TELEDYNE HASTINGS INSTRUMENTS

INSTRUCTION MANUAL

DIGITAL 300
SOFTWARE
GUIDE

TELEDYNE
HASTINGS INSTRUMENTS
A Teledyne Technologies Company

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 167-092004)...September 2004
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Revision C (Document Number 167-062010) ....June 2010
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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 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. General Information

1.1. Flow Instrument States

Upon application of input power, the switching supply ramps up the supplies. 300ms after the +5V supply exceeds 4.65V the flow instrument will enter the Initialization state (1) The network command prompts contain the INIT mode string, and flow values will postfix the "*I" init mode validity string.

The sensor read interrupt routine pulses the tops of each bridge. If, after 20 - 25 seconds, both bridges are not stabilized at/above the minimum operating voltage, with top and bottom nodes within low and high limits, FAIL mode is set, where after command prompts will contain the FAIL mode string and flow rate values will show the error validity string.

After successful completion of the initialization state, the instrument drops into Idle state (2). While in the Idle state the instrument can measure flow properly but will not attempt valve control. The valve will stay in the default position. Normally the flow controllers will leave the factory configured to automatically proceed into the Operate state (4). This automatic procession can be disabled by a configuration bit in the sensor list, whereupon a network command must be received to move into the Operate state. Once in operate state, the instrument will measure and control flow normally.

If a system error occurs the flow instrument will go into the fail state (6). In the fail state, all flow control and flow measurement is stopped. Once in the fail state a network command must be received to move into the Abort state (5). In the abort state, flow measurement occurs but the valve is held in the default position.

State	Description
1	Initialization
2	Idle
3	?
4	Operate
5	Abort
6	Fail
7	Cal
8	Test
9	Recover
10	Tune

A network command can move the flow instrument from the abort state to the Recover state (9). Once in the recover state the flow instrument will automatically drop into the Idle state after completion of any necessary initializations. Normally the instrument would proceed automatically on into the Operate state.

The Calibration (7), Test (8) and Tune (10) states can only be reached if the flow instrument is presently in the idle state. The automatic transition to Operate must be disabled to reach these states.

1.2. Terminal Emulator Programs

In order to communicate digitally with digital instrument some sort of communications program must be operating on a host computer. In many cases this will be a custom routine designed to send specific commands and display the instrument responses in a particular format. These programs may be written in C, Quickbasic, Java, Labview etc. When the time and expense of creating a custom solution is not desirable or when only a few commands need to be sent for testing or configuration a terminal emulator program would be appropriate when the instrument provides text response to standard ascii text commands. Terminal emulators allow the user to type specific commands and see the textual responses sequentially on the computer display.

Earlier versions of the Windows operating system (Windows 3.1 up to Windows XP) shipped with a terminal emulator program installed (Hyperterminal). Start – Programs – Accessories – Communications – Hyperterminal. The Hyperterminal program is no longer part of the Windows operating system. It was not included with Vista and will not be part of Windows 7. Hyperterminal can still be purchased (~ $60) and installed from the following location: Hyperterminal http://www.hilgraeve.com/htpe/download.html

See Hyperterminal Configuration instructions in the appendix.

Another choice is the free terminal program Tera Term. It can be downloaded and installed from the following site to provide similar terminal communications with digital instruments.

Tera Term http://en.sourceforge.jp/projects/ttssh2/downloads/40947/teraterm-4.63.exe

See Tera Term Configuration instructions below.

1.3. Organization of Data

Most of data in the Digital 300 series is organized into lists/menus. Each list contains information/controls for a particular function of the instrument. Each list can be read in its entirety or each item within the list can be read individually. Many configuration settings, alarms and warnings are stored as bits in a hexadecimal word. If this format is unfamiliar, an explanation of this format can be found at http://www.teledyne-hi.com/tech-papers/Hexadecimal Flag.doc

The Sensor list contains data on the instrument as a whole and the flow measurement process. The instrument serial number, firmware revision number, sensor measurements, serial port information, running hours total and the active gas number are all stored in the Sensor list. The active gas and configuration parameters such as the auto-zero process can be controlled from within this menu.

The Valve list contains data on the valve control process. This list will not be present in an instrument without a control valve. The current set point, valve drive values, loop control PID parameters, and control alarms/warning points are all accessed from this list. The controller can be set to analog or network control from this menu. The closed loop PID values in this list can also be adjusted to optimize the flow control for the system.

Network commands implemented to access "mode" items such as states, alarms and warnings are placed in the Mode list. This list contains the alarm/warning status bytes. There is an alarm summary word, alarm word, latched alarms word, flow status word, latched flow status word, warnings word, and latched warnings word present within this list. The summary word is a top-level status indicator. Active alarms or warnings in the other words will activate a bit in the alarm summary word. Some alarms/warnings may intermittently come and go before the processor samples the alarm status word. In order to notify the controlling process of intermittent occurrence the latched status words are used. The alarms/warnings that are triggered by the process are placed into the latched status words where they stay until they are acknowledged by the controlling system.

Each flow instrument contains a thermal mass flow senor and a flow divider (shunt). Each of these devices will be slightly different from other similar parts due to manufacturing differences. Therefore each flow instrument will have individual characteristics that cannot be calculated and must be measured for each instrument. This measurement occurs at the factory. During a calibration run a known gas flows through the instrument and its output is compared to a flow reference. The sensitivity to flow and the non-linearity of the instrument are measured for this gas. Information from this calibration run is placed within the instrument in a Calibration record. The calibration information can be accessed from the calibration list. Since gas density can affect the linearity of the flow divider slightly, there may be more than one of these calibration runs stored within the flow instrument. There may be up to 10 different calibration lists. Calibration list 0 is locked to prevent it from accidental corruption. Other calibration lists can be created and used for after market or field calibrations.

A gas record is used to convert the information measured during the calibration run into valid flow information or other gases and flow units. There may be up to 10 different gas records. Each record can be accessed individually by specifying the particular gas list desired or the active gas list can be read as default. Each gas list will point toward and acquire information from a particular calibration record. The number of the gas list will not normally correspond with the number of the calibration list. Each gas list could point to any of the stored calibration records. However, typically all of the gas lists will acquire information from Calibration list 0. Gas list 0 will be for air or nitrogen and is locked to prevent it from accidental corruption. Other gas lists can be created and used for after market or field calibrations.

1.4. Digital Responses

While network command entries have fixed structure, command responses may be tailored to some extent to accommodate automated network use as well as human use. Automated networks generally desire compact and cryptic responses, while a human user might benefit from verbosity.

The verbosity of responses varies according to user preferences and to command types. The case of letters in network commands determines the style of output.

If all letters in a network command are lower case, the response will be "cryptic", intended primarily for automated receipt. Cryptic responses generally include only a numeric value with no postfix units (but validity characters will be postfix as necessary).

If any one or more letters in a network command are uppercase, the response will be "verbose", incorporating all of the cryptic response, as well as a mnemonic unit (when appropriate).

Mnemonic units can be forced for either lower or upper case command text by setting a bit in the MFM Configuration Word (command "S 2"). See section "MFM CONFIGURATION WORD".

A prefixed data description string will also appear if configured to do so by setting a bit in the MFM Configuration Word (command "S 2"). See section "MFM CONFIGURATION WORD"

Certain network commands elicit multiple lines of responses that are lists of data items. These commands are not intended for brevity, and therefore always include prefixed data description strings as well as units mnemonics for each data item.

All output via RS-232 or RS-485 ports occurs in response to network commands. When network commands use "addressed mode", all responses and error messages from commands sent using the broadcast address will be suppressed.

Network commands related to MFC flow control and data items will return an error message if the MFC option is not configured. See: "prod cfg", user accessed as data item "S 64". A bit should be zero if the flow control feature is not installed. See PRODUCT CONFIGURATION WORD.

1.5. Responses with Validity Postfix String

Measured values are error-checked. If an error or alarm condition is detected that is associated with a reported value a character is appended that will identify the conditions.

Postfix characters are X and I. 'X' indicates a data error (when the error is detected). 'I' indicates a measurement read during initialization mode.

Because flow values are filtered with both leading and lagging filter sections, it is not feasible to relate validity indicators with the accuracy of measurement samples taken immediately after an error condition ceases.

Example:

"...2.34" reports indicated flow with no detected error condition

"...234*I" reports a flow value taken during Initialization mode

" ..*X" reports an flow value error (alarms and derived modes may be incorrect)

Any numeric value shown with a "*X" postfix is untrustworthy. The "X" postfix overrides "I".

1.6. Data Units

At the level of the user interface, numeric data is presented and entered in three types of units. "Raw" units are intended for factory or exceptional user usage.

Engineering Units:

Engineering unit values are generally floating point format based on a full-scale calibration at known and in user-designated units. The calibration referenced may be one or more factory-provided calibration instances.

%FS units:

Engineering unit values can also be accessed as % full scale. Most if not all such values have a magnitude (absolute value) limit of 199.99%, some are bipolar. The magnitude limit exists due to use of fixed-point storage and computation, where at least 2.0 x numerical range is provided. Note that this does not imply that specification for accuracy etc. will apply above 100% FS. Full-scale is reported as '"100", rather then "1.0", and '% is postfixed whenever units are requested.

Raw units and non-dimensioned values:

This category exists for values where engineering unit conversion is not possible or justifiable, or meaningless. It also includes string values such as Calibration Date.

A list of units may be obtained by the "LUNT" network command.

1.7. Newline and Prompt Strings

The character sequence at the end of responses to network commands may be set as desired. System data items 65 and 66 allow users to define end-of-line and prompt strings.

Strings are entered and queried as hex values. Zero to four bytes are allowed. To enter zero bytes (eg., no string), use =x00;

Example newline entries are:

For carriage-return (default), enter “s 65 =x0d”.

For carriage-return linefeed, enter “s 65 =x0d0a” or “s 65 =x0a0d” as desired.

For “space space carriage-return” enter “s 65 =x20200d”

Example prompt entries are:

For a right arrow ‘>’ use “s 66 =x3e”

For a dot (decimal point) ‘>’ use “s 66 =x2e”

To make a “smiley face: prompt use “s 66 =x3a2d29”.

Generally, the prompt string uses characters that will not appear in output strings so as to facilitate parsing of received data by the master controller.

Values may be entered as decimal rather than hex format. Refer to table of ASCII characters translated to hexadecimal values.

1.8. Auto-Echo at Serial Port

Users can configure character auto-echoing by setting/clearing bit 5 in the MFM Configuration Word . Refer to section “MFM CONFIGURATION WORD”.

Use network command “S 2 =xhhhhh” to set this bit. The auto-echo function should be disabled for normal RS-485 multi-dropped network use by clearing this bit to zero so that the instrument does not transmit except after successful receipt of query network commands that cause output. Setting this bit will enable auto-echo.

