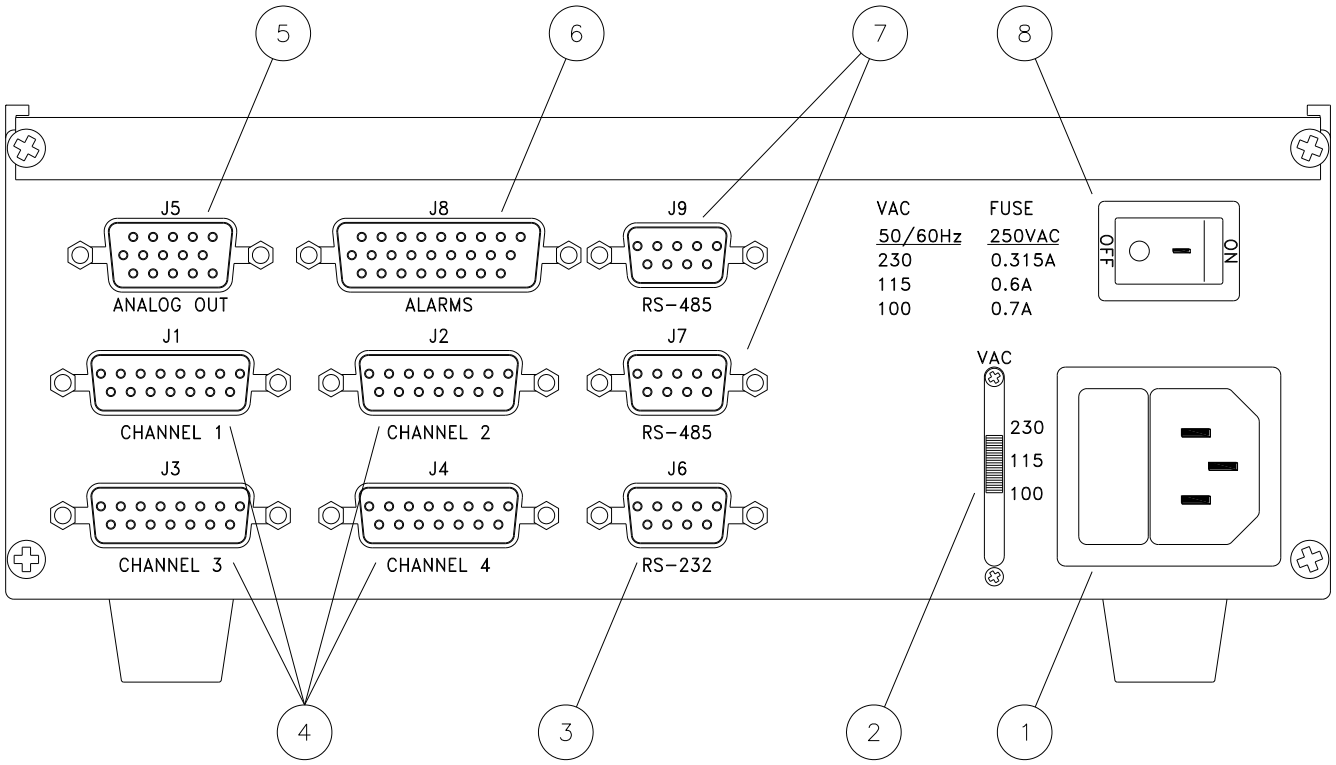
6. **OVERRIDE:** Used with CH SEL to override Setpoint (Control) voltage inputs with valve OPEN or valve CLOSE signals. RUN disables OPEN or CLOSE selection.

7. **CH SEL:** Used to scroll through Channels 1, 2, 3 and 4 to update the selected Channel's Setpoint (Control) voltage or to send the selected OVERRIDE signal.

8. **MENU:** Key used to enter MENU or manual setup sequence.

9. **SCROLL:** Used to scroll MENU selections UP or DOWN

4.0 Rear Panel

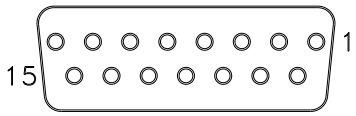


1. **POWER INLET WITH FUSE (1 amp TIME DELAY or SLO BLO)**
2. **POWER SELECTOR SWITCH**
3. **RS232 SERIAL PORT (J6)**
4. **TRANSDUCER CONNECTORS (J1, J2, J3, J4)**
5. **ANALOG OUTPUT (J5)**
6. **ALARMS (J8)**
7. **RS-485 SERIAL PORT (J7, J9)**
8. **POWER ON/OFF SWITCH**

5.0 Connector Pin Designations

TRANSDUCER CONNECTORS (J1, J2, J3, J4)

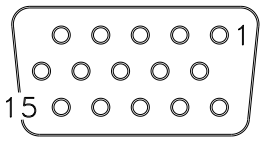
1 SIGNAL COMMON
2 SINGNAL OUTPUT
3 GROUND
4 VALVE OPEN
5 SETPOINT COMMON
6 -15Vdc
7 NC
8 SETPOINT SIGNAL
9 GROUND
10 GROUND
11 NC
12 VALVE OFF
13 +15Vdc
14 NC
15 NC



Transducer Connector (Female)
Rear Panel View

ANALOG OUTPUT (J5)

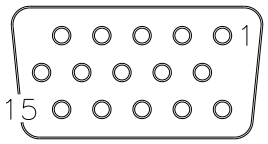
1 SIGNAL CH 1
2 SIGNAL COMMON CH 1
3 SIGNAL CH2
4 SIGNAL COMMON CH2
5 NC
6 NC
7 NC
8 NC
9 NC
10 NC
11 SIGNAL CH3
12 SIGNAL COMMON CH3
13 SIGNAL CH4
14 SIGNAL COMMON CH4
15 NC



Analog Output Connector (Female)
Rear Panel View

ALARMS (J8)

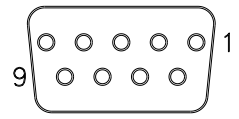
1 CH1 HIGH ALARM
2 CH 1 LO W ALARM
3 CH1 ALARM COMMON
4 CH2 HIGH ALARM
5 CH2 LOW ALARM
6 CH2 ALARM COMMON
7 NC
8 NC
9 NC10 NC
11 NC
12 NC
13 NC
14 NC
15 NC
16 NC
17 NC
18 NC
19 CH3 HIGH ALARM
20 CH3 LOW ALARM
21 CH3 ALARM COMMON
22 CH4 HIGH ALARM
23 CH4 LOW ALARM
24 CH4 ALARM COMMON
25 NC
26 NC



Alarm Connector (Female)
Rear Panel View

RS232 (J6)

1 NC
2 RXD
3 TXD
4 DTR
5 DIGITAL GROUND
6 DSR
7 NC
8 NC
9 NC



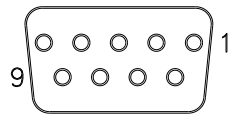
RS232 Connector (Female)
Rear Panel View

RS485 (J7, J9)

1 NC
2 RXD(-)
3 TXD(+)
4 DIGITAL GROUND

5 NC

6 NC
7 RXD(+)
8 TXD(-)
9 NC



RS232 Connector (Female)
Rear Panel View

6.0 Start Up

The 4-Channel MFC has a 100 Vac, 115 Vac or 230 Vac, 50/60 Hz power selector switch located at the rear of the instrument. Please refer to page 4 to locate this switch. Verify the power selector switch is in the proper position prior to connecting the power cable to the unit. Verify power ON/OFF switch is in the OFF position. Then perform the following steps.

- Connect the power cable to the instrument and apply the proper input power. Do not make any other connections to the instrument.
- Turn power ON/OFF switch ON.
- The display will momentarily display the current version of the firmware utilized, then show the following factory default display.

126.72 SCCM #1
126.72 SCCM #2
126.71 SCCM 3H6O
126.72 SCCM C2H3N

Note: All 4 channels should have the CLOSE annunciators illuminated. The values 126.71 and 126.72 are approximate and is the display for an open signal input. It may not correspond exactly to the display shown on this unit.

- Change the Units of Measure and Gas Identifiers as desired. Please refer to page 10. To blank the Units of Measure select "00" then "ENT". To blank the Gas Identifier select "000" then "ENT". To blank the entire line, please refer to RS232/485 Commands, electing/Blanking/Reading Display on page 21.
- The 4-Channel MFC is factory calibrated at 0.000 and 5.000Vdc to display 0.00 and 100.00 for each channel. To change the display range, without recalibration, see MANUAL CAL/RANGE, Range (Changing Range) on page 15. To enter a Gas Correction Factor or Multiplier, refer to MANUAL CAL/RANGE, Calibrate (Multiplier) on page 16. The factory Multiplier setting is 1.0000.
- The 4-Channel MFC can accept 0-5Vdc, 0-10Vdc or 4-20mA input signals. If either 0-10Vdc or 4-20mA is required, the instrument needs to be recalibrated. Select the proper signal input for the Transducer to be used for each channel. Please refer to MANUAL SETUP, Selecting Input on page 11. Do not attempt to recalibrate the instrument at this time. The factory Input setting is 0-5Vdc.
- Select Filter to optimize reading stability and conversion speed. The factory Filter setting is 15Hz.
- Allow 30 minutes warm-up time.
- Turn power ON/OFF switch OFF.
- Connect Transducer #1 to J1 on the 4-Channel MFC using the Connector Pin Designation information on page 5. Connect all ground connections available to the transducer. Example: If the transducer has 3 ground pins, connect all three ground pins shown on J1. All ground pins on J1, J2, J3 and J4 are common but are routed on separate wires from the connector to a ground plane on the instrument motherboard.
- Connect Transducers #2, 3 and 4 to the instrument. The instrument is designed to provide +/- 15Vdc @ 250 mA to each transducer. Do not use a Transducer that requires more than +/- 15Vdc @ 350mA on any channel.