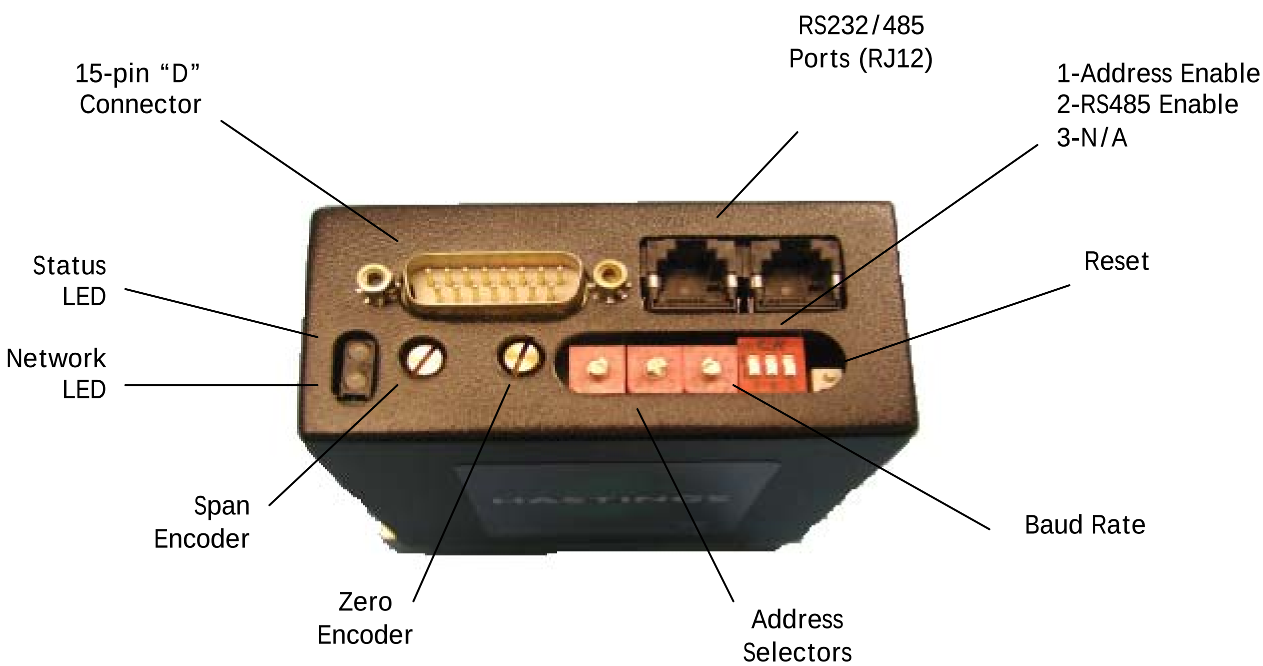
2. Serial Port Configurations

The present Digital 300 Series Instrument has two parallel RJ-12 female sockets that are connected to a single asynchronous serial port. Either socket may be used for communications. The two sockets are used when daisy-chaining a serial communications bus between addressed instruments. The serial port can operate at RS-232 or RS-485 levels, and can be set to operate at bit rates of 1200 to 19200 bps using the rotary switch nearest the dipswitch. Position settings are as follows:

Position	Bit rate
"0"	1200bps
"1"	2400bps
"2"	4800bps
"3"	9600bps
"4"	19200bps
"5" through "9"	9600bps

2.1. Network Addressed and Non-Addressed

If network command reception is set to require "addressed" commands, the first network command string field is always a destination address field. This field type is fixed length (three characters) and includes a leading asterisk '*' followed by two decimal digits. If the receiving instrument is operating in addressed mode, and if the command digits match the setting of the two rotary address switches, the command will be accepted for processing. (Address "99" is reserved for broadcast addressing, by which all listening instruments will process these network commands).



Network commands may be either addressed or non-addressed. The choice is mutually exclusive and made by setting dipswitch pole #1 (see fig 1). The address enable is not required for single point RS485 communications. If this switch is not enabled the instrument will respond on the RS485 bus to non-addressed commands. This is not advisable if more than one instrument is connected to the bus. If this switch is enabled when connected to an RS232 port the instrument will require all commands to be preceded by its address.

2.2. RS-485 and RS-232 SELECTION for the Serial Port

RS-232 operation is enabled by setting Dipswitch #2 (second from left, end nearest rotary selector switches) to the down/off/0 position. RS485 operation is selected by setting this switch to the up/on/1 position. Software checks this switch approximately every four seconds, and will change then.

The RS-485 signal naming and polarity convention used by Digital 300 is consistent with the TIA/EIA-485 standard as follows:

Signals TXA and TXB are driving outputs from the Digital 300. The "logic 0" (spacing) state is defined by TIA/EIA-485 to be the case where Signal TXA is more positive than TXB. Logic "1" (marking) exists with TXB more positive then TXA.

When the RS-485 port is used for asynchronous character transmission by Digital 300, the idle line state (no character in progress) is logic "1" (TXB (or RXB) more positive than TXA (or RXA)).

Like RS-232 mode, RS-485 mode can be used for a point-to-point connection. With a point-to-point connection, Digital 300 can be operated in the "nonaddressed" network command mode.

To establish "non-addressed" network mode using RS-485:

1. Place pole #2 of Dipswitch in on/up/1 position to enable RS-485 mode.
2. Place pole #1 of Dipswitch in the down/off/0 position to disable "addressed network" mode. No address will be required at the beginning of network commands.
3. Set auto-echo as desired. See NETWORK COMMAND PORTS: Auto-Echo at User Port (CP1)

Software checks the dipswitches switch approximately every four seconds, and will recognize a change within that time.

To use RS-485 signaling, the jumper field on the PC-872 board must be configured for the specific RJ12 pinout desired. Be certain to provide a ground connection to all other RS-485 devices using at least one pin of J402 and J403. (RS-232/RS-485 ground is common to the instrument base/case should that be desired as a grounding point).

2.3. Rotary Switches for Network Address of Serial Port

The pair of rotary switches nearest the encoders is used to set the network address that is active in the "network/addressed" mode ("OFF/ONLINE" dipswitch #1 up/on). In this mode, the first three characters of a network command string must be "*nn". The switch nearest the encoders selects the most significant digit. Values from "00" to "99" are selectable.

Adopted settings may be read using the "S"' or "SL" network commands. Changes are adopted within 20 seconds. If the connected network is active, to avoid unexpected reaction to commands addressed to another instrument, the "OFF/ONLINE" dipswitch (pole #1 nearest the rotary switches) should be set to the downward/off/offline position before changing the address select switches, and for at least 20 seconds thereafter (or until verified by command read).

2.4. RS-485 Mode Network Addressed Commands

To establish "network/addressed" command mode for the serial port using RS-485:

1. Place pole #2 of dipswitch in on/up/1 position to enable RS-485 mode (while disabling RS232).
2. Place pole #1 of dipswitch in the on/up/1 position to enable "network" mode. An address is required at the beginning of commands, eg., "*aa xxxxx" where "*aa" is the address portion, aa is the numeric address set into the network address rotary switches, and " xxxx..." is the remainder of a command.

   Software checks the dipswitches switch approximately every four seconds, and will recognize a change within that time.
3. Disable auto-echo. See NETWORK COMMAND PORTS: Auto-Echo at User Port (CP1)

Network address "99" is the broadcast address to which all online instruments will listen ("Online" in this context means that dipswitch poles #1 and #2 are in the up/on/1 position, and the instrument is otherwise operational).

Many network commands will not respond to a broadcast command. These are commands that necessarily evoke a response. If more than one instrument responded, the collisions of data would garble all responses.

Examples of addressed commands are:

"*31 f" query the indicated flow from address 31 ('3' and '1' set into rotary switches for address election)
"*99 ss =4" place all online instruments into OPERATE state

2.5. RS-485 Tri-stating

The serial port can be configured for RS-485 electrical levels. Command strings are identical for both RS-232 and RS-485 modes (ASCII asynchronous N-8-1) but RS-485 supports multi-drop operation when all attached instruments are properly configured. It is expected that users would set multi-dropped instruments into ONLINE mode with tri-stated transmit outputs by setting both dipswitch poles #1 and #2 to the up/on position.

Set dipswitch pole #2 up/on when RS-485 mode is to tri-state (high impedance state) its output after the last character transmitted until the next is ready to be transmitted. If bit cleared by setting dipswitch pole #2 down/off, RS485 output drive is always active (never tri-states), which should not be done if more than one instrument is connected to an RS-485 circuit.

Tri-stating works as follows. When the transmitter for the serial port is inactive (hardware double buffers empty), RS-485 output is disabled (tri-stated). When a character exists in either transmitter buffer, it is either about to be or is in the process of transmission and RS-485 output is enabled (not tri-stated). Port driver software will enable the RS-485 output when initializing character output. The 1 millisecond interrupt routine tests buffer state and if empty, will disable the RS485 output drive. Therefore, drive is enabled just before the ASCII asynchronous "start" bit is sent, and will be disabled within 2 milliseconds (worst case) after the stop bit is sent.

The 2 millisecond delay in tri-stating RS-485 output can cause character errors in RS-485 half-duplex (2-wire) setups if the master responds quickly to data output by a Digital 300 instrument and emits a character before the Digital 300 instrument tri-states its output.

Digital 300 instrument hardware and software assume that RS-485 signaling polarity is such that the "marking" condition (which is same polarity as asynchronous stop bits) is maintained when the RS485 output drive is disabled (tri-stated). Therefore, the receivers of all connected instruments never see a "line break" condition resulting from this tri-stating action. "Break" conditions are supposed to be caught by the asynchronous receiver/transmitter error-detect mechanisms, but when caused by erratic opens and/or shorts will create false characters that are accepted by the receiver.

2.6. RS-485 2-Wire mode

The serial port can be configured for RS-485 half-duplex (2-wire) mode. Tie the Tx+ to the Rx+ line (RJ12 Pin 1 & 6) and tie the Tx- to the Rx- line (RJ12 Pin 2 & 5). After connecting these lines together, the instrument will receive its own transmitted response as a command string on the input line. If this response string is not terminated with a proper end-of-line character, the next valid command will be appended to the previous response string and determined to be an invalid command and ignored. In this mode, the "prompt" string (S66) must terminate with the same character(s) that are present in the "nextline" string (S65). This is typically the carriage return character (x0D). See section 4.3 below. If the prompt and nextline match the instrument will receive its own response as entire command string and determine that it is not valid command. It will ignore it and will receive the next command string as a new entity.

3. Operations

3.1. LED Indicators

There are two bicolor (red, green) LEDs. They are controlled as follows:

LED associated with instrument

Instrument State	LED Mode	Condition
No or Low Power	off	No power or voltage insufficient
Initializing	alt. red & green	Warmup/Init/SelfTest/
Executing	green	
Fatal fault	red	

LED associated with network

Network Mode	LED Mode	Condition
No power/Offline	off	
Online, received command	green	On for every byte received
Online, ready for command	off	

3.2. Alarm and Warning Limits

Gas instance records keep upper and lower flow rate alarm and warning limits. Limits are checked at 8mS intervals against linearized, normalized and filtered flow measurements that have been converted to FS units.

A user-adjustable delay is imposed before reporting and clearing these alarms and warning conditions. The first violation of a limit will start a timer. If after timeout, the over-limit condition is still active, the corresponding alarm (or warning) flag will be set in the alarm (or warning) flags word. This process acts similarly with delay for clearing of these alarm conditions.

Settling delays are intended to minimize alarms due to transient flow changes. Alarms and warnings may be enabled and inhibited by network commands. See section: ALARMS, WARNINGS.

Independent timers for high and low alarms exist in order to allow alarms to be reported in the case where flow cycles rapidly above the upper and below the lower alarm limits, which may occur if they are closely spaced. It is possible for both alarm conditions to briefly exist simultaneously due to this delay mechanism.

No hysteresis is applied. Also, it is possible for users to set the upper alarm and warning limits below the lower, and vice versa.

3.3. Changing Units

The units of flow can be changed between supported types. Unit changes affect only values that are based on a measured and/or stored full-scale value. When a change is requested, only the ratio of the engineering unit to %FS is changed; the various scalings and offsets used to compute FS are not changed.

The engineering unit values for indicated flow and total flow are never stored, but are always computed on-demand from FS values.

Integrated flow (total flow) is kept internally as the integral of linearized/normalized sensor power difference in 0.1 hours, and therefore remains unaffected by both units changes, gas-type rescaling and %FS rescaling. Only changes in sensor itself or to the chosen linearization polynomial will introduce errors in gas flow totals.

3.4. Gas Types

186 SEMI standard gas types are stored by SEMI gas code. Each gas instance may be assigned one gas type code.

A list of gas codes with mnemonics can be accessed by the "LGSY" network command.

3.5. Flow and Flowing Time Integration

Values for integrated flow (total flow) and flowing hours are stored internally as the integral of linearized/normalized sensor power difference in 0.1 hours, and as flowing 0.1 hours, respectively, accumulated every 10 seconds when flow rate is above 1% of present user full-scale.

Total flow is stored per gas instance. Values are reported based on the present flow rate units (eg. if flow units are presently L/min, total flow will be reported/entered as nnn.nnn L). Since flow accumulation is kept in raw sensor units, it is not affected by changes to engineering unit type nor FS scaling. (Adjusting the rotary encoders will, however, change the scaling of subsequent integration).

Total flow is queried for gas instances using network commands "g 30" or "gi [d] 30" (for watt-hours), and "g 31" or "gi [d] 31" (for EU). Data item "g 30" may be specified to be output in units of counts*hours or as watt*hours as configured per bit 6 in the MFM Configuration word.

Flowing hours are maintained for the instrument (as opposed to per-gas-instance) and is queried using network command "s 12".

Network commands to change the totals are unrestricted so users can change to other values. "Resetting" is done by changing to 0.0 (examples: "gi 4 31 =0.0" or "s 12 =0.0"). .

Gas units, full-scale EU and full scale power difference values can be changed without destroying flow totalizer scaling. This is because flow totalizers are maintained in internal units of power difference. However, changing the fundamental scaling of the sensor will affect total flow values as they are not automatically rescaled for sensor data modifications (must be done manually).

3.6. MFC Operation

Flow control is activated by setting MFC mode to "1" (AUTO, use "V 1 =1")) and instrument state to OPERATE ("ss 4").

Flow control action is modifiable by:

- soft start
- adjustment of PID coefficients
- selection between two types of derivative action
- adjustment of drive values for valve shut, valve cracked and valve upper limit.

Note that the "valve cracked" drive value serves as the "output bias" amount that is added to the controller output.

Network commands related to MFC flow control and data items will return an error message if the MFC option is not configured. See bit 1 in variable "prod cfg", accessed as data item "S 64". This bit should be zero if the flow control feature is not installed. See PRODUCT CONFIGURATION WORD.

Valve control operates in accordance with the MFM "state" data item (refer to MFC MODE WORD , data item "V 1" "MFC mode:"), and also per the "MFC mode" (refer to MFC MODE WORD , data item "V 1" "MFC mode:").

Network commands exist to directly control valve working (set to default position - purge or shut, force shut, force open (purge), set into automatic closed loop mode, set to "hold" mode (valve stays where was in auto mode), set valve drive "manually" per command).

3.7. 1% Shutoff Threshold

When the flow control setpoint (V 6 "cmmd setpt") is less than 1% of full scale flow rate for the active gas rec (G 18 "FS flow") then:

1. the implemented setpoint value is forced to zero (V 8 "impl setpt:")
2. Valve is forced shut.

Bit x02 in "V 3" (valve mode:) is set to indicate this.

The action can be disabled. See MFC configuration word.

Flow loop tracking error alarm & warning remain active (if user enabled) in HOLD mode as well as when setpoint is below the 1% FS threshold.

Note that tracking error is the difference between the implemented and the measured flow. Therefore the tracking alarm should not be active when 1% shutoff is active, except possibly as a transient condition.

There is a small amount of hysteresis in the 1% shutoff limit. If the command setpoint is < 1% FS, the implemented setpoint is zeroed and the valve is placed in the shut mode. If enabled, softstart operates for both network commanded setpoint as well as for analog command setpoint.

3.8. Selection of Type of Derivative Action

Bit 0 (lsb) of data item "v 2" (MFC config) select either (1) derivative is rate of change of the difference controlled variable minus setpoint (in case of bit cleared to 0), or (2)) derivative is rate of change of controlled variable (with no effect by setpoint changes (in case of bit set to 1)

Clearing this bit so that derivative action is the difference controlled variable minus setpoint will cause a pre-shoot in controller response of amplitude proportional to the coefficient of the derivative (rate) term (V 25 "PID rate coeff:").

3.9. Soft Start

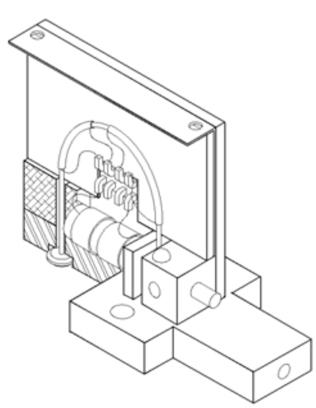
MFC action provides a user enabled soft start action. Soft start operates as a slew rate limit that acts upon changes to the network setpoint command, or to an analog setpoint input. It operates all the time that flow control is active, not just during "starting".

Soft start action conflicts with the TUNE state and is disabled in TUNE state.

There is a delay of up to 1/32 second after reception of a new setpoint command before the implemented setpoint is updated. When the soft start function is enabled, special handling of the setpoint is activated when going from a 0 flow command to a high flow value to prevent large overshoots when initiating flow. When first commanding the controller to open the initial setpoint is limited internally to around 5% of full scale until the flow starts to increase from zero. Once an initial flow value is seen the softstart will increase the setpoint to the desired value. If this is undesirable when using setpoint commands via an analog input, just disable the soft start function.

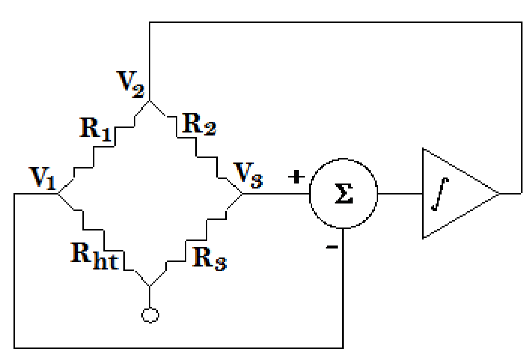
Users of the analog setpoint command method should be aware that imposing a slew rate limit may destabilize "outer" control loops that embed the MFC as an "inner loop" controller.

3.10.Flow Calculation Algorithm



This discussion covers the Digital 300 flow data acquisition and processing. It does not include dynamic events such as noise reduction filtering or sensor speedup filters.

A cut-a-way drawing of the 300 Series Flow Sensor is shown to the left. This sensor consists of 4 windings split between two identical bridge circuits – an upstream bridge (ub) & a downstream



bridge (db). A schematic of one of the bridge circuits (either ub or db) is shown on the right. The winding on the flow tube is denoted R_{ht} and the winding on the aluminum ambient bar is denoted R_s.

The flow reading derivation starts by the acquisition of four voltages from the sensor A/D (ub sense, ub comm, db sense, db comm.). The respective values of these four voltages can be obtained by reading (via the HFM-D-300 Series serial port) S40 – S43 in the sensor list. The "sense" values (S40 – ub sense & S42 db sense) are typically between 1 and 3 VDC; the "comm" values (S41 ub comm & S43 db comm) are typically between 5 and 7 VDC.

Note: If any of these voltages are near 0 VDC, then the flow sensor will not give meaningful data and most likely will need to be replaced.

The "ub" values correspond to the upstream bridge pair and the "db" values correspond to the downstream bridge pair. Each "comm" value is the voltage across its corresponding sensor coil. Each "sense" value is the voltage across a 150 ohm precision resistor in series with the sensor coil. The "sense" voltages are divided by 150 to determine the current through each sensor. This current is multiplied by the "comm" voltage to generate a value corresponding to the power supplied to each sensor coil. These bridge powers are reported in the sensor list as "ub power" and "db power" (S46 & S47).

If the two bridges were perfectly symmetrical, then when no flow was passing through the sensor tube, the power in each bridge would be exactly the same. In this case, the power difference between the bridges would be exactly zero. However, since there are slight non-symmetries between the bridges, the residual power difference between the bridges must be measured and stored when the flow is completely stopped. This residual power difference is stored in the sensor list as "total zero offset" (S15). Therefore, a measurement of the power, which is directly proportional to the molar flow through the sensor, is obtained by subtracting the total zero offset (z) from the power difference between the upstream and downstream bridge:

$$(ub - db) - z$$

The 300 Series flow sensor's power output responds linearly to changes in the gas flow rate. However, further improvements to the accuracy can be achieved through linearization. Before linearization can be executed, a normalized (i.e. 0 – 1) output is calculated by taking the zeroed power difference and dividing by the "sensor spec full scale" (SFS). The value for SFS, typically 40 mW, can be found by observing S28.

$$S = \frac{(ub - db) - z}{SFS}$$

This resultant sensor value is linearized with a 5th order normalized polynomial based upon calibration data for each D-300 instrument. This polynomial does not have a constant term and the sum of the coefficients of this polynomial equal 1.0. Therefore this polynomial will not affect the zero flow sensor output or the sensor output at the sensor full scale value (no zero shift or span effect). It will only adjust mid-level values. The coefficients of this polynomial are available as "Linz coef 1" through "Linz coef 5" in the gas record (G24 – G28).

$$A(S) + B(S^2) + C(S^3) + D(S^4) + E(S^5) = SL$$

The resultant linearized sensor value (SL) is also typically (but not always) between 0 and 1.

Next, the linearized unit-less sensor output is scaled by multiplying by both the "sensor spec full scale" (SFS) located in S28 and by the "span encoder factor" (Ef) wich is located in G34 of the gas list. The resultant linearized sensor power flow indication can be accessed via the "Fr" command.

$$Fr = SL(SFS)(Ef)$$

A few other factors must be measured before the flow rate can be calculated. The first of these factors is the "cal inst FS flow" or CFS. During initial calibration of the flow meter, the flow rate required to generate the "sensor full scale" power (typically 40 mW) is measured. This flow rate is then recorded in the gas list as "cal inst FS flow" (CFS) and can be found in the Gas List at G22. Typically, CFS is reported in standard liters per minute of nitrogen gas.

Next, the Digital 300 can be configured to allow the user to change the overall span of the flow meter by adjusting the span encoder which is accessible at the top of the flow meter. This "span encoder factor" (Ef) is recorded in G34. The factory default setting for G34 is 1.0. Note also that the span encoder is disabled by the factory to ensure the calibration of the meter. If the user wants to use the span encoder, then it must be enabled by changing the "mfm config word" located at S2.

The units ratio (U) is located at G8. This factor converts the flow reading from SLM to the desired units. And finally, the "span corr factor" (Sf) is located at G17. The span correction factor, Sf, is the product of all other span factors that are not corrected by the units factor. These include the reference conditions (STP) other than 0C & 760 Torr, gas correction factors for various gases, and the density factor if a direct mass unit is being used.

The last step in the calculation of the flow rate is to scale the linearized sensor output SL by CFS, Ef, U, and Sf. The Digital flowrate is accessed with the "F" command.

$$F = \frac{SL(CFS)(Ef)(U)}{(Sf)}$$

3.11. Generation of the Analog Output

The Digital 300 Series includes an analog out signal. This can be either 0-5 VDC, 4-20 mA, 0-10 VDC, or 0-20 mA). The output is generated by a precision D/A converter. The value of the analog output is calculated by first dividing the digital flow rate ("F") by the full scale flow ("FSF" stored at G18). This fraction, typically between 0 and 1, is scaled by the range of the analog output (AFS – A0), where AFS is the full scale analog output value located at S37 and A0 is the zero flow analog output located at S36. As an example, for a 4-20 mA output instrument, AFS (S37) = 20 mA and A0 (S36) = 4 mA. The analog output is then given by:

$$Out = A0 + \frac{F}{FSF} * (AFS - A0)$$

3.12. Multiple Gas Calibration Records/Instances

The Digital 300 Series is capable of storing up to ten different calibration records also known as instances. The gas instance is selected by changing the value of the "Active Gas Inst" which is located in S6. A cal record is created during initial calibration. At this time, the Cal Inst FS Flow (see CFS above) is measured and stored (G22). Typically, only gas instance 0 is written, but others can be stored by the factory if multiple calibration runs were performed using different calibration gases.

Also during the initial calibration run, linearization coefficients are determined and stored. If multiple calibration runs were performed, then additional linearization coefficients may exist. Typically coefficient set 0 contains the equation of a straight line (no linearization) and coefficient set 1 contains the coefficients calculated during the cal run. The coefficient set is selected by changing the value stored in G23 (linz instance).