- Verify the display illuminates and the transducer readings are essentially correct. If the selected signal input for a channel is 0-5Vdc proceed to Step 11 for that channel. If the selected signal input for a channel is 0-10Vdc or 4-20mA, that channel needs to be recalibrated. Refer to MANUAL CAL/RANGE, Calibrate section pages 14 and 15 to recalibrate that channel.
- To utilize the Setpoint (Control) voltage for MFC's, set the Setpoint voltage for each channel to the desired setting. Please refer to MANUAL SETUP, Selecting Setpoint (Control Voltage) on page 10. The factory Setpoint default is 0.0000 for all 4 channels.

  The Setpoint voltage, for a 0-5Vdc signal input, is calculated as follows.

  Setpoint Voltage = (Setpoint Value/Range Value) * 5.000Vdc

  *Example: If the Setpoint Value = 120.00 SCCM and the Range Value is 250.00 SCCM the Setpoint Voltage = (120.00/250.00)*5.000 = 2.400Vdc.*

  For a 0-10Vdc signal input
  *The Setpoint Voltage= (120.00/250.00)*10.000Vdc = 4.800Vdc*

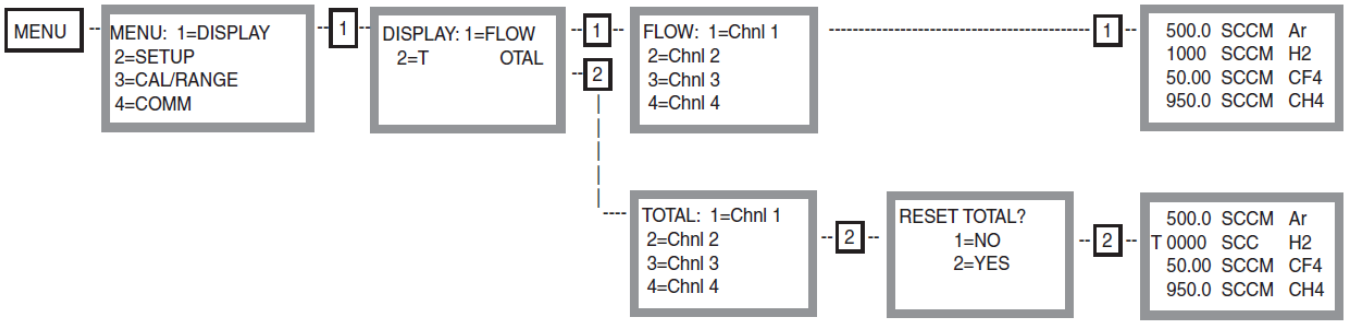
  For a 4-20mA signal input
  *The Setpoint Current = (120.00/250.00)*16mA + 4mA = 11.68mA.*

- The Flowrate Alarms are used to monitor the flowrate of the MFC. If the flow rate is not within the selected HIGH and LOW Alarm values, an opto-isolated open collector output is activated. This output can be used to illuminate warning lights to alert the user if the Flow Controller's Setpoint (Control) voltage is not controlling the flow within a desired window. Refer to MANUAL SETUP, Selecting Alarms on page 12. The factory default is HIGH Alarm set at 75.000, LOW Alarm at 25.000 and HYSTERESIS at 010 counts.
- To activate the Setpoint (Control) voltage to the MFC, select RUN for the desired channel. Reference MANUAL SETUP, Selecting Valve Override (Open, Close or Run) on page 9. The default at power-up is Valve Close.
- If the Units of Measure are in flow units, the 4-Channel MFC automatically calculates TOTAL flow using a Riemann Sum Integration method. To display TOTAL or to reset the TOTAL display, refer to MANUAL/SETUP, Selecting Display (Flow or Total) on page 9. If the Units of Measure are not in flow units, the TOTAL is not calculated or displayed.
- The 4-Channel MFC has both RS232 and RS485 serial communications ports. Only one port is active at any one time and is user selectable. The RS232 port has (1) 9-pin D-sub connector, while the RS485 port has (2) 9-pin D-sub connectors. All Setups described earlier can be performed using the serial communications ports. Reference RS232/485 Hookup and Commands on pages 17 through 26.

7.0 Manual Set Up

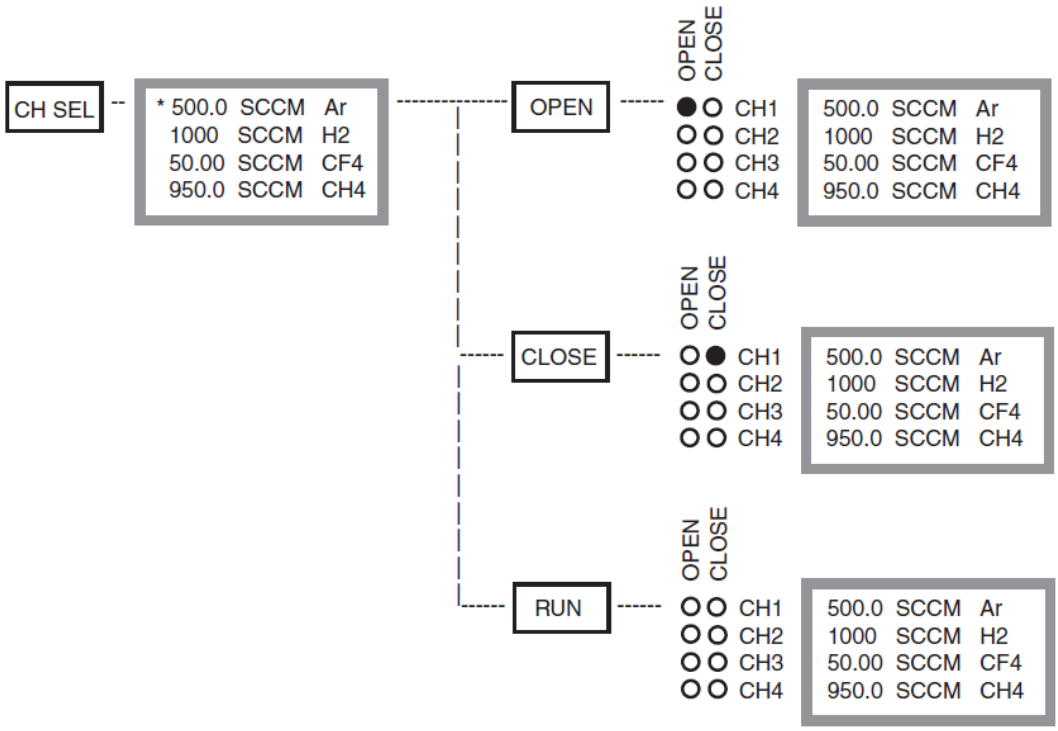
Selecting Display (Flow or Total)

If Flow is selected, the most significant digit location will be left blank. If Total is selected, a "T" appears in this location and the Unit of Measure changes accordingly. If the Unit of Measure selected is not a flow rate unit of measure, Total will not be displayed.

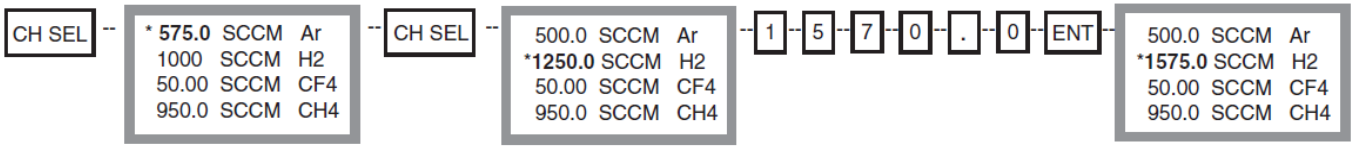


Selecting Valve Override (Open, Close or Run)

Channel 1 is shown selected above. An asterisk appears to signify the Channel selected. To select Channel 2, depress **CH SEL** switch twice, then select **OPEN**, **CLOSE** or **RUN**. If **OPEN** is selected, ground is applied to the appropriate channel connector pin-4. This ground is at the same potential as pin-9. If **CLOSE** is selected, ground is applied to pin-12. Both pin-4 and pin-12 are grounded with an open collector transistor capable of sinking 250mA at 25V. If **RUN** is selected, no override signals are sent and the MFC Setpoint control is activated.

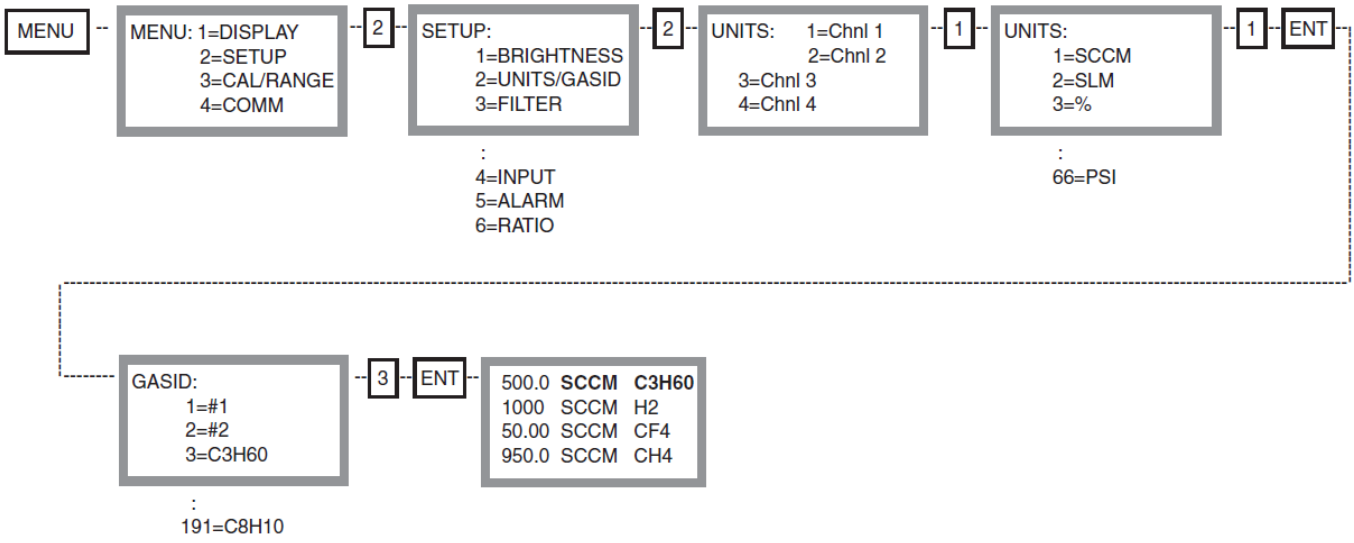


Selecting Setpoint (Control Voltage)



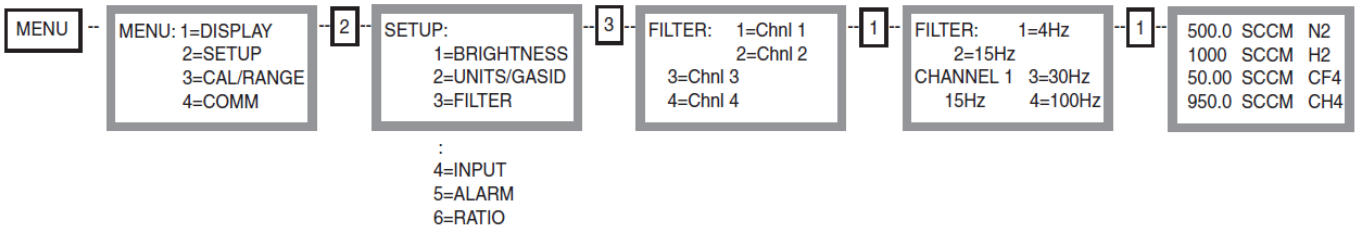
The example above shows how the setpoint for Channel 2 is changed. When **CH SEL** is depressed an asterisk points to the channel selected. To select Channel 4, depress **CH SEL** switch 4 times. The value displayed after the asterisk is the current setpoint value. Typing in a new value overrides the old value. If **ESC** is depressed instead of **ENT,** the old value is retained.

Selecting Units of Measure and Gas Identifiers



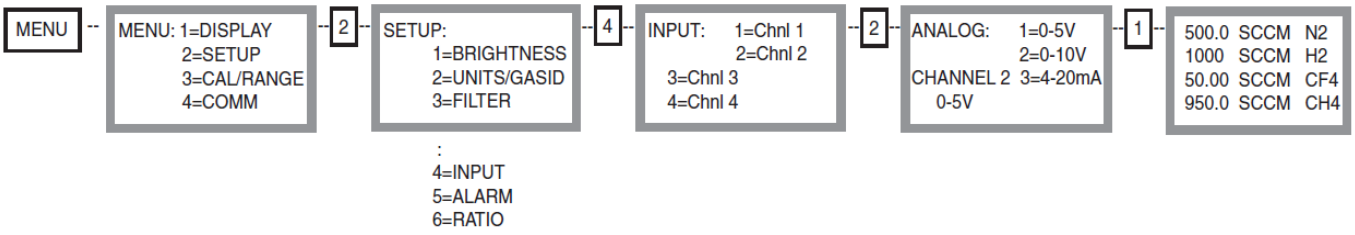
The bold characters shown in the above flow chart indicate the updated Units of Measure and Gas Identifier selected. Note: When the Units of Measure and Gas Identifiers are selected, ENT must be depressed before the selection is made. This is because it may require the inputting of more than 1 digit to make the desired selection.

Selecting Filter (-3db A/D Converter Filter Frequency)



The Filter selection sets the output word rate which in turn sets the corner frequency for the sigma-delta A/D converter. With an output word rate of 15Hz, the filter's corner frequency is typically 12.7Hz. The filters are optimized to settle to full accuracy every conversion and yield better than 80dB rejection for both 50 and 60Hz with output word rates at or below 15Hz. The last filter output word rate setting for the selected channel is displayed for user convenience. Each channel may be set to a different filter output word rate. The factory default is15Hz for each channel to optimize response time and noise rejection.

Selecting Input (0-5Vdc, 0-10Vdc or 4-20mA Signal Input)

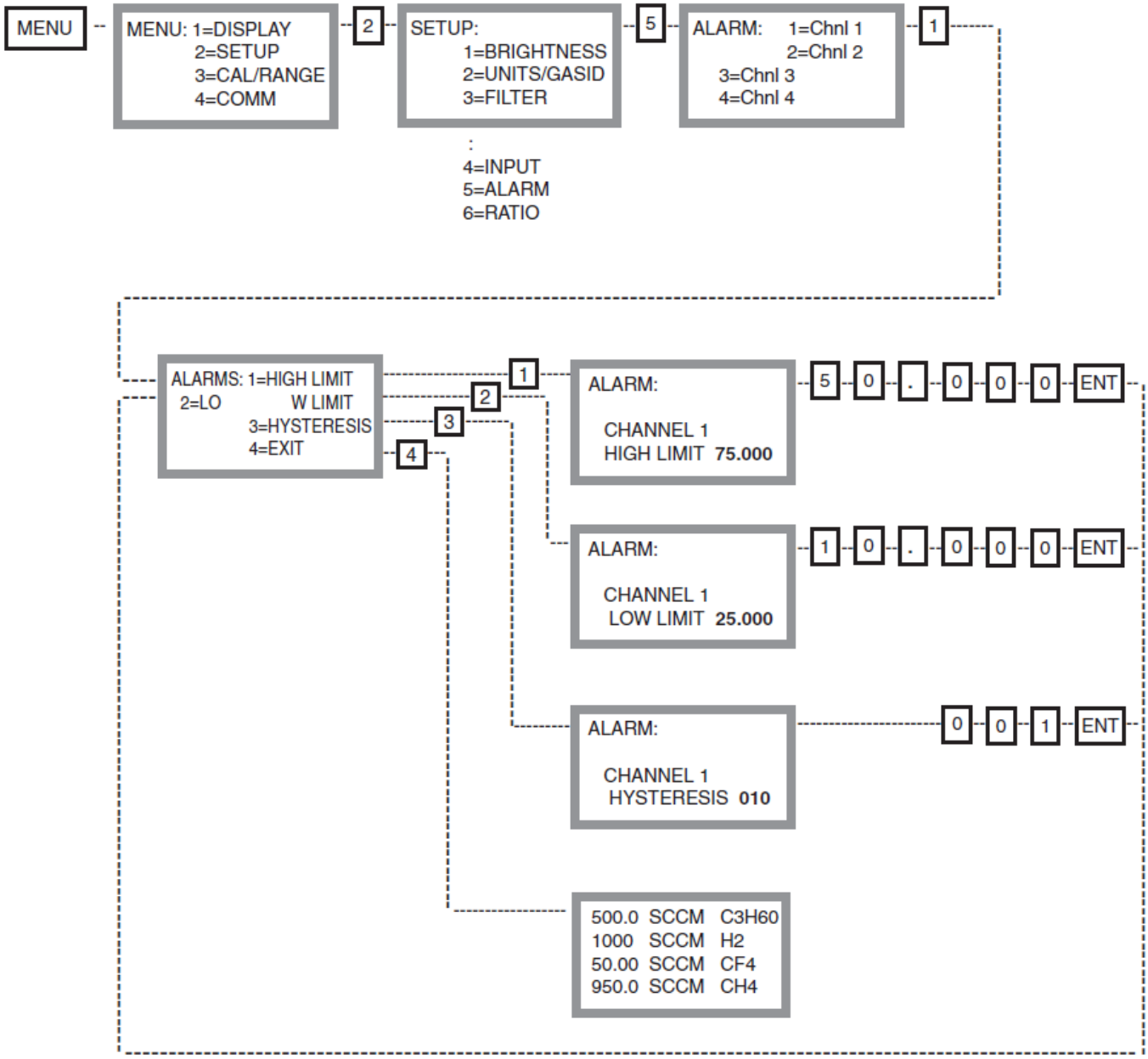


The Input selection sets the full scale input signal and the full scale setpoint (control) signal for the selected channel. The selected channel and the input signal setting that was previously selected is displayed during selection. The factory default is 0-5V for each channel. Any input may be selected for any channel. The instrument compensates for any incompatibilities even in the Master/Slave configuration.

Example: If the full scale input selected is 0-10V, then the full scale setpoint output is also 0-10V. If the Master Channel is 0-10V and the Slave Channel is 4-20mA, the instrument compensates for the incompatibility and sends a 0-10V setpoint signal for the Master and a 4-20mA setpoint signal proportional to the 0-10V input signal for the Slave.

Note: For most MFC's the full scale input is 0-5V, while for pressure transducers the input is 0-10V.