Each gas instance points to both a calibration record (selected by G19) and a set of linearization coefficients (selected by G23). A table is given below to help illustrate the relationship (the arrows indicate possible arrangement of the records):

Calibration Instance (G19)	Gas Instance (S6)	Linearization Coef. (G23)
0	0 (Typically N2or Air)	0 (Linear Only)
1	1	1 (Determined during calibration)
2	2	2
.	.	.
.	.	.

The sensor full scale value (SFS, S 28) multiplied by the ratio between the Cal Inst FS flow (CFS, G 22) and the FS flow (FSF) results in the Full Scale power difference (FdP, G 29).

The Digital 300 series instruments has a storage area that can contain 10 different gas records, 10 different Cal records, and 10 different linearization polynomials. The cal record is created during initial calibration to store the Cal Inst FS flow. Multiple cal records may exist on older instruments or if multiple runs were performed using different calibration gases but typically only record 0 exists. The active cal record is selected by changing the value store in G 19 (cal inst). This initial calibration run is also used to calculate the fit coefficients for the 5th order polynomial. There may be multiple gas records if the flow meter has been calibrated for multiple gases or units. Typically a meter will contain one gas record for nitrogen or air (record 0) and another record for the customer specified gas/range. The record is selected by changing the value in S 6 (active Gas instance).

$$SFS\frac{CFS}{FSF} = FdP$$

3.13. Adjusting Calibration

A new Digital 300 instrument is shipped with calibration records and data sheets; calibration is not necessary. However, customers with accurate flow references may adjust the calibration of the Digital 300 using the following steps. Please note that for this procedure, the user must have digital communication (RS232 or 485) established with the Digital 300 Series instrument.

1. Unit should be warmed up (At least under power for 30 minutes)
2. Ensure that no gas is flowing through the instrument (i.e. no leaks)
3. Zero the instrument using “ZRO” command
4. Verify that zero is established using “F” (Readings should be < 0.1% full scale)
5. Establish flow near the full scale of the Digital 300 Series instrument
6. Enter “Unlock Key” (contact factory if needed)
7. Enter G17 (G17=x.xxxx) using the formula given below
8. Verify correct digital flow reading by using “F”

$$G17(New) = \left(\frac{Digital\ 300\,\mathrm{Re}ading}{Flow\ \mathrm{Re}\ ference\,\mathrm{Re}ading} \right) * \quad G17(Old)$$

As an example a 500 slm full scale flow Digital 300 Series instrument reads 490.1 when the reference meter indicates 500.1; if the current value of G17 is 1.09, then the new value should be (490.1/500.1)*1.09 = 1.0682.

3.14. Span and Offset Encoders

These encoders adjust sensor offset and gain in steps of 1/2048 (~0.05%) of FS per click (FS is that of the gas instance, and not sensor FS). An acceleration scheme permits slow single-stepping with ability to make large adjustments in a single twist motion. These encoders may be enabled/disabled in software using the MFM Configuration Word (S 2). See MFM Configuration Word section for further information.

Encoder steps and direction are detected in hardware, accumulated (by direction) about every 8 milliseconds, with span factors and zero offset values updated every 125 milliseconds. This method will accurately accumulate individual clicks as fast as about 5 shaft rotations per second, and is free of directional aliasing in the event of faster rapid stepping.

Encoder adjustment values are stored independently of other offset and scaling factors in order that the numerical components due to encoder operation can be removed or changed by network command without knowledge of, confusing or losing other factors.

The span encoder can be enabled or disabled by the bit 16 of the MFM config word (S 2). The default condition is disabled. Span encoder adjustment range is limited to a range of 0.0625 to 15.999.

The zero encoder can be enabled or disabled by the bit 17 of the MFM config word (S 2). The default condition is enabled. The zero encoder offset value is stored as associated with the sensor. Rezeroing using the user "remote zero" ZRO command or factory FZRO command will zero the encoder zero offset value.

Four zero-offset variables are maintained in NVRAM, factory offset, user offset, Autozero offset and encoder offset. The purpose of factory offset is to remove a large static offset value as may be required. The user offset component should have smaller magnitude.

The span encoder factor is stored associated with each gas instance. Therefore, changing gas instances will restore the span encoder factor in effect the last time an encoder adjustment was made using a particular gas instance. Recalibration of full-scale gas flow using the GFS command will set the span encoder factor for then current gas instance to 1.000. The span factor may be changed at any time using the G or GI network command.

4. Network Commands

Network commands are grouped into several categories, each of which has a unique first letter that also is the first letter of the associated mnemonics. The purpose is to loosely organize the large number of command functions and objects around the underlying types of data. There are exceptions to this pattern.

Groups are:
F: flow, read-only data for indicated flow
S: data associated with the sensor
G: gas measurement setups ("instances" in Devicenet'ese)
C: calibration instances
V: valve and flow control
Z: linearization coefficient arrays
L: lists, logs, reports.
M: state, modes, alarms, warnings, status

4.1. Command Syntax

Network commands are comprised of carriage-return terminated ASCII strings containing one or more fields (arguments). Arguments used to write a value are prefixed by '='. Only one argument per command type may be so designated.

In the following examples of syntax codes, the special characters are explained:

- The characters within the symbols ( ) are the common abbreviations for the one digit ASCII control codes which they represent, (e.g. (cr) represents carriage return (ascii 13, hex 0D) and (s) represents a space (ascii 32, hex 20)).
- All command strings must be followed by the "nxtline" terminator character. Typically this is the carriage return (cr, x0D), also known as ENTER. It is set by the S65 command. All of the following examples assume that the "nxtline" character is the default carriage return.
- Brackets [ ] are used to enclose characters that should be sent when transmitting on an addressed bus only (typically used with RS485). Do not include the bracket characters when transmitting the command. Omit the characters within the brackets when transmitting on an unaddressed bus (Normally RS232 port).
- Brackets { } are used to enclose characters that encase user selectable values. Do not include the bracket characters when transmitting the command.
- All commands are accepted in lower case or upper case (capital letters).
- Character Description Valid Inputs:

  * = Addressed bus (RS485) attention character; only used on for addressed communications.

  a = Address character (decimal 0-9)

  m = Most Significant Digit of Mantissa

  d = Decimal Digit 0 - 9

  e = Exponent

  ± = sign character may be - or +. May be omitted for positive values.

  x = a hexadecimal number prefix (example: x1F)

  , = Command Separator (comma)

  (s) = Space between characters

  (cr) = Command Terminator (carriage return)

- The default instrument address (RS485) as shipped from the factory is 11.

Valid list types are:

List	Character
All lists	sfl or SFL
Sensor	s or S
Valve	v or V
Gas	g or G
Cal Instance	ci or CI
Mode	m or M
Polynomial Instance	zi

4.2. Generic Commands

Flow Reading: (read only)

F(cr) or *[aa]F(cr)

Sample reply: .99996(s)SLM(cr)>

This reports the indicated flow value in engineering units. If a lower case "f" is used for the command the engineering units will not be transmitted.

Instrument Zero: (write only)

ZRO(cr) or *[aa]ZRO(cr)

Sample reply: (cr)>

This command adjusts the offset value of the flow meter such that the indicated flow reads zero flow at the present flow rate. Updates user offset value. This command should be executed periodically on flow meters when the flow rate is known to be zero. If this command is sent when the flow rate is non-zero this can cause significant flow reading errors. Flow controllers typically have the "autozero" function enabled and will not need to be re-zeroed. See MFM config word below.

% Full Scale Flow Reading: (read only)

FS(cr) or *[aa]FS(cr)

Sample reply: 1.9999%(cr)>

This reports the indicated flow value in percent of full scale flow units. If a lower case "f" is used for the command the percentage unit will not be transmitted.

Sensor Power Level Reading: (read only)

FR(cr) or *[aa]FR(cr)

Sample reply: .030231 W(cr)>

Read the output from the sensor in raw units (watts or counts). This is normally used only for troubleshooting or sensor analysis. The sensor power level should be near zero when no flow is present and be 0.02 – 0.04 watts when full scale flow is present.

Lock/Unlock: (write only)

FLOK ={code}(cr) or *[aa]FLOK ={code}(cr)

Sample reply: (cr)>

Certain data items, records and network commands have an access lock. The FLOK command opens or closes access to these. The list commands will respond with an abbreviated list until the instrument is unlocked. The full lists can be viewed in the lock state with the SFL command. Once the unlock command has been received the instrument will remain unlocked until either the FLOK command is received without the code or until the instrument is reset by either the reset switch or cycling the power.

Set State: (write only)

SS d(cr) or *[aa] SS d(cr) Note if setting to Cal state command must include calibration instance. SS 7 d

Sample reply: (cr)>

Sets the instrument to the desired state. Cal, Test & Tune states can only be set if the present state is Idle. If the instrument is setup to automatically drop from Idle to Operate, setting the state to 2 will automatically bring up state 4. See Section 1.1 Flow Instrument States for more information.

Value	State
1.	INIT.
2.	IDLE.
3.	reserved
4.	OPERATE
5.	ABORT
6.	SFAIL
7.	CAL
8.	TEST
9.	RECOVER
10.	TUNE

Stop Test: (write only)

TOFF(cr) or *[aa]TOFF(cr)

Sample reply: (cr)>

Stop test mode. Stops all active tests. Instrument remains in the test state. Unit must be in Test State (8) to accept this command. See Set State command above.

Set Output to Zero: (write only)

TDAO(cr) or *[aa]TDAO(cr)

Sample reply: (cr)>

Sets the analog output to the value that it would indicate for a flow rate of zero. Used for adjusting the analog output signal zero value. See DAC Zero Code (S51) in System Full List section below.

Unit must be in Test State (8) to accept this command. See Set State command above.

Set Output to Full Scale: (write only)

TDAS(cr) or *[aa]TDAS(cr)

Sample reply: (cr)>

Sets the analog output to the value that it would indicate for a flow rate of full scale. Used for adjusting the analog output signal to the full scale value. See DAC FS Code (S52) in System Full List section below.

Unit must be in Test State (8) to accept this command. See Set State command above.

Set Output to Minimum: (write only)

TDAZ(cr) or *[aa]TDAZ(cr)

Sample reply: (cr)>

Sets the analog output to the lowest possible value that it can. Used for troubleshooting the analog output circuit. Unit must be in Test State (8) to accept this command. See Set State command above.

List Gas Symbols: (read only)

LGSY(cr) or *[aa]LGSY {dd}(cr)

Sample reply: code 1: He (cr)>

Or

code 1: He

code 2: Ne

code 3: Rn

code 4: Ar

code 5: Kr

code 6: Xe

.....

Reports the Gas Symbol Information for the gas specified by the Gas standard code value. If the desired code is blank, the instrument will list all of the gas numbers and names. See Appendix for printed list.

List Engineering Units: (read only)

LUNT(cr) or *[aa]LUNT {dd}(cr)

Sample reply: code 1: std.liter/minute: SLM: 1 (cr)>

Or

code 0: std.cubic cm/minute: SCCM: 1000.

code 1: std.liter/minute: SLM: 1.

code 2: percent: %:

code 3: volt: V:

code 4: millivolt: MV:

code 5: counts: CNT:

.....

Reports the engineering unit information for the gas specified by the Gas standard code value. If the desired code is blank, the instrument will list all of the gas numbers and names. See Appendix for printed list.

4.3. Sensor List

S d [=n] Set/read system/sensor data items by item code d. The blank spaces are not necessary and are ignored. The commands may be received in upper case or lower case. In RS485 mode the “S” command must be preceded by an asterisk* and the address(macid).

S [d](cr) or *[aa]S [d](cr)

SL List all system/sensor data items, values and units. This list will be abbreviated to simplify normal instrument operation if the instrument has not been unlocked (See FLOK command above). Only items (1, 2, 5-10, 12, 14-18, 26-27, 36-37, 54, 56, 59, & 62-68) present in the simplified list are documented in this section. All items can be read with the SFL command or with the FL command after successful receipt of the FLOK command. The items that are not documented in this section are documented in the System Full List section below.