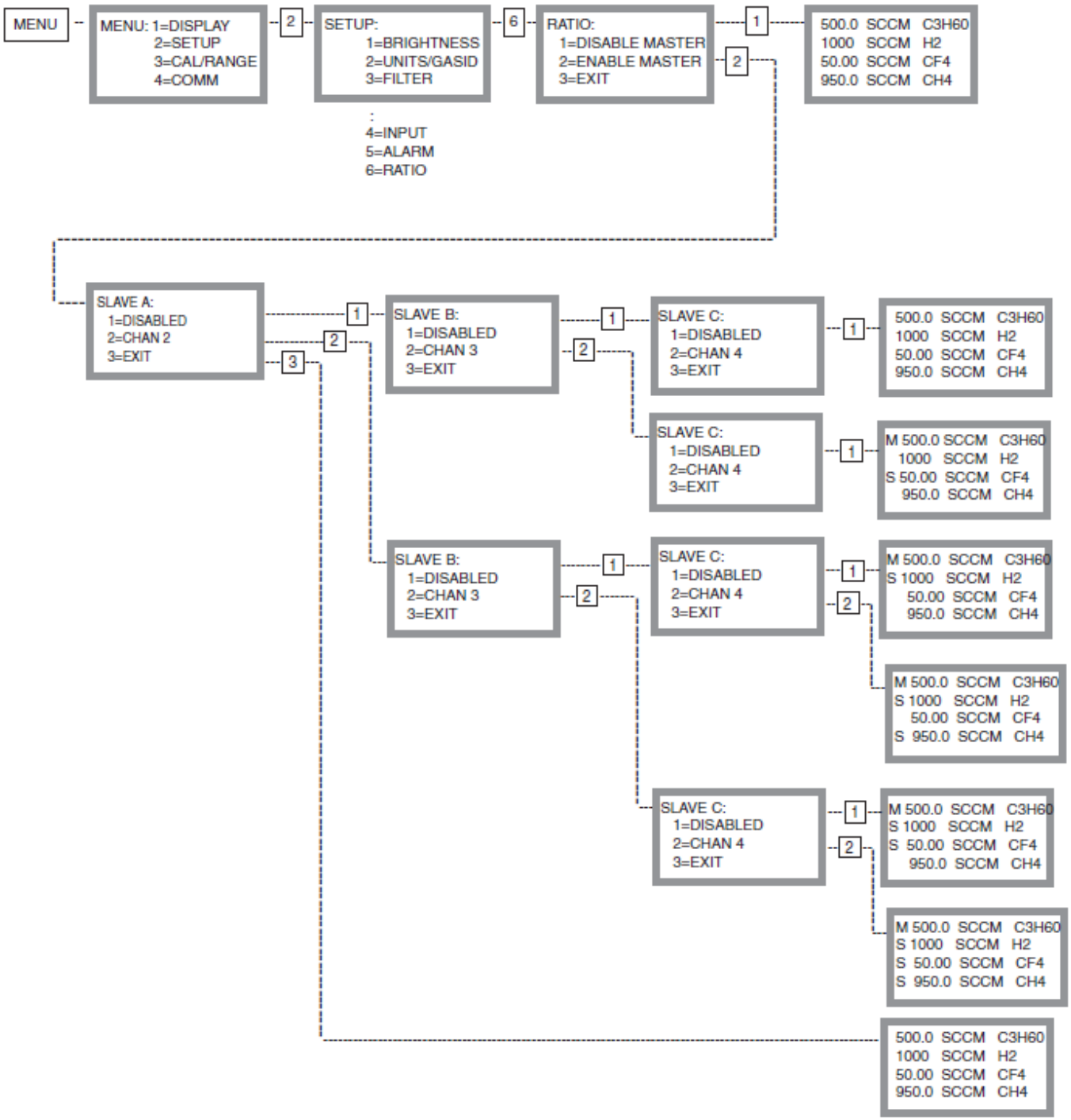
Selecting Alarms (High and Low with Hysteresis



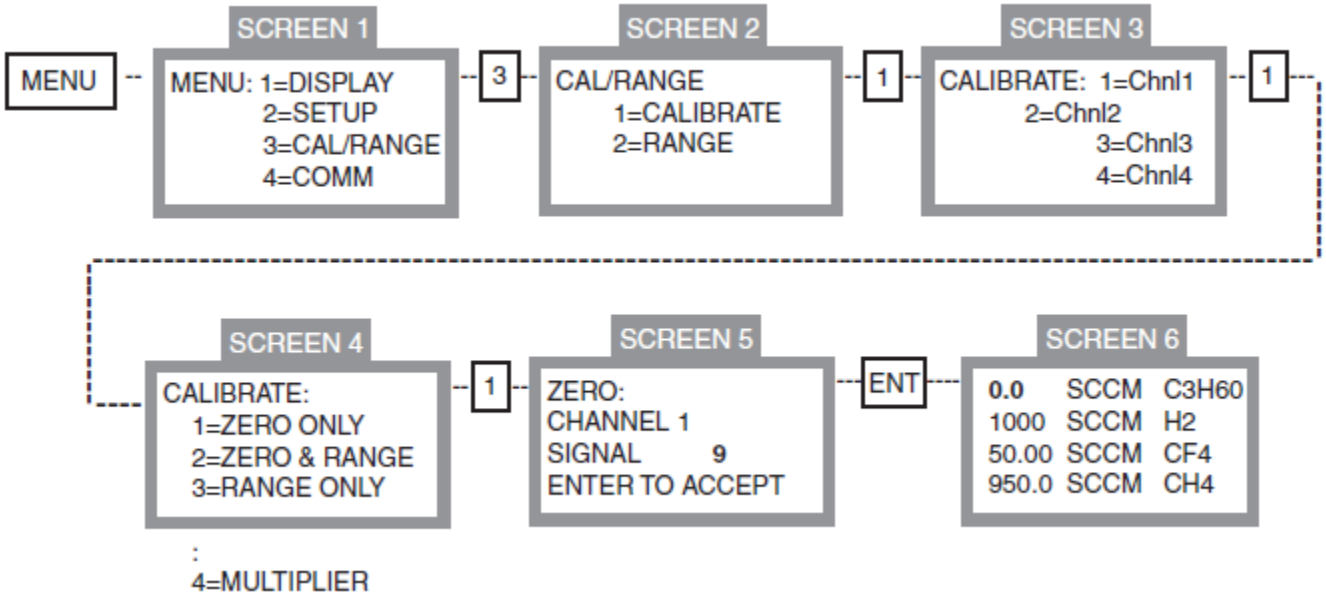
Each channel has a HIGH and LOW alarm to monitor the flow rate signal. If the flow rate is higher than the HIGH alarm or less than the LOW alarm, an optically isolated open collector output is turned on. This alarm may be used as a warning that the flow rate is not within the limits set by the setpoint (control) signal. A programmable HYSTERESIS of 1 to 999 counts provide a deadband for the alarms. To exit the alarm setup a **"4"** to exit must be selected.

In the above example, the HIGH alarm limit was changed from 75.000 to 50.000, the LOW alarm limit from 25.000 to 10.000 and HYSTERESIS from 010 to 001. The factory default is 75.000, 25.000 and 010 for the HIGH, LOW and HYSTERESIS settings, respectively

Selecting Ratio (Master/Slave Operation)

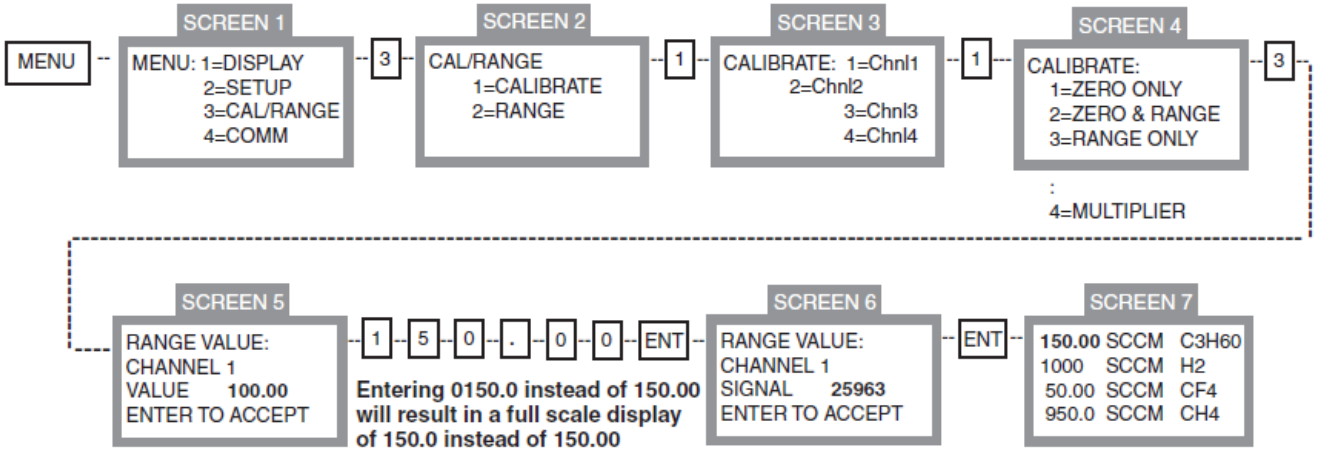


Calibrate (Zero only)



The "Zero only" sequence shown above is used to zero the MFC. Verify the input signal is at or close to zero prior to performing this sequence. In **SCREEN 5**, the data shown after "SIGNAL" is the raw analog-to-digital data corresponding to the input signal applied. This data is live and will change as the input signal is changed. It should be close to zero, unless the MFC is being zeroed at a point other than zero. If **ENT** is depressed during **SCREEN 5**, the value present at the input will be zeroed on the display, as shown in **SCREEN 6**. If **ESC** is entered, the previous zeroed value applies.

Calibrate (Range only)



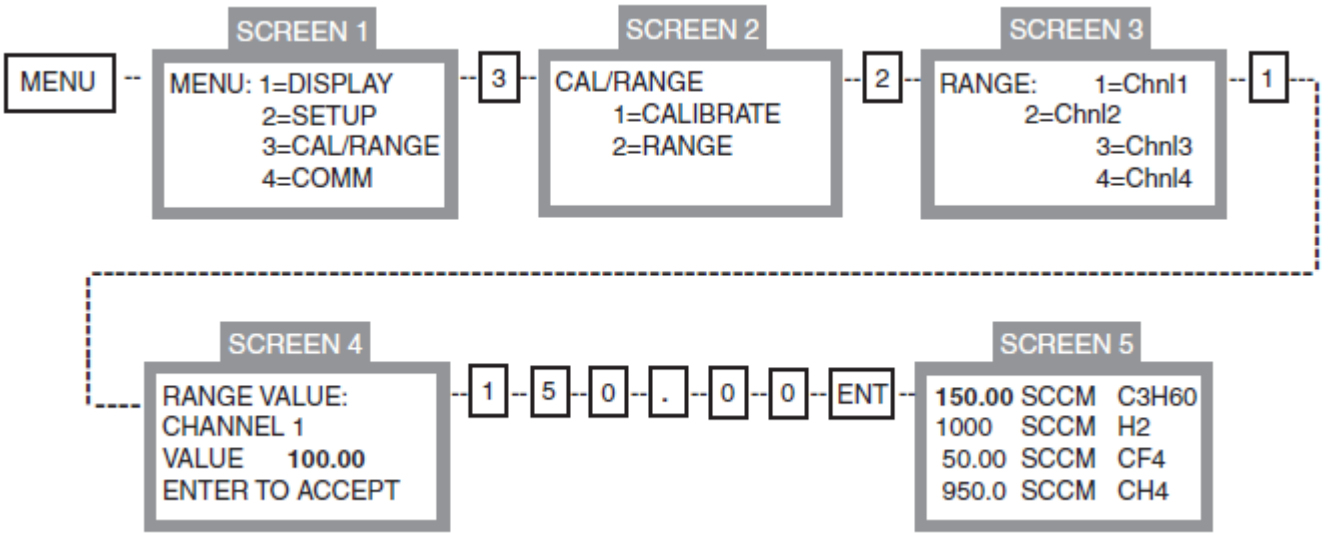
The Range only sequence is used to calibrate the full scale reading of the MFC. Apply a full scale input signal, typically 5Vdc to the signal input prior to performing this sequence. At **SCREEN 5**, the user has 2 alternatives. The first is to accept the display **RANGE** value shown by depressing **ENT**. The second is to enter a new **RANGE** value, as shown above, prior to completing the RANGE sequence. The Signal displayed on **SCREEN 6** is the live, un-scaled analog-to-digital converter data, and will change as the input changes. The value present when **ENT** is depressed will be used in the

full scale calibration calculations. If **ESC** is entered instead of **ENT**, the previous calibration applies. *NOTE: DO NOT USE THE RANGE ONLY SEQUENCE TO CHANGE RANGES. USE SELECTION 2 SHOWN IN SCREEN 2.*

Calibrate (Zero & Range)

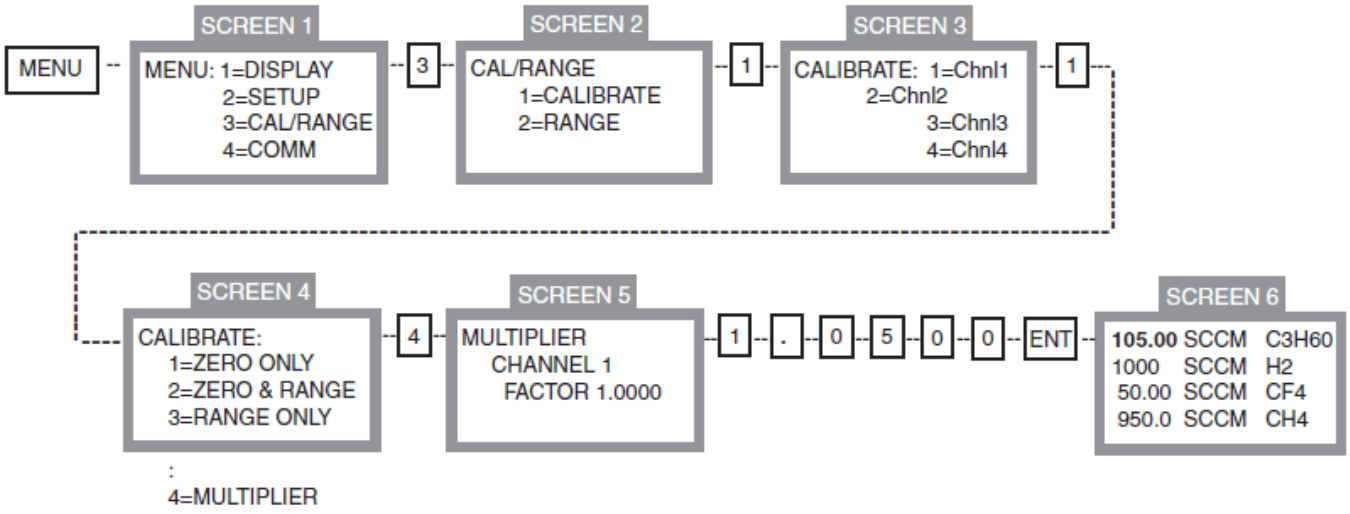
The Zero & Range calibration allows both zero and full scale calibrations to be performed in the same sequence. The input signal needs to be changed from a zero to a full scale value during the calibration sequence. The same rules apply as previously mentioned in the Zero only and Range only procedures.

Range (Changing Range



The Range sequence is **not** a calibration sequence. Changing the Range value simply replaces the Range value used during the previous full scale calibration. The analog-to-digital converter data used during the previous full scale calibration is still valid. Ranging is a simple way to change ranges when changing MFC's. It assumes the full scale output voltage of the new MFC is the same as the previous MFC.

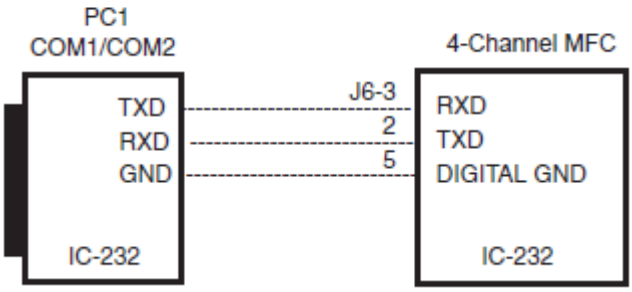
Calibrate (Multiplier)



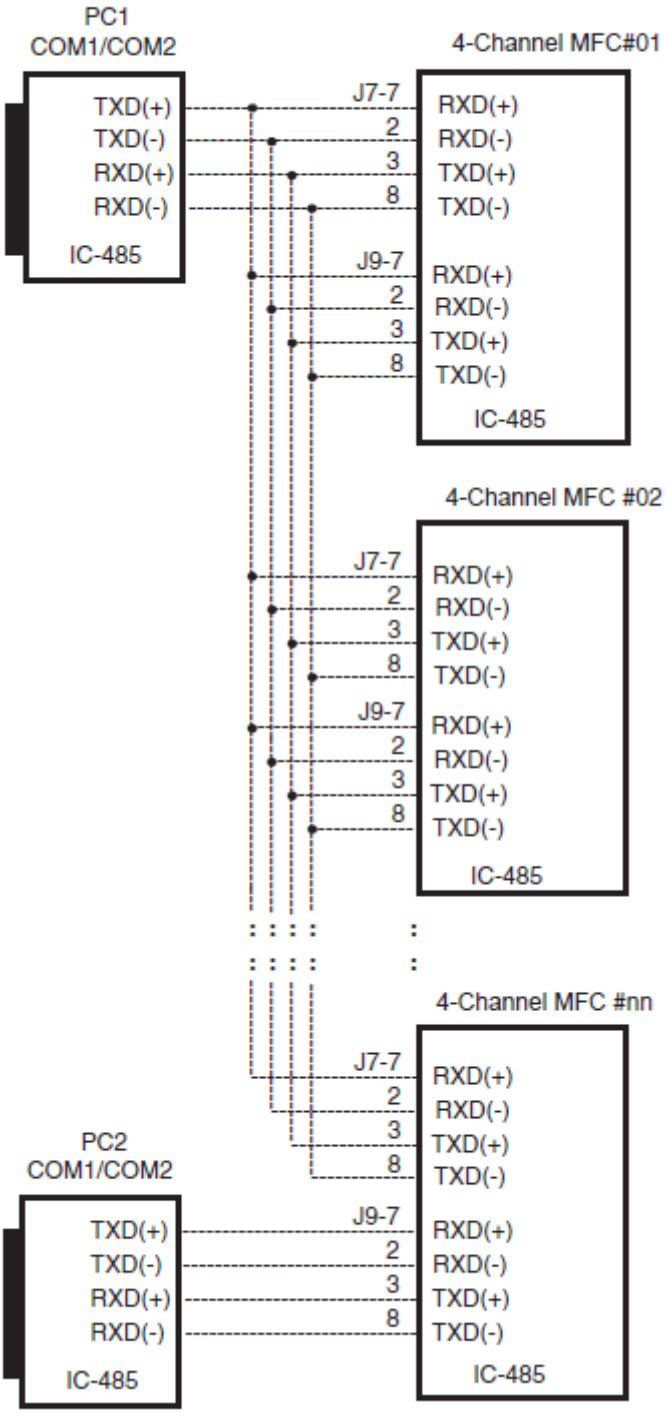
Entering a MULTIPLIER value changes the display by that multiplier factor. All data values are multiplied by the MULTIPLIER prior to display. The MULTIPLIER is sometimes referred to as a GAS CORRECTION factor when used with MFC's. If the MFC is calibrated with nitrogen and another gas is used with the MFC, a GAS CORRECTION factor can be entered to recalibrate the MFC to the gas used.

8.0 RS232/485 Hookup 9.0

BI-DIRECTIONAL RS-232 CONNECTION



MULTIDROP/4-WIRE FULL DUPLEX RS-485 CONNECTION



RS232/485 data is transmitted at 9600 or 19.2K baud (user-selectable) in the following format:

One Start Bit
Eight Data Bits in ASCII Format No Parity Bit
One Stop Bit

Note: All commands and queries are case sensitive and require an upper case character.