SL(cr) or *[aa]SL(cr)

Sensor Item List (SL)

item 1 :model

item 2 :mfm config

item 5 :macid

item 6 :active gas inst

item 7 :flow alarm enable

item 8 :flow alarm delay

item 9 :flow warn enable

item 10 :flow warn delay

item 12 :flowing hours

item 14 :precision

item 15 :total zero offset

item 16 :user zero offset

item 17 :autozero offset

item 18 :encdr zero offset

item 26 :A/D#0

item 27 :A/D#1

item 36 :ub sen cnvrt factor

item 37 :ub com cnvrt factor

item 54 :comment

item 56 :cal inst gas

item 59 :units symb

item 62 :cal date

item 63 :cal temp

item 64 :prod cfg

item 65 :nxtline

item 66 :prompt

item 67 :fact zero offset

item 68 :serial number

4.4. Sensor List by item number

item 1: model: (read only)

read S1(cr) or *[aa]S1(cr)

Sample reply: (s)DIGITAL(s)300(s)v1.4.6.1(cr)>

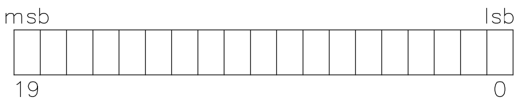
This identifies the instrument as a 300 series and gives the version of the firmware currently loaded into memory.

item 2: mfm config:

read S2(cr) or *[aa]S2(cr)

Sample reply: x2FC54(cr)>

write S2=xdddd(cr) or *[aa]S2=xdddd(cr)



The MFM Configuration Word selects or enables various instrument features as described below.

Settings are nonvolatile.

bit 19 (msb)-18: Unused
bit 17: Set to enable the Zero encoder
bit 16: Set to enable the Span encoder
bit 15 (msb): Set to enable high and low flow rate alarms, clear to disable.
bit 14: Set to enable high and low flow rate warnings, clear to disable.
bit 13: Set to enable AutoZero capability. Clear to disable. If set - Autozero action will rezero the instrument approximately 3 minutes after receiving a command to shut the valve.
bit 12: Set if instrument is to automatically enter OPERATE state after successfully entering IDLE state.
bit 11: Set to enable tracking error alarm, clear to disable. (Unused if MFC not configured).
bit 10: Set to enable tracking error warning, clear to disable. (Unused if MFC not configured).
bit 9: Set to enable prefixing of state mnemonic to network command prompt character
Mnemonics representing instrument state may be prefixed to command prompt character “>”
These are as follows:

SFAIL	Sensor or flow related failure
INIT	Initiate state (1)
CAL	Calibration state (7)
TEST	Test state (8)
IDLE	Idle state (no valve control) (2)
OPER	Operating state (4).
ABORT	Abort state (5)
RCVR	Recovering state (9)

bit 8: Set to append value units to command response strings irrespective of case letters in command line
bit 7: Set to prepend data item descriptions to command response strings
bit 6: Set to select output of bridge power difference values in watts, else clear to output in counts>>8.
bit 5: Set if user port CP1 is to echo received characters in non-addressed RS-232 and in RS-485 modes. (Port #0 always echoes). Echoing is disabled when in RS232 and RS485 network addressed modes (refer to section NETWORK COMMAND PORTS: Auto-Echo at User Port).
bit 4: Set if user port CP1 when in RS-485 mode will tristate transmit drive after last character transmitted until next. Used for electrical half-duplex and multidrop schemes. If cleared, RS485 transmit drive is always active.
bit 3: Reserved.
bits 2 - 0: Field specifies number of digits precision in floating point number output strings. (Minimum is 3, maximum is 7)

item 5: macid : (read only)

read S5(cr) or *[aa]S5(cr)

Sample reply: 11(cr)>

This provides the user with the current MAC ID. Address set by rotary switches on the top of instrument.

item 6: active gas inst:

read S6(cr) or *[aa]S6(cr)

Sample reply: 1(cr)>

write S6=d(cr) or *[aa]S6=d(cr)

This number reports which of the 10 available gas calibration records is currently active. Values from 0 – 9 are acceptable. Each gas record contains the conversion factors to change the measured flow rate from the flow units used internally to the engineering units desired by the customer. These are variables such as the reference temperature, volumetric or mass unit, time units, or flowing gas. If these are not filled out in the active record, then the flow meter will not be able to respond to a flow rate command.

A flow meter will have at least one record completed by Hastings when the instrument is shipped. Multiple records may be completed if calibrations for multiple gases or for different ranges or reference temperatures were ordered. Customers may create new records if desired. See the section on the gas list for information on each of the variables. The default gas record is 0.

item 7: flow alarm enable:

read S7(cr) or *[aa]S7(cr)

Sample reply: 1(cr)>

write S7=d(cr) or *[aa]S7=d(cr)

This is a binary value that when enabled it will allow flow values that exceed alarm limits for a time longer than specified by the flow alarm delay to set bit 15 or bit 14 of the alarm status word. Setting this bit also sets the bit 15 of the MFM config word (S2).

item 8: flow alarm delay:

read S8(cr) or *[aa]S8(cr)

Sample reply: 0(cr)>

write S8=dd.d(cr) or *[aa]S8=dd.d(cr)

This defines the length of time in seconds between the start of an error condition until the time it is reported by the status words.

item 9: flow warn enable:

read S9(cr) or *[aa]S9(cr)

Sample reply: 1(cr)>

write S9=dd.d(cr) or *[aa]S9=dd.dcr)

This is a binary value that when enabled it will allow flow values that exceed warning limits for a time longer than specified by the flow warn delay to set bit 15 or bit 14 of the warning status word. Setting this bit also sets the bit 14 of the MFM config word (S2).

item 10: flow warn delay:

read S10(cr) or *[aa]S10(cr)

Sample reply: 0(cr)>

write S10=dd.d(cr) or *[aa]S10=dd.d(cr)

This defines the length of time in seconds between the start of an error condition until the time it is reported by the warn status word. A setting of 0.00 will result in an immediate response.

item 12: flowing hours: (read only)

read S12(cr) or *[aa]S12(cr)

Sample reply: 49.96(s)H(cr)>

This defines the time that flow (>2%FS) has been passing through the instrument. This can be reset to 0. Useful for determining maintenance schedules.

item 14: precision:

read S14(cr) or *[aa]S14(cr)

Sample reply: 4(cr)>

write S14=d(cr) or *[aa]S14=d(cr)

This item controls the number of places after the decimal point that the output data will have. This can be any number from 0 – 8.

item 15: total zero offset: (read only)

read S15(cr) or *[aa]S15(cr)

Sample reply: -0.003957(s)W(cr)>

This is the differential power value that is subtracted from the sensor value to determine the zero flow value.

item 16: user zero offset:

read S16(cr) or *[aa]S16(cr)

Sample reply: -0.002217(s)W(cr)>

write S16=±dd.d(cr) or *[aa]S16=±d.dd(cr)

This item stores the value of the sensor offset voltage. This is the value of the sensor output when the flow is stopped. This offset is subtracted from the magnitude of the current sensor output to remove the effects of sensor internal non-symmetry. This value is typically between -0.3 and +0.3 volts.

This value can be written but it is normally controlled by the internal routines that handle the re-zero requests. When the processor receives a re-zero request via the “zro” command, from the internal switch or from the external remote zero lines the processor will read the current sensor value and store it in item 16.

item 17: autozero offset:

read S17(cr) or *[aa]S17(cr)

Sample reply: 0(s)W(cr)>

write S17=±d.d(cr) or *[aa]S17=±d.d(cr)

This value is updated every time an auto zero event occurs.

item 18: encdr zero offset:

read S18(cr) or *[aa]S18(cr)

Sample reply: 0(s)W(cr)>

write S18=±d.d(cr) or *[aa]S18=±d.d(cr)

This is used to re-zero the instrument from the rotary encoder.

item 26: A/D#0: (read only)

read S26(cr) or *[aa]S26(cr)

Sample reply: 1.817(s)V(cr)>

This item reports value of the analog signal that is being received on the set-point analog input lines. This analog input value is capability is also present in the flow meters but it is not interpreted as a set-point input for a control valve. This could be used to read the output signal from another remote sensor. This value will have the same range and units as the analog output signal from the flow meter.

item 27: A/D#1: (read only)

read S25(cr) or *[aa]S25(cr)

Sample reply: 0(s)V(cr)>

These are the values read on the 2 analog input pins. Typically the set point is on A/D #1.

item 36: ub sen cnvrt factor: (read only)

read S36(cr) or *[aa]S36(cr)

Sample reply: 0(s)V(cr)>

item 37: ub com cnvrt factor: (read only)

read S37(cr) or *[aa]S37(cr)

Sample reply: 5(s)V(cr)>

item 54: comment

read S54(cr) or *[aa]S54(cr)

Sample reply: "hello"(cr)>

write S54=a(cr) or *[aa]S54=a(cr)

This is space reserved for the customer. This could be used to provide a text message to identify instrument for users. 30 characters are available.

item 56: cal inst gas: (read only)

read S56(cr) or *[aa]S56(cr)

Sample reply: N2(cr)>

This is space reserved for the customer. This could be used to provide a text message to identify instrument for users. 30 characters are available

item 59: units symb: (read only)

read S59(cr) or *[aa]S59(cr)

Sample reply: SCCM(cr)>

This provides the user with the current unit symbol.

item 62: cal date:

read S62(cr) or *[aa]S62(cr)

Sample reply: 07/22/09(cr)>

This is the calibration date.

item 63: cal temp:

read S59(cr) or *[aa]S59(cr)

Sample reply: 22(cr)>

This is information about the active calibration temperature.

item 64: prod cfg:

read S64(cr) or *[aa]S64(cr)

Sample reply: x00(cr)>

This is hexadecimal information stored in the instrument after manufacture to tell the processor which of the various optional analog input or output configurations are installed in this particular instrument. The analog full scale value reported with the S11 command is generated from this list. **Do not change this value unless the I/O boards are being replaced.**

	S64	
Option	Meter	Controller
0-5 VDC	X00	X01
0-10 VDC	X02	X03
0-20 mA	X14	X15
4-20 mA	X1C	X1D
1-5 VDC	X08	X09

item 65: nxtline:

read S65(cr) or *[aa]S65(cr)

Sample reply: x0D000000(cr)>

write S65=x0A(cr) or *[aa]S65=x0A(cr) (change to linefeed)

This is the hexadecimal version of the ascii code for the character you will use to signal flow instrument that the transmission from the computer is complete instead of the normal carriage return(x0D). This could be a line feed (x0A) or other seldom used character such as >(x3E), <(x3C), #(x23) or ^(x5E). After this command is complete the flow instrument will only respond to commands that terminate with the newly specified character. I. E. to read item 65 the new command structure would appear as: write S65> or *[aa]S65> if x3E were chosen as the new terminator.

Be careful when choosing a new terminator to ensure that the software that is used to communicate with the instrument can generate the chosen character. Most terminal programs cannot generate most of the unprintable character ascii codes that are less than x20 (other than x0D and x0A) or greater than x7F. Routines written in Labview® or other programming environment can be set up to use these codes. If an instrument has been setup with a terminating character that cannot be generated locally there will be no way to communicate with the instrument to return the terminator to the original condition. The instrument would need to be returned to the factory for to reset this.

item 66: prompt:

read S66(cr) or *[aa]S66(cr)

Sample reply: x3E000000(cr)>

write S66=x0D0A3E(cr) or *[aa]S65=x0D0A3E(cr)

This is the hexadecimal representation of the ascii codes for the character string that the instrument will use to signal to the computer that it has ended its transmission. This string may be up to 11 characters long. The string format starts with an “x” to signal that the string is hexadecimal and it is followed by a series of pairs of hexadecimal digits. Each hexadecimal pair is the hexadecimal ascii code for a character to transmit as part of the “end of transmission” message.

The character sequence at the end of responses to network commands may be set as desired. System data items 65 and 66 allow users to define end-of-line and prompt strings.

Strings are entered and queried as hex values. Zero to four bytes are allowed. To enter zero bytes (eg., no string), use =x00;

Example newline entries are:

For carriage-return (default), enter “s 65 =x0d”.

For carriage-return linefeed, enter “s 65 =x0d0a” or “s 65 =x0a0d” as desired.

For “space space carriage-return” enter “s 65 =x20200d”

Example prompt entries are:

For a right arrow '>' use "s 66 =x3e"

For a dot (decimal point) '>' use "s 66 =x2e"

To make a "smiley face: prompt use "s 66 =x3a2d29".

Generally, the prompt string uses characters that will not appear in output strings so as to facilitate parsing of received data by the master controller.

Values may be entered as decimal rather than hex format. Refer to table of ASCII characters translated to hexadecimal values.

item 67: fact zero offset:

read S67(cr) or *[aa]S67(cr)

Sample reply: -0.00174(s)W(cr)>

This value is set at the factory.

item 68: serial number: Comply-3

read S68(cr) or *[aa]S68(cr)

Sample reply: (s)0000000000(cr)>

This provides the serial number for the particular instrument being used. This value must match the serial number printed on the label on the side of the instrument. Do Not Change This.

4.5. Gas List

There are provisions for 10 different sets of gas records in these flow instruments. At least one of them will be filled out and ready for use (record 0). Other records may be also filled out with alternative calibrations for use with other gases or flow units if multiple calibrations were requested on the original order. The Digital 300 recognizes one gas instance as the "active" gas instance, that instance is used for flow measurement and related functions. The sensor list command S6 (active gas inst) controls which record is "active". A subset of network commands for gas data access/control exists that operate upon the active gas instance; others require the target instance to be identified as a command argument. The zeroth instances are "factory default" and are "access locked" instances.

GIC i j Copy existing gas instance record (i) to another (j) by instance number. This is used to create new gas records for other ranges or for use with other gases. This is useful to create a new gas record that is similar to an existing record. The target record must have been previously deleted. If it does exist, send a delete command (GID i j) to delete it.

Gic [d] [d](cr) or *[aa]Gic [d] [d](cr)

GID i [u] Delete existing gas instance record by instance number. Deletion sets a bit within the record that marks it as "deleted". Deletion does not increase nor decrease the number of instance records available in nonvolatile memory. Deletion is useful for hiding records that are not to be used. Deleted status can be determined by querying any data item in the gas or cal instance. An error message "#014:ERR: INSTANCE INVALID OR DELETED" implies the instance is deleted. Gas record 0 is locked and cannot be deleted until it is unlocked. The active gas record cannot be deleted.

Optional char 'u' as second argument will undelete a record. (GID i u)

Gid [d](cr) or *[aa]Gid [d](cr)

G d [=n] Set/read gas/calibration data items from the active gas instance by item code d. The blank spaces are not necessary and are ignored. The commands may be received in upper case or lower case. In RS485 mode the "G" command must be preceded by an asterisk* and the address (macid). Gas record zero is locked to prevent accidental corruption.

G [d](cr) or *[aa]G [d](cr)

GL List all gas record data items, values and units for the active gas record

GL(cr) or *[aa]GL(cr)

Gi i d [=n] Set/read gas/calibration data items from a particular gas instance(i) by item code (d). A blank space between the gas instance number and the item number is necessary for separation. The commands may be received in upper case or lower case. In RS485 mode the "Gi" command must be preceded by an asterisk* and the address (macid). Gas record zero is locked to prevent accidental corruption.

Gi [d] [d](cr) or *[aa]Gi [d] [d](cr)

GIL i List all gas record data items, values and units for a particular gas record (i).

GIL [d](cr) or *[aa]GIL [d](cr)

Gas Item List (GL / GIL)

item 1 :gas instance
item 2 :instance mode
item 3 :gas code
item 4 :gas symbol
item 5 :units code
item 6 :units name
item 7 :units symb
item 8 :units ratio
item 9 :hi alarm limit
item 10:hi alarm limit
item 11:low alarm limit
item 12:low alarm limit
item 13:hi warn limit
item 14:hi warn limit
item 15:low warn limit
item 16:low warn limit
item 17:span corr factor
item 18:FS flow
item 19:cal inst
item 20:cal inst gas code
item 21:cal inst gas
item 22:cal inst FS flow
item 23:linz instance
item 24:linz coef 1
item 25:linz coef 2
item 26:linz coef 3
item 27:linz coef 4
item 28:linz coef 5
item 29:FS flow pwr diff
item 30:integrated flow
item 31:integrated flow
item 32:ready status
item 33:inst config
item 34:span encdr factor
item 35: gas rec ver

4.6. Gas List by item number

All commands are shown in the instance version. All commands will respond with the values for the currently active gas list if the "i" is dropped from the "Gi" command and the instance value is deleted. "Gi 1 1" becomes "G1"

item 1: gas instance: (read only)

read Gi[d]1(cr) or *[aa]Gi[d]1(cr)

Sample reply: 0(cr)>

This is the gas record number and the value that must be set in "s 6" to activate this particular record.

item 2: instance mode: (read only)

read Gi[d]2(cr) or *[aa]Gi[d]2(cr)

Sample reply: Ready(cr)>

"Ready" means this gas record may be used for normal operation. If not ready, Item 32 may be used to debug why.

item 3: gas code: (read only)

read Gi[d]3(cr) or *[aa]Gi[d]3(cr)

Sample reply: 13(cr)>

This is used to identify the gas for which this record is calibrated. This is only a text identifier and does not affect the calibration. Any identifier that is 9 characters or less may be used for gas identification.

item 4: gas symbol: (read only)

read Gi[d]4(cr) or *[aa]Gi[d]4(cr)

Sample reply: (s)N2(cr)>

This used to identify the gas for which this record is calibrated. This is only a text identifier and does not affect the calibration. Any identifier that is 9 characters or less may be used for gas identification.

item 5: units code: (read only)

read Gi[d]5(cr) or *[aa]Gi[d]5(cr)

Sample reply: 1(cr)>

This value refers to the specific unit code given in section 5.Appendix of this manual.

item 6: units name: (read only)

read Gi[d]6(cr) or *[aa]Gi[d]6(cr)

Sample reply: std.liter/minute(cr)>

This provides the user with the current unit name.

item 7: units symb: (read only)

read Gi[d]7(cr) or *[aa]Gi[d]7(cr)

Sample reply: (s)SLM(cr)>

This used to identify the flow unit for which this record is calibrated. This is only a text identifier and does not affect the calibration. Any identifier that is 9 characters or less may be used for engineering unit identification.

item 8: units ratio: (read only)

read Gi[d]8(cr) or *[aa]Gi[d]8(cr)

Sample reply: 1(cr)>

This is the engineering unit used to report the flow values and the ratio between the particular unit and a standard liter. These engineering units and their codes can be found in the appendix.

item 9: hi alarm limit: flow units (read only)

read Gi[d]9(cr) or *[aa]Gi[d]9(cr)

Sample reply: 27.31(s)SLM(cr)>

write Gi[d]9=[d.dd](cr) or *[aa]Gi[d]9=[d.dd](cr)

This value is the engineering units representation of the "hi alarm limit". Any flow above this value will set the high flow alarm bit in the status words.

item 10: hi alarm limit: % of full scale (read only)

read Gi[d]10(cr) or *[aa]Gi[d]10(cr)

Sample reply: 27.31%(cr)>

write Gi[d]10=[d.dd](cr) or *[aa]Gi[d]10=[d.dd](cr)

This value is the %FS representation of the "hi alarm limit". Any flow above this value will set the high flow alarm bit in the status words.

item 11: low alarm limit: flow units (read only)

read Gi[d]11(cr) or *[aa]Gi[d]11(cr)

Sample reply: 10(s)SLM(cr)>

write Gi[d]11=[d.dd](cr) or *[aa]Gi[d]11=[d.dd](cr)

This value is the flow units representation of the "low alarm limit". Any flow less than this value will set the low flow alarm bit in the status words.

item 12: low alarm limit: % of full scale (read only)

read Gi[d]12(cr) or *[aa]Gi[d]12(cr)

Sample reply: 10%(cr)>

write Gi[d]12=[d.dd](cr) or *[aa]Gi[d]12=[d.dd](cr)

This is the %FS representation of the "low alarm limit". Any flow less than this value will set the low flow alarm bit in the status words.

item 13: hi warn limit: flow units (read only)

read Gi[d]13(cr) or *[aa]Gi[d]13(cr)

Sample reply: 30.04(s)SLM(cr)>

write Gi[d]13=[d.dd](cr) or *[aa]Gi[d]13=[d.dd](cr)

This value is the flow units representation of the "hi warn limit". Any flow above this value will set the high flow warning bit in the status words.

item 14: hi warn limit: % of full scale (read only)

read Gi[d]14(cr) or *[aa]Gi[d]14(cr)

Sample reply: 30.04%(cr)>

write Gi[d]14=[d.dd](cr) or *[aa]Gi[d]14=[d.dd](cr)

This is the %FS representation of the "hi warn limit". Any flow above this value will set the high flow warning bit in the status words.

item 15: low warn limit: flow units (read only)

read Gi[d]15(cr) or *[aa]Gi[d]15(cr)

Sample reply: 10.91(s)SLM(cr)>

write Gi[d]15=[d.dd](cr) or *[aa]Gi[d]15=[d.dd](cr)

This value is the flow units representation of the "low warn limit". Any flow less than this value will set the high flow warning bit in the status words.

item 16: low warn limit: % of full scale (read only)

read Gi[d]16(cr) or *[aa]Gi[d]16(cr)

Sample reply: 10.91%(cr)>

write Gi[d]16=[d.dd](cr) or *[aa]Gi[d]16=[d.dd](cr)

This is the %FS representation of the "low warn limit". Any flow less than this value will set the low flow warning bit in the status words.

item 17: span corr factor:

read Gi[d]17(cr) or *[aa]Gi[d]17(cr)

Sample reply: 1(cr)>

write Gi[d]17=[d.dd](cr) or *[aa]Gi[d]17=[d.dd](cr)

This value is used to correct the indicated flow rate to the value on a reference flow meter. This value typically incorporates the differences between the gases, flow units and reference temperatures between the gas record and the Calibration record.

item 18: FS flow:

read Gi[d]18(cr) or *[aa]Gi[d]18(cr)

Sample reply: 100(cr)>

write Gi[d]18=[d.dd](cr) or *[aa]Gi[d]18=[d.dd](cr)

This unit is the full scale flow rate for the instrument in engineering units. Other gas records may be present in the same instrument with differing full scale values. This goes from 0-1.9.

item 19: cal inst:

read Gi[d]19(cr) or *[aa]Gi[d]19(cr)

Sample reply: 0(cr)>

write Gi[d]19=[d](cr) or *[aa]Gi[d]19=[d](cr)

This is the calibration record that this gas record is using, either a 0 or 1.

item 20: cal inst gas code: (read only) read Gi[d]20(cr) or *[aa]Gi[d]20(cr)

Sample reply: 13(cr)>

This value refers to the specific code number given to each gas. For code list, refer to section 6.Gas Data of this manual.

item 21: cal inst gas: (read only)

read Gi[d]21(cr) or *[aa]Gi[d]21(cr)

Sample reply: (s)N2(cr)>

This is the surrogate gas that was used during the linearization run.

item 22: cal inst FS flow: (read only)

read Gi[d]22(cr) or *[aa]Gi[d]22(cr)

Sample reply: 100(s)SLM(cr)>

This is the maximum flow for which the calibration data is valid.

item 23: linz instance:

read Gi[d]23(cr) or *[aa]Gi[d]23(cr)

Sample reply: 0(cr)>

write Gi[d]23=[d.dd](cr) or *[aa]Gi[d]23=[d.dd](cr)

This uses the coefficients of items 24-28 to compensate for non-linearization in the reported flow.