Reading Display

RS232 Query:
C1 Response: CH1<>sddd.dd<>eeeee<>xxxxx<>z where: <>= blank (ASCII 20)

s= polarity sign (blank for +, ASCII 2E for -)
ddd.dd= data in ASCII format with decimal in displayed position. eeeee= unit of measure
xxxxx= gas id
z= carriage return (ASCII 0D)

C5 Response:
"CH1<>sddd.dd<>eeeee<>xxxxx<>z
CH2<>sddd.dd<>eeeee<>xxxxx<>z
CH3<>sddd.dd<>eeeee<>xxxxx<>z
CH4<>sddd.dd<>eeeee<>xxxxx<>z"

RS485 Query:
*aaC1 Response: "CH1<>sddd.dd<>eeeee<>xxxxx<>z

*aaC5 Response:
"CH1<>sddd.dd<>eeeee<>xxxxx<>z
CH2<>sddd.dd<>eeeee<>xxxxx<>z
CH3<>sddd.dd<>eeeee<>xxxxx<>z
CH4<>sddd.dd<>eeeee<>xxxxx<>z"
where: aa= 4-Channel MFC address
Reference: Checking/Changing RS485 Address on pg 19.

RS232/485 Commands – Cont.

Checking 4-Channel MFC RS485 Address Setting

RS485 Query:
*00X Response: "MULTIDROP ADDRESS: 01"
Note: All 4-Channel MFC's will respond to * 0 0 X. To prevent bus contention, connect only 1 4-Channel MFC to the RS485 port for this check.

Setting Setpoint (Control) Voltage

RS232 Command:
SP1<dd.ddd> Set CH1 Setpoint to dd.ddd
SP2<dd.ddd> Set CH2 Setpoint to dd.ddd
SP3<dd.ddd> Set CH3 Setpoint to dd.ddd
SP4<dd.ddd> Set CH4 Setpoint to dd.ddd
Example: Send S P 1 1 0 0 . 0 0
CH1 Setpoint (Control) Voltage setting will be 100.00.
Note < > must contain 5 digits and 1 decimal point.
<ddddd.> is a valid entry. Setpoint is always positive.

RS485 Command:

*aaSP1<dd.ddd> Set CH1 Setpoint at Address 01 to dd.ddd
*aaSP2<dd.ddd> Set CH2 Setpoint at Address 01 to dd.ddd
*aaSP3<dd.ddd> Set CH3 Setpoint at Address 01 to dd.ddd
*aaSP4<dd.ddd> Set CH4 Setpoint at Address 01 to dd.ddd
Example: Send * 0 1 S P 2 2 5 0 0 . 0
4-Channel MFC with Address 01 will have CH2 Setpoint (Control) Voltage set to 2500.0

Setting Alarms

RS232 Command:
A1H<dd.ddd> Set CH1 High Alarm to dd.ddd
A2L<dd.ddd> Set CH1 Low Alarm to dd.ddd
A2H<dd.ddd> Set CH2 High Alarm to dd.ddd
A2L<dd.ddd> Set CH2 Low Alarm to dd.ddd
A3H<dd.ddd> Set CH3 High Alarm to dd.ddd
A3L<dd.ddd> Set CH3 Low Alarm to dd.ddd
A4H<dd.ddd> Set CH4 High Alarm to dd.ddd
A4L<dd.ddd> Set CH4 Low Alarm to dd.ddd
Example: Send A 4 L 3 5 . 0 0 0
CH4 Low Alarm Setpoint will be 35.000
RS485 Command:
*aaA1H<dd.ddd> Set CH1 High Alar m at Address 02 to dd.ddd
*aaA1L<dd.ddd> Set CH1 Lo w Alarm at Address 02 to dd.ddd
*aaA2H<dd.ddd> Set CH2 High Alar m at Address 02 to dd.ddd
*aaA2L<dd.ddd> Set CH2 Lo w Alarm at Address 02 to dd.ddd
*aaA3H<dd.ddd> Set CH3 High Alar m at Address 02 to dd.ddd
*aaA3L<dd.ddd> Set CH3 Lo w Alarm at Address 02 to dd.ddd
Example: Send *02A3H500.00
4-Channel MFC with Address 02 will have CH3 High Alarm set to 500.00

Changing 4-Channel MFC RS485 Address Setting

RS485 Command:
*00x<aa> Set 4-Channel MFC Address to aa
Example: Send * 0 0 x 2 2
4-Channel MFC will respond with a "spade" character to acknowledge receipt of this command and change its Address to "22"

Reading Setpoint (Control) Voltage

RS232 Query:
SP1 Response: "SP1ddd.dd"
SP2 Response: "SP2ddd.dd"
SP3 Response: "SP3ddd.dd"
SP4 Response: "SP4ddd.dd"

RS485 Query:

*aaSP1 Response: "SP1ddd.dd"
*aaSP2 Response: "SP2ddd.dd"
*aaSP3 Response: "SP3ddd.dd"
*aaSP4 Response: "SP4ddd.dd"

Reading Alarms

RS232 Query:
A1H Response: A1H ddd.dd
A1L Response: A1L ddd.dd
A2H Response: A2H ddd.dd
A2L Response: A2L ddd.dd
A3H Response: A3H ddd.dd
A3L Response: A3L ddd.dd
A4H Response: A4H ddd.dd
A4L Response: A4lL ddd.dd

RS485 Query:
*aaA1H Response: A1H ddd.dd
*aaA1L Response: A1H ddd.dd
*aaA2H Response: A2H ddd.dd
*aaA2L Response: A2L ddd.dd
*aaA3H Response: A3H ddd.dd
*aaA3L Response: A3L ddd.dd
*aaA4H Response: A4H ddd.dd
*aaA4L Response: A4L ddd.dd

RS232/485 Commands – Cont.

Setting Alarm Hysteresis

RS232 Command:

HY1<ddd> Set CH1 Alarm Hysteresis to ddd
HY2<ddd> Set CH2 Alarm Hysteresis to ddd
HY3<ddd> Set CH3 Alarm Hysteresis to ddd
HY4<ddd> Set CH4 Alarm Hysteresis to ddd
where 000<ddd<250
Example: Send HY1010
CH1 Alarm Hysteresis set to 10 counts. RS485 Command:
*aaHY1<ddd> Set CH1 Hysteresis at Address aa to ddd
*aaHY2<ddd> Set CH2 Hysteresis at Address aa to ddd
*aaHY3<ddd> Set CH3 Hysteresis at Address aa to ddd
*aaHY4<ddd> Set CH4 Hysteresis at Address aa to ddd
Example: Send * 0 1 HY3100
4-Channel MFC with Address 01 will have CH3 Alarm Hysteresis set to 100

Setting Units of Measure

RS232 Command:

UM1<dd> Set CH1 Unit of Measure to selection dd
UM2<dd> Set CH2 Unit of Measure to selection dd
UM3<dd> Set CH3 Unit of Measure to selection dd
UM4<dd> Set CH4 Unit of Measure to selection dd
Reference Units of Measure Table on pg 14 for selection
Example: Send UM101
CH1 Unit of Measure will be SCCM
RS485 Command:
*aaUM1<dd> Set CH1 Unit of Measure at Address 02 to selection dd
*aaUM2<dd> Set CH1 Unit of Measure at Address 02 to selection dd
*aaUM3<dd> Set CH3 Unit of Measure at Address 02 to selection dd
*aaUM4<dd> Set CH2 Unit of Measure at Address 02 to selection dd
Example: Send *03UM366
4-Channel MFC with Address 02 will have CH3 Unit of Measure set to PSI

Setting Gas Idenfifier

RS232 Command:

GS1<ddd> Set CH1 Gas Identifier to selection dd
GS2<ddd> Set CH2 Gas Identifier to selection dd
GS3<ddd> Set CH3 Gas Identifier to selection dd
GS4<ddd> Set CH4 Gas Identifier to selection dd
Reference Gas Identifier Table on pgs 15, 16 and 17 for selection
Example: Send GS1050
CH1 Gas Identifier will be C2H6O

Reading Alarm Hysteresis

RS232 Query:

HY1 Response: HY1ddd
HY2 Response: HY2ddd
HY3 Response: HY3ddd
HY4 Response: HY4ddd
Example: Send IN3 Response: IN3

RS485 Query:

*aaHY1 Response: HY1ddd
*aaHY2 Response: HY2ddd
*aaHY3 Response: HY3ddd
*aaHY4 Response: HY4ddd

Reading Units of Measure

RS232 Query:

UM1 Response: UM1dd
UM2 Response: UM2dd
UM3 Response: UM3dd
UM4 Response: UM4dd
Example: Send UM1
Response: UM11 if CH1 Unit of Measure was SCCM

RS485 Query:

*aaUM1 Response: UM1dd
*aaUM2 Response: UM2dd
*aaUM3 Response: UM3dd
*aaUM4 Response: UM4dd

Reading Gas Identifier

RS232 Query:

GS1 Response: GS1ddd
GS2 Response: GS2ddd
GS3 Response: GS3ddd
GS4 Response: GS4ddd
Example: Send GS3
Response: GS3050 if CH1 Gas Identifier was C2H60

RS232/485 Commands – Cont.

Setting Signal Input

RS232 Command:

IN1<d> Set CH1 Signal Input to selection d
IN2<d> Set CH2 Signal Input to selection d
IN3<d> Set CH3 Signal Input to selection d
IN4<d> Set CH4 Signal Input to selection d
where d=1 Signal Input = 0-5V
d=2 Signal Input = 0-10V
d=3 Signal Input = 4-20mA
Example: Send IN33

CH3 Signal Input selection is 4-20mA.
This also sets CH3 Setpoint (Control) signal to 4-20mA.

RS485 Command:

*aaIN1<d> Set CH1 Signal Input at Address aa to selection d
*aaIN2<d> Set CH2 Signal Input at Address aa to selection d
*aaIN3<ddd> Set CH3 Signal Input at Address aa to selection d
*aaIN4<ddd> Set CH4 Signal Input at Address aa to selection d
Example: Send *01IN31
4-Channel MFC with Address 01 will have CH3 Signal Input set for 0-5V.