*****Items 24 – 28 are used to compensate for non-linearization in the reported flow.

item 24: linz coef 1: (read only)

read Gi[d]24(cr) or *[aa]Gi[d]24(cr)

Sample reply: 1(cr)>

item 25: linz coef 2: (read only)

read Gi[d]25(cr) or *[aa]Gi[d]25(cr)

Sample reply: 0(cr)>

item 26: linz coef 3: (read only)

read Gi[d]26(cr) or *[aa]Gi[d]26(cr)

Sample reply: 0(cr)>

item 27: linz coef 4: (read only)

read Gi[d]27(cr) or *[aa]Gi[d]27(cr)

Sample reply: 0(cr)>

item 28: linz coef 5: (read only)

read Gi[d]28(cr) or *[aa]Gi[d]28(cr)

Sample reply: 0(cr)>

This is the normalized linearizing polynomial values. See the zi command for more information.

item 29: FS flow pwr diff: (read only)

read Gi[d]29(cr) or *[aa]Gi[d]29(cr)

Sample reply: 0.03993(s)W(cr)>

This is the output of the sensor when the instrument is at the desired full scale flow.

item 30: integrated flow:

read Gi[d]30(cr) or *[aa]Gi[d]30(cr)

Sample reply: 0.005008(s)WH(cr)>

write G[d]30=[d.dd](cr) or *[aa]G[d]30=[d.dd](cr)

This is the amount of gas that has passed through the flow instrument since the last time that this value was reset. Reset this value by sending a "g 31 =0" command. This value is useful for measuring the total flow that used during a process or to fill a container and is given in watts.

item 31: integrated flow:

read Gi[d]31(cr) or *[aa]Gi[d]31(cr)

Sample reply: 753(s)SL(cr)>

write Gi[d]31=[d.dd](cr) or *[aa]Gi[d]31=[d.dd](cr)

This is the amount of gas that has passed through the flow instrument while the specified instance value was the active instance since the last time that this value was reset. Ensure the specified instance is the active instance or use the active gas record version of this command. "g31". Reset this value by sending a "g 31 =0" command. This value is useful for measuring the total flow that used during a process or to fill a container and is given in flow units.

item 32: ready status:

read Gi[d]32(cr) or *[aa]Gi[d]32(cr)

Sample reply: x1F(cr)>

write G[d]32=[x](cr) or *[aa]G[d]32=[x](cr)

The bit arrangement is as follows:

Bit 0 = Gas Code Valid

Bit 1 = Units Code Valid

Bit 2 = Full-Scale power difference valid

Bit 3 = Full-Scale flow valid

Bit 4 = Calibration Instance valid

Bit 7 = Gas record needs to be re-calculated

item 33: inst config: (read only)

read Gi[d]33(cr) or *[aa]Gi[d]33(cr)

Sample reply: x18(cr)>

write Gi[d]33=[x](cr) or *[aa]Gi[d]33=[x](cr)

Applicable outputs:

0x00 = Gas received

0x01 = Calibration received

0x02 = Sensor received

0x04 = Record is undergoing updates that, if not completed, may make data inconsistent.

0x08 = Factory access locked (ex. modifiable only with unlock)

0x10 = Factory default record (cannot be deleted)

0x80 = Record deleted

item 34: span encdr factor:

read Gi[d]34(cr) or *[aa]Gi[d]34(cr)

Sample reply: 1(cr)>

write G[d.dd]34=[d](cr) or *[aa]G[d]34=[d.dd](cr)

This value is adjusted simultaneously for all gas records when the span encoder on the top of the instrument is adjusted. Normally this should be 1 or very close to it. Certain spurious conditions have been known to set this value to ~ 0.06. Resetting this value back to 1 will return the instrument into operation.

item 35: gas rec ver: (read only)

read Gi[d]35(cr) or *[aa]Gi[d]35(cr)

Sample reply: 1(cr)>

User-assignable version# for tracking changes to the gas record. This is Information only.

4.7. Calibration List

There are provisions for 10 different sets of calibration records in these flow instruments. At least one of them will be filled out and ready for use (record 0). These records are created calibration flow data. Other records may be also filled out with alternative calibrations for use with other gases or flow units if multiple calibrations were requested on the original order. The gas list variable G19 (cal inst) controls which calibration record is used to generate flow information for a particular gas record. Each gas record could refer to a different calibration instance.

CIC i j Copy existing calibration instance record (i) to another (j) by instance number. The target instance (j) must have been previously deleted. If it does exist, send a delete command (GID i j) to delete it. This is used to create new calibration records for field calibration or for calibrations with other surrogate gases.

Cic [d] [d](cr) or *[aa]Cic [d] [d](cr)

CID i [u] Delete existing calibration instance record by instance number. Deletion sets a bit within the record that marks it as “deleted”. Deletion does not increase nor decrease the number of instance records available in nonvolatile memory. Deletion is useful for hiding records that are not to be used. Calibration record 0 is locked and cannot be deleted until it is unlocked. Any calibration record that is pointed to by a gas record cannot be deleted. Any calibration record that has the same record number as the active gas record cannot be deleted. An error message “#014:ERR: INSTANCE INVALID OR DELETED” implies the instance is deleted.

Optional char ‘u’ as second argument will undelete a record. (CID i u)

Cid [d](cr) or *[aa]Cid [d](cr)

Ci i d [=n] Set/read gas/calibration for instance “I” data items by item code d. A blank space is necessary between the instance code and the item code. Other blanks are ignored. The commands may be received in upper case or lower case. In RS485 mode the “Ci” command must be preceded by an asterisk* and the address (macid). There is no active calibration instance all calibration value accesses must use an instance number.

Ci[i] [d](cr) or *[aa]Ci[i] [d](cr)

CiI [i] List all gas record data items, values and units for instance “I”

GL(cr) or *[aa]CiI [i](cr)

>cil 0

4.8. Calibration List by item number

item 1: cal inst: (read only)

read Ci[d](s)1(cr) or *[aa]Ci[d](s)1(cr)

Sample reply: 1(cr)>

This is the calibration instance that gas records should use in "g 19".

Calibration list (CIL)

item 1 :cal inst
item 2 :instance mode
item 3 :comment
item 4 :gas code
item 5 :gas symbol
item 6 :units code
item 7 :units name
item 8 :units symb
item 9 :units ratio
item 10:span corr factor
item 11:FS flow
item 12:linz instance
item 13:linz coef 1
item 14:linz coef 2
item 15:linz coef 3
item 16:linz coef 4
item 17:linz coef 5
item 18:cal date
item 19:cal temp
item 20:FS flow pwr diff
item 21:ready status
item 22:inst config
item 23:cal rec ver

item 2: instance mode: (read only)

read Ci[d](s)2(cr) or *[aa]Ci[d](s)2(cr)

Sample reply: Ready(cr)>

"Ready" means this gas record may be used for normal operation. If not ready, Item 32 may be used to debug why.

item 3: comment: (read only)

read Ci[d](s)3(cr) or *[aa]Ci[d](s)3(cr)

Sample reply: (s)"hello"(cr)>

This is space reserved for the customer. This could be used to provide a text message to identify instrument for users. 30 characters are available.

item 4: gas code: (read only)

read Ci[d](s)4(cr) or *[aa]Ci[d](s)4(cr)

Sample reply: 13(cr)>

This is used to identify the gas for which this record is calibrated. This is only a text identifier and does not affect the calibration. Any identifier that is 9 characters or less may be used for gas identification.

item 5: gas symbol: (read only)

read Ci[d](s)5(cr) or *[aa]Ci[d](s)5(cr)

Sample reply: (s)N2(cr)>

This used to identify the gas for which this record is calibrated. This is only a text identifier and does not affect the calibration. Any identifier that is 9 characters or less may be used for gas identification.

item 6: units code: (read only)

read Ci[d](s)6(cr) or *[aa]Ci[d](s)6(cr)

Sample reply: 1(cr)>

item 7: units name: (read only)

read Ci[d](s)7(cr) or *[aa]Ci[d](s)7(cr)

Sample reply: std.liter/minute(cr)>

item 8: units symb: (read only)

read Ci[d](s)8(cr) or *[aa]Ci[d](s)8(cr)

Sample reply: (s)SLM(cr)>

This is the engineering units that were used during the calibration. See appendix for unit codes.

item 9: units ratio: (read only)

read Ci[d](s)9(cr) or *[aa]Ci[d](s)9(cr)

Sample reply: 1(cr)>

This provides the ratio between the calibration units and standard liters.

item 10: span corr factor: (read only)

read Ci[d](s)10(cr) or *[aa]Ci[d](s)10(cr)

Sample reply: 1(cr)>

This should always be 1.

item 11: FS flow: (read only)

read Ci[d](s)11(cr) or *[aa]Ci[d](s)11(cr)

Sample reply: 100(cr)>

This provides the maximum flow for which the calibration data is valid.

item 12: linz instance: (read only)

read Ci[d](s)12(cr) or *[aa]Ci[d](s)12(cr)

Sample reply: 9.997559%(cr)>

write Ci12= or *[aa]Ci12=

This uses the coefficients of items 13-16 to compensate for non-linearization in the reported flow.

*****Items 13 – 16 are used to compensate for non-linearization in the reported flow.

item 13: linz coef 1: (read only)

read Ci[d](s)13(cr) or *[aa]Ci[d](s)13(cr)

Sample reply: 1(cr)>

item 14: linz coef 2: (read only)

read Ci[d](s)14(cr) or *[aa]Ci[d](s)14(cr)

Sample reply: 0(cr)>

item 15: linz coef 3: (read only)

read Ci[d](s)15(cr) or *[aa]Ci[d](s)15(cr)

Sample reply: 0(cr)>

item 16: linz coef 4: (read only)

read Ci[d](s)16(cr) or *[aa]Ci[d](s)16(cr)

Sample reply: 0(cr)>

item 17: linz coef 5: (read only)

read Ci[d](s)17(cr) or *[aa]Ci[d](s)17(cr)

Sample reply: 0(cr)>

The normalized linearizing polynomial values. See the zi command for more information.

item 18: cal date: (read only)

read Ci[d](s)18(cr) or *[aa]Ci[d](s)18(cr)

Sample reply: (s)"06/103(cr)>

The date the calibration run was performed.

item 19: cal temp: (read only)

read Ci[d](s)19(cr) or *[aa]Ci[d](s)19(cr)

Sample reply: 0(cr)>

This is the reference temperature for the standard volumetric flow unit used during the calibration.

item 20: flow pwr diff: (read only)

read Ci[d](s)20(cr) or *[aa]Ci[d](s)20(cr)

Sample reply: 0.03993(cr)>

This is the sensor output signal for the maximum flow. This should be 0.040 watts

item 21: ready status: (read only)

read Ci[d](s)21(cr) or *[aa]Ci[d](s)21(cr)

Sample reply: x1F(cr)>

The bit arrangement is as follows:

Bit 0 = Gas Code Valid

Bit 1 = Units Code Valid

Bit 2 = Full-Scale power difference valid

Bit 3 = Full-Scale flow valid

Bit 4 = Calibration Instance valid

Bit 7 = Cal record needs to be re-calculated

item 22: inst config: (read only)

read Ci[d](s)22(cr) or *[aa]Ci[d](s)22(cr)

Sample reply: x01(cr)>

Applicable outputs:

0x00 = Gas received

0x01 = Calibration received

0x02 = Sensor received

0x04 = Record is undergoing updates that, if not completed, may make data inconsistent.

0x08 = Factory access locked (ex. modifiable only with unlock)

0x10 = Factory default record (cannot be deleted)

0x80 = Record deleted

item 23: cal rec ver: (read only)

read Ci[d](s)23(cr) or *[aa]Ci[d](s)23(cr)

Sample reply: 1(cr)>

User-assignable version# for tracking changes to the cal record. This is Information only.