Setting Filter

RS232 Command:

FL1<d> Set CH1 Filter selection to d
FL2<d> Set CH2 Filter selection to d
FL3<d> Set CH3 Filter selection to d
FL4<d> Set CH4 Filter selection to d
Where d=1 Filter = 4Hz
d=2 Filter = 15Hz
d=3 Filter = 30Hz
d=4 Filter =100Hz
Example: Send FL12
CH1 Filter f(-3dB) will be 15Hz

RS485 Command:

*aaFL1<d> Set CH1 Filter at Address aa to selection d
*aaFL2<d> Set CH1 Filter at Address aa to selection d
*aaFL3<d> Set CH3 Filter at Address aa to selection d
*aaFL4<d> Set CH2 Filter at Address aa to selection d
Example: Send *03FL13
4-Channel MFC with Address 03 will have CH1 Filter selection set for 30Hz.

Reading Signal Input Selection

RS232 Query:

IN1 Response: IN1<>d<>zzzzz
IN2 Response: IN2<>d<>zzzzz
IN3 Response: IN3<>d<>zzzzz
IN4 Response: IN4<>d<>zzzzz
Where zzzzz = 0-5V for d=1
zzzzz = 0-10V for d=2
zzzzz = 4-20mA for d=3

Example: Send IN3 Response: IN3 3 4-20mA

RS485 Query:

*aaIN1 Response: IN1<>d<>zzzzz
*aaIN2 Response: IN2<>d<>zzzzz
*aaIN3 Response: IN3<>d<>zzzzz
*aaIN4 Response: IN4<>d<>zzzzz
Example: Send *10IN2 Response: IN2 1 0-5V

Reading Filter

RS232 Query:

FL1 Response: FL1<>d<>zzzzz
FL2 Response: FL2<>d<>zzzzz
FL3 Response: FL3<>d<>zzzzz
FL4 Response: FL4<>d<>zzzzz
Where zzzzz = 4Hz for d=1
zzzzz = 15Hz for d=2
zzzzz = 30Hz for d=3
zzzzz = 100Hz for d=4
Example: Send FL1
Response: FL1 2 15Hz if CH1 Filter selection was 2.

RS485 Query:

*aaFL1 Response: FL<>1<>zzzzz
*aaFL2 Response: FL<>2<>zzzzz
*aaFL3 Response: FL<>3<>zzzzz
*aaFL4 Response: FL4<>4<>zzzzz

RS232/485 Commands – Cont.

Setting Multiplier

RS232 Command:

ML1<d.dddd> Set CH1 Multiplier to d.dddd
ML2<d.dddd> Set CH2 Multiplier to d.dddd
ML3<d.dddd> Set CH3 Multiplier to d.dddd
ML4<d.dddd> Set CH4 Multiplier to d.dddd
Example: Send ML31.1375
CH3 Multiplier=1.1375

RS485 Command:

*aaML1<d.dddd> Set CH1 Multiplier at Address aa to d.dddd
*aaML2<d.dddd> Set CH2 Multiplier at Address aa to d.dddd
*aaIN3<d.dddd> Set CH3 Multiplier at Address aa to d.dddd
*aaIN4<d.dddd> Set CH4 Multiplier at Address aa to d.dddd
Example: Send *05ML31.0000
4-Channel MFC with Address 05 will have CH3 Multiplier set to 1.0000.

Setting/Blanking Display (Flow or Total)

RS232 Command:

D1<d> Set CH1 Display to selection d
D2<d> Set CH2 Display to selection d
D3<d> Set CH3 Display to selection d
D4<d> Set CH4 Display to selection d
Where d=1 sets Display for TOTAL
d=2 sets Display for FLOW
d=3 blanks Display for selected Channel
Example: Send D11
CH1 Display shows TOTAL

RS485 Command:

*aaD1d Set CH1 Display at Address aa to selection d
*aaD2d Set CH2 Display at Address aa to selection d
*aaD3d Set CH3 Display at Address aa to selection d
*aaD4d Set CH4 Display at Address aa to selection d
Example: Send *03D12
4-Channel MFC with Address 03 will display FLOW on CH1

Reading Multiplier

RS232 Query:

ML1 Response: ML1<><>d.dddd
ML2 Response: ML2<><>d.dddd
ML3 Response: ML3<><>d.dddd
ML4 Response: ML4<><>d.dddd
Example: Send ML3 Response: ML3 1.1375

RS485 Query:

*aaML1 Response: ML1<><>d.dddd
*aaML2 Response: ML2<><>d.dddd
*aaML3 Response: ML3<><>d.dddd
*aaML4 Response: ML4<><>d.dddd

Reading Display (Selection)

RS232 Query:

D1 Response: D1d
D2 Response: D2d
D3 Response: D3d
D4 Response: D4d

Example: Send D1
Response: D12 indicates d=2 for FLOW on CH1

RS485 Query:

*aaD1 Response: D1d
*aaD2 Response: D2d
*aaD3 Response: D3d
*aaD4 Response: D4d

9.0 Units of Measure table

#	Description	Abbrev	Total	#	Description	Abbrev	Total
1	Standard Cubic Centimeters per Minute	SCCM	SCC	34	Normal Cubic Meters per Hour	NCMH	NCM
2	Standard Liters per Minute	SLM	SL	35	Standard Cubic Meters per Hour	SCMH	SCM
3	Percent	%	NA	36	Normal Cubic Inches per Minute	NCIM	NCI
4	Volts	V	NA	37	Standard Cubic Inches per Secon	SCIS	SCI
5	Millivolts	MV	NA	38	Normal Cubic Inches per Second	NCIS	NCI
6	Counts	CNT	NA	39	Standard Cubic Inches per Hour	SCIH	SCI
7	Normal Liters per Minute	NLM	NL	40	Normal Cubic Incher per Hour	NCIH	NCI
8	Standard Liters per Second	SLS	SL	41	Pounds per Minute	LBM	LB
9	Normal Liters per Second	NLS	NL	42	Pounds per Second	LBS	LB
10	Standard Liters per Hour	SLH	SL	43	Pounds per Hour	LBH	LB
11	Normal Liters per Hour	NLH	NL	44	Kilograms per Minute	KgM	Kg
12	Standard Milliliters per Minute	SMLM	SML	45	Kilograms per Second	KgS	Kg
13	Normal Milliliters per Minute	NMLM	NML	46	Kilograms per Hour	KgH	Kg
14	Standard Milliliters per Second	SMLS	SML	47	Grams per Minute	GRM	GR
15	Normal Mililiters per Second	NMLS	NML	48	Grams per Second	GRS	GR
16	Standard Milliliters per Hour	SMLH	SML	49	Grams per Hour	GRH	GR
17	Normal Milliliters per Hour	NMLH	NML	50	Moles per Minute	MolM	Mol
18	Normal Cubic Centimeters per Minute	NCCM	NCC	51	Moles per Second	MolS	Mol
19	Standard Cubic Centimeters per Secon	SCCS	SCC	52	Moles per Hour	MolH	Mol
20	Normal Cubic Centimeters per Second	NCCS	NCC	53	Kilomoles per Minute	KMolM	KMol
21	Standard Cubic Centimeters per Hour	SCCH	SCC	54	Kilomoles per Second	KMolS	KMol
22	Normal Cubic Centimeters per Hour	NCCH	NCC	55	Kilomoles per Hour	KMol	KMol
23	Standard Cubic Feet per Minute	SCFM	SCF	56	Watts	W	NA
24	Normal Cubic Feet per Minute	NCFM	NCF	57	Bits per Second	BPS	BP
25	Standard Cubic Feet per Second	SCFS	SCF	58	Seconds	S	NA
26	Normal Cubic Feet per Second	NCFS	NCF	59	Minutes	M	NA
27	Standard Cubic Feet per Hour	SCFH	SCF	60	Hours	H	NA
28	Normal Cubic Feet per Hour	NCFH	NCF	61	Watt*Hours	WH	W
29	Standard Cubic Meters per Minute	SCMM	SCM	62	Torr	TORR	NA
30	Normal Cubic Meters per Minute	NCMM	NCM	63	Bar	BAR	NA
31	Standard Cubic Meters per Second	SCMS	SCM	64	Pascals	Pa	NA
32	Normal Cubic Meters per Second	NCMS	NCM	65	Inches of Water	inH20	NA
33	Standard Cubic Meters per Hour	SCMH	SCM	66	Pounds per Square Inch	PSI	NA

10.0 Gas Identification Table

#	GAS	GAS ID	DISPLAY	#	GAS	GAS ID	DISPLAY
1	Acetic Acid	C2H4F2	#1	41	R21	CHCl2F	R21
2	Acetic Acid, Anhydride	C4H603	#2	42	Dichloromethane	CH2Cl2	#42
3	Acetone	C3H60	C3H60	43	Dichloropropane	C3H6Cl2	#43
4	Acetonitryl	C2H3N	C2H3N	44	Dichlorosilane	H2SiCl2	#44
5	Acetylene	C2H2	C2H2	45	Diethyl Amine	C4H11N	#45
6	Air	Air	Air	46	Diethyl Ether	C4H10O	#46
7	Allene	C3H4	C3H4	47	Diethyl Sulfide	C4H10S	#47
8	Ammonia	NH3	NH3	48	Difluoroethylene	C2H2F2	#48
9	Argon	Ar	Ar	49	Dimethylamine	C2H7N	C2H7N
10	Arsine	AsH3	AsH3	50	Dimethyl Ether	C2H6O	C2H6O
11	Benzene	C6H6	C6H6	51	Dimethyl Sulfide	C2H6S	C2H6S
12	Boron Trichloride	BCl3	BCl3	52	Divinyl	C4H6	C4H6
13	Boron Triflouride	BF3	BF3	53	Ethane	C2H6	C2H6
14	Bromine	Br2	Br2	54	Ethane, 1-chloro-1,1,2,2-tetraflouro-	C2HClF4	#54
15	Bromochlorodifluoromethane	CBrClF2	#15	55	Ethane, 1-chloro-1,2,2,2-tetrafluoro-	C2HClF4	#55
16	Bromodifluoromethane	CHBrF2	#16	56	Ethanol	C2H6O	C2H6O
17	Bromotrifluormethane	CBrF3	CBrF3	57	Ethylacetylene	C4H6	C4H6
18	Butane	C4H10	C4H10	58	Ethyl Amine	C2H7N	C2H7N
19	Butanol	C4H10O	C4H10O	59	Ethylbenzene	C8H10	C8H10
20	Butene	C4H8	C4H8	60	Ethyl Bromide	C2H5Br	#60
21	Carbon Dioxide	CO2	CO2	61	Ethyl Chloride	C2H5Cl	#61
22	Carbon Disulfide	CS2	CS2	62	Ethyl Fluoride	C2H5F	C2H5F
23	Carbon Monoxide	CO	CO	63	Ethylene	C2H4	C2H4
24	Carbon Tetrachloride	CCl4	CCl4	64	Ethylene Dibromide	C2H4Br2	#64
25	Carbonl Sulfide	COS	COS	65	Ethylene Dichloride	C2H4Cl2	#65
26	Chlorine	Cl2	Cl2	66	Ethylene Oxide	C2H4O	C2H4O
27	Chlorine Trifluoride	ClF3	ClF3	67	Ethyleneimine	C2H4N	C2H4N
28	Chlorobenzene	C6H5Cl	#28	68	Ethylidene Dichloride	C2H4Cl2	#68
29	Chlorodifluoroethane	C2H3ClF	#29	69	Ethyl Mercaptan	C2H6S	C2H6S
30	Chloroform	CHCl3	CHCl3	70	Fluorine	F2	F2
31	Chloropentafluoroethane	C2ClF5	#31	71	Formaldehyde	CH2O	CH2O
32	Chloropropane	C3H7Cl	#32	72	Freon 11	CCl3F	CCl3F
33	Cisbutene	C4H8	C4H8	73	Freon 12	CCl2F2	#73
34	Cyanogen	C2N2	C2N2	74	Freon 13	CClF3	CClF3
35	Cyanogen Chloride	ClCN	ClCN	75	Freon 14	CF4	CF4
36	Cyclobutane	C4H8	C4H8	76	Freon 22	CHClF2	#76
37	Cyclopropane	C3H6	C3H6	77	Freon 23	CHF3	CHF3
38	Deuterium	H22	H22	78	Freon 114	C2Cl2F4	#78
39	Diborane	B2H6	B2H6	79	Furan	C4H4O	C4H4O
40	Dibromodifluoromethane	CBr2F2	#40	80	Helium	He	He

Gas Identification Table cont.

#	GAS	GAS ID	DISPLAY	#	GAS	GAS ID	DISPLAY
81	Heptafluoropropane	C3HF7	C3HF7	121	Neon	Ne	Ne
82	HMDS	C6H19NSi2	HMDS	122	Nitric Oxide	NO	NO
83	Hexamethyldisiloxane	C6H18OSi2	#83	123	Nitrogen	N2	N2
84	Hexane	C6H14	C6H14	124	Nitrogen Dioxide	NO2	NO2
85	Hexafluorobenzene	C6F6	C6F6	125	Nitrogen Tetroxide	N2O4	N2O4
86	Hexene	C6H12	C6H12	126	Nitroge Trifluoride	NF3	NF3
87	Hydrazine	N2H4	N2H4	127	Nitromethane	CH3NO2	#127
88	Hydrogen	H2	H2	128	Nitrosyl Chloride	NOCl	NOCl
89	Hydrogen Bromide	HBr	HBr	129	Nitrous Oxide	N2O	N2O
90	Hydrogen Chloride	HCl	HCl	130	n-Pentane	C5H12	C5H12
91	Hydrogen Cyanide	CHN	CHN	131	Octane	C8H18	C8H18
92	Hydrogen Fluoride	HF	HF	132	Oxygen	O2	O2
93	Hydrogen Iodide	HI	HI	133	Oxygen Difluor	ide	F2O
94	Hydrogen Selenide	H2Se	H2Se	134	Ozone	O3	O3
95	Hydrogen Sulfide	H2S	H2S	135	Pentaborane	B5H9	B5H9
96	Isobutane	C4H10	C4H10	136	Pentane	C5H12	C5H12
97	Isobutanol	C4H10O	#97	137	Perchloryl Fluoride	ClFO3	CLFO3
98	Isobutene	C4H8	C4H8	138	Perfluorocyclobutane	C4F8	C4F8
99	Isopentane	C5H12	C5H12	139	R116	C2F6	C2F6
100	Isopropyl Alcohol	C3H8O	C3H8O	140	Perfluoropropane	C3F8	C3F8
101	Isoxazole	C3H3NO	#101	141	Phenol	C6H6O	C6H6O
102	Ketene	C2H2O	C2H2O	142	Phosgene	COCl2	COCl2
103	Krypton	Kr	Kr	143	Phosphine	PH3	PH3
104	Methane	CH4O	CH4O	144	Phosphorus Trifluoride	PF3	PF3
105	Methanol	CH4O	CH4O	145	Propane	C3H8	C3H8
106	Methyl Acetate	C3H6O2	#106	146	Propyl Alcohol	C3H8O	C3H8O
107	Methyl Acetylene	C3H4	C3H4	147	Propyl Amine	C3H9N	C3H9N
108	Methylamine	CH5N	CH5N	148	Propylene	C3H6	C3H6
109	Methyl Bromide	CH3Br	CH3Br	149	Pyradine	C5H5N	C5H5N
110	Methyl Chloride	CH3Cl	CH3Cl	150	R32	CH2F2	CH2F2
111	Methylcyclohexane	C7H14	C7H14	151	R123	C2HCl2F3	R123
112	Methyl Ethyl Amine	C3H9N	C3H9N	152	R123A	C2HCl2F3	R123A
113	Methyl Ethyl Ether	C3H8O	C3H8O	153	R125	C2HF5	C2HF5
114	Methyl Ethyl Sulfide	C3H8S	C3H8S	154	R134	C2H2F4	R134
115	Methyl Fluoride	CH3F	CH3F	155	R134A	C2H2F4	R134A
116	Methyl Formate	C2H4O2	#116	156	R143	C2H3F3	R143
117	Methyl Iodide	CH3I	CH3I	157	R143A	C2H3F3	R143A
118	Methyl Mercaptan	CH4S	CH4S	158	R152A	C2H4F2	R152A
119	Methylpentene	C6H12	C6H12	159	R218	C3F8	C3F8
120	Methyl Vinyl Ether	C3H6O	C3H6O	160	R1416	C2H3Cl2F	R1416

Gas Identification Table cont.

#	GAS	GAS ID	DISPLAY
161	Radon	Rn	Rn
162	Sec-butanol	C4H10O	#162
163	Silane	SiH4	SiH4
164	Silicon Tetrafluoride	SiF4	SiF4
165	Sulfur Dioxide	SO2	SO2
166	Sulfur Hexafluoride	SF6	SF6
167	Sulfur Tetrafluoride	SF4	SF4
168	Sulfur Trifluoride	SF3	SF3
169	Sulfur Trioxide	SO3	SO3
170	Tetrachloroethylene	C2Cl4	#170
171	Tetrafluoroethylene	C2F4	C2F4
172	Tetrahydrofuran	C4H8O	C4H8O
173	Tert-butanol	C4H10O	#173
174	Thiophene	C4H4S	C4H4S
175	Toluene	C7H8	C7H8
176	Transbutene	C4H8	C4H8
177	Trichloroethane	C2H3Cl3	#177
178	Trichloroethylene	C2HCl4	#178
179	R113	C2Cl3F3	R113
180	Triethylamine	C6H15N	#180
181	Trimethyl Amine	C3H9N	C3H9N
182	Tungsten Hexafluoride	WF6	WF6
183	Uranium Hexafluoride	UF6	UF6
184	Vinyl Bromide	C2H3Br	#184
185	Vinyl Chloride	C2H3Cl	#185
186	Vinyl Fluoride	C2H3F	C2H3F
187	Water Vapor	H2O	H2O
188	Xenon	Xe	Xe
189	Xylene, m-	C8H10	C8H10
190	Xylene, 0-	C8H10	C8H10
191	Xylene, p-	C8H10	C8H10

11.0 Warranty

Warranty Repair Policy

Hastings Instruments warrants this product for a period of one year from the date of shipment to be free from defects in material and workmanship. This warranty does not apply to defects or failures resulting from unauthorized modification, misuse or mishandling of the product. This warranty does not apply to batteries or other expendable parts, nor to damage caused by leaking batteries or any similar occurrence. This warranty does not apply to any instrument which has had a tamper seal removed or broken.

This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty as to fitness for a particular use. Hastings Instruments shall not be liable for any indirect or consequential damages.

Hastings Instruments, will, at its option, repair, replace or refund the selling price of the product if Hastings Instruments determines, in good faith, that it is defective in materials or workmanship during the warranty period. Defective instruments should be returned to Hastings Instruments, shipment prepaid, together with a written statement of the problem and a Return Material Authorization (RMA) number. Please consult the factory for your RMA number before returning any product for repair. Collect freight will not be accepted.

Non-Warranty Repair Policy

Any product returned for a non-warranty repair must be accompanied by a purchase order, RMA form and a written description of the problem with the instrument. If the repair cost is higher, you will be contacted for authorization before we proceed with any repairs. If you then choose not to have the product repaired, a minimum will be charged to cover the processing and inspection. Please consult the factory for your RMA number before returning any product repair.

TELEDYNE HASTINGS INSTRUMENTS

804 NEWCOMBE AVENUE

HAMPTON, VIRGINIA 23669 U.S.A.

ATTENTION: REPAIR DEPARTMENT

TELEPHONE (757) 723-6531 1-800-950-2468

FAX (757) 723-3925

E MAIL mailto:hastings_instruments@teledyne.com

INTERNET ADDRESS http://www.hastings-inst.com

Repair Forms may be obtained from the “Information Request” section of the Hastings Instruments