4.9. Valve List (Controller versions only)

V d [=n] Set/read flow control data items by item code d. The blank spaces are not necessary and are ignored. The commands may be received in upper case or lower case. In RS485 mode the "S" command must be preceded by an asterisk* and the address (macid).

V [d](cr) or *[aa]V [d](cr)

VL List all valve control data items, values and units

VL(cr) or *[aa]VL(cr)

Valve item number list (VL)

item 1: MFC mode
item 2: MFC config
item 3: valve posn
item 4: netwk setpt
item 5: netwk setpt
item 6: cmmd setpt
item 7: cmmd setpt
item 8: impl setpt
item 9: impl setpt
item 10: cntrlld var
item 11: cntrlld var
item 12: softstart type
item 13: softstart value
item 14: trckg error
item 15: trckg error
item 16: trckg alarm limit
item 17: trckg alarm limit
item 18: trckg alarm enable
item 19: trckg alarm delay
item 20: trckg warn limit
item 21: trckg warn limit
item 22: trckg warn enable
item 23: trckg warn delay
item 24: PID propor coeff
item 25: PID rate coeff
item 26: PID intg coeff
item 27: valve drive
item 28: valve set
item 29: valve crackg
item 30: valve shut
item 31: valve lim
item 32: MFC intgratr

4.10. Valve List by item number

item 1: MFC mode:

read V1(cr) or *[aa]V1(cr)

Sample reply: 1(cr)>

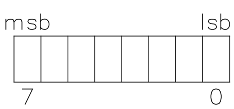
write V1= d(cr) or *[aa]V1= d(cr)

(Data item "V 1" "MFC mode")

Note: Available only if instrument has flow control option)

The MFC Mode Word stores the network commanded MFC mode, and is set by command "V 1". It is user-writeable and nonvolatile (if instrument resets from ERROR or HOLD modes, MFC MODE will be forced to DEFAULT).

Do not confuse the MFC Mode Word with the Valve Status Word



0: DEFAULT mode. Valve is set into the user default position as specified in MFCMODE_VALVEDEF. Automatic closed-loop action is disabled.

1: AUTO Automatic closed-loop operation is enabled. Valve position is controlled to maintain flow at the implemented setpoint.

2: HOLD Automatic closed-loop operation is suspended. Valve drive is maintained constant. Can be set only from AUTO mode while in OPERATE state. If instrument is reset or repowered while in HOLD mode, valve position will revert to the user defined default position.

3: SHUT Valve is set to the shut position. Automatic closed-loop operation is disabled.

4: PURGE Valve is set to the full-open position. Automatic closed-loop operation is disabled.

5: VARIABLE (or "manual") Valve drive is controlled by network command ("V 28"), or by analog voltage input as chosen in the MFC (Flow Controller) Configuration Word (Data item "V 2"). Automatic closed-loop operation is disabled.

6: ERROR Valve is set into the user default position as specified in MFCMODE_VALVEDEF. Automatic closed-loop action is disabled. If instrument is reset or repowered while in ERROR mode, MFC mode will become DEFAULT and valve position will revert to the user defined default position. The ERROR mode may be set by internal detection of an error condition, or by network command. Once set, the ERROR mode is maintained until changed by user. These operations are not intended as a safety feature.

item 2: MFC config:

read V2(cr) or *[aa]V2(cr)

Sample reply: x0041(cr)>

write V2= xdddd(cr) or *[aa]V2= xdddd(cr)

This controls the source of the command signal.

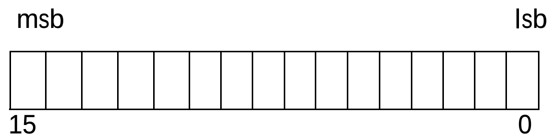
X0041 = Digital control

X0081 = Analog Control

(Data item "V 2" "MFC config")

Note: Available only if instrument has flow control option.

The MFC Configuration word stores user settings that establish the features and behavior of the flow controller, and is set by network command "V 2". It is user-writeable and nonvolatile.



bits 15(msb) to 9; reserved, unused

bit 8: One bit field controls automatic valve shutoff threshold. Setting bit to 1 disables the 1% threshold for automatic valve shutoff when the implemented setpoint is 1% or less.

When this bit is clear (0) the instrument will interpret any command of less than 1% of full scale to be a command to close the valve.

If this bit is set (1) the instrument will control flows down to 0% Full scale. Command signals that are identically = 0% or less will activate the close valve control..
Flow totalizer threshold action is not affected.

bits 7(msb), 6: Field of two bits selects source of command setpoint:

00 = invalid assignment, choice will be forced to default (network)
01 = command setpoint taken from network command
10 = command setpoint taken from A/D converter #1
11 = invalid assignment, choice will be forced to default (network)

bits 5,4: Field of two bits selects source of controlled variable:

00 = Controlled variable taken MFM sensor flow value
01 = Controlled variable taken from A/D converter #0
10 = Controlled variable taken from A/D converter #1
11 = undefined

bits 3,2: Field of two bits selects source of valve override command:

00 = no valve override except powerup default, on error and by network command
01 = valve override from A/D converter #0
10 = valve override from A/D converter #1
11 = undefined

bit 1: Set if valve powerup and error default is PURGE.
Clear if valve powerup and error default is SHUT.

bit 0 (lsb): Set if derivative (rate) term in feedback control loop is taken as the derivative of tracking error (controlled variable minus implemented setpoint.
Clear if derivative (rate) term in feedback control loop is taken as the derivative of controlled variable.
A change in this selection will not be bump less.

item 3: valve posn: (read only)

read V3(cr) or *[aa]V3(cr)

Sample reply: x12(cr)>

Read only indicator of valve control status.

(Data item "V 3" "valve posn:")

Note: Available only if instrument has flow control option)

This data item is controlled indirectly by the MFC (Flow Controller) Mode Word (data item "V 1")

Bits 7 - 4: (upper 4 bit field)

0x10 SHUT. Valve forced closed (no current). Automatic re-zeroing can be enabled in this circumstance.

0x20 PURGE. Valve forced 100% open (max current per data item "V 31" valve lim:)

0x30 HOLD. Valve current held at last auto mode value. This condition can only be entered by transition from a prior automatic control mode.). Automatic rezeroing can be enabled in this circumstance.

0x40 MANUAL. Valve current is non-zero, and may be in the range from closed to max open (max current per data item "V 31") as commanded by analog input from A/D or by network command "V 28 =nnnn" to program valve current per data item 28:valve set:. Automatic closed loop control is disabled. Automatic rezeroing will not be enabled.

0x50 AUTO. Valve operating under automatic closed loop control.

bit 3: Bit set only when soft-start behavior is permitted (but not necessarily in effect). Valve Position Word must be = CONTROL. Soft start may be disabled when implemented setpoint less than 1%, but this bit will remain set in that circumstance.

bit 2: Bit set when A/D# 0 input above 5 volts and valve override enabled per bits 2 and 3 of the MFC Configuration word (Data item "V 2" "MFC config:"). Valve will be overridden into SHUT position when operating under automatic closed loop control (when bits field 4-7 above = AUTO) . Automatic rezeroing can be enabled in this circumstance

bit 1: Bit set when implemented setpoint is at or below the Valve Shutdown Threshold (1.00% or 0.00%, or similar if A/D is setpoint source). Valve will be overridden into SHUT position when operating under automatic closed loop control (when bits field 4-7 above = AUTO). Automatic rezeroing can be enabled in this circumstance.

bit 0(lsb): Bit set when A/D# 0 input below 1 volt and valve override enabled per bits 2 and 3 of the MFC Configuration word (Data item "V 2" "MFC config:"). Valve will be overridden into SHUT position when operating under automatic closed loop control (when bits field 4-7 above = AUTO). Automatic rezeroing can be enabled in this circumstance.

item 4: netwk setpt: flow units

read V4(cr) or *[aa]V4(cr)

Sample reply: 9.37(s)SLM(cr)>

write V4=d.dd (cr) or *[aa]V4=d.dd (cr)

This is the value of the setpoint that was received digitally. This item configures or reports the setpoint in the flow units chosen in the active gas record. Writing to this item will affect the value reported back by V5 below. The flow controller will increase or decrease the valve opening until the flow reading equals this desired flow value. The value received here is ignored if V2 is set for analog control.

item 5: netwk setpt: % of full scale

read V5(cr) or *[aa]V5(cr)

Sample reply: 9.37%(cr)>

write V5=d.dd(cr) or *[aa]V5=d.dd(cr)

This is the last digital command that was received in either engineering units or % of Full scale. A change to these values will change the flow controller set point when the MFC Configuration word is set for digital control. “v 5 =100” will change the flow to 100%.

item 6: cmmd setpt: flow units (read only)

read V6(cr) or *[aa]V6(cr)

Sample reply: 9.37(s)SLM(cr)>

This value is the flow units representation of the “cmmd setpt”. These values are read only and correspond to the current set point plus any modification to allow soft-start control changes.

item 7: cmmd setpt: % of full scale

read V7(cr) or *[aa]V7(cr)

Sample reply: 9.37%(cr)>

This value is the %FS representation of the “cmmd setpt”. These values are read only and correspond to the current set point plus any modification to allow soft-start control changes.

item 8: impl setpt: flow units read only

read V8(cr) or *[aa]V8(cr)

Sample reply: 9.37(s)SLM(cr)>

This is the flow setpoint value that the controller is trying to implement. This may be the analog setpoint, the digital setpoint or some other value such as 0.00 if the valve is in shutdown mode. The command source is controlled by the values stored in V1 and V2. This item configures or reports the setpoint in the flow units chosen in the active gas record.

item 9: impl setpt: % of full scale (read only)

read V9(cr) or *[aa]V9(cr)

Sample reply: 9.37%(cr)>

These values are the set point that is being used to control the flow. They will correspond to the Digital or Analog set point depending on the condition of the MFC Configuration word.

item 10: cntrlld var: % of full scale (read only)

read V10(cr) or *[aa]V10(cr)

Sample reply: 200%(cr)>

This is the current value of the system parameter that is being controlled by the valve. In a flow controller this is the current flow reading. This item reports the flow as a % of the full scale flow value listed in the active gas record.

item 11: cntrlld var: flow units (read only)

read V11(cr) or *[aa]V11(cr)

Sample reply: 200(s)SLM(cr)>

This is the current value of the system parameter that is being controlled by the valve. Typically this is the current flow reading but it could be an analog value on A/D#0 or A/D#1 if an external system parameter such as pressure is being controlled.

item 12: softstart type:

read V12(cr) or *[aa]V12(cr)

Sample reply: 0(cr)>

write V12= d(cr) or *[aa]V12=d(cr)

This is the type of soft start that is active.

item 13: softstart value:

read V13(cr) or *[aa]V13(cr)

Sample reply: 100(cr)>

write V13=ddd(cr) or *[aa]V13=ddd(cr)

Decreasing this value will speed up the response of the system to changes in the command signal. Increasing it will slow down the command ramp to minimize overshoot. The number ranges from 0-100 decimal.

item 14: trckg error: flow units (read only)

read V14(cr) or *[aa]V14(cr)

Sample reply: 190.6(s)SLM(cr)>

This is the error between the desired flow (setpoint command) and the actual indicated flow reported in the flow units chosen in the active gas record (G7). It is normal for significant errors to occur for a short time immediately after a change in the setpoint due to the time it takes to move the valve to a new stable position. This error should decrease over time and approach a very small value. A large error that persists for a significant amount of time after a change in the command signal is an indication of a failure in the system. Typically, this is caused by insufficient pressure for the requested flow or a failed valve.

item 15: trckg error: % of full scale (read only)

read V15(cr) or *[aa]V15(cr)

Sample reply: 190.6%*X(cr)>

This is the error between the command signal and the process variable. Read only. A large error that persists a significant amount of time after changes in the command signal are indications of failures in the system. Typically, this is cause by insufficient pressure for the requested flow or a failed valve.

item 16: trckg alarm limit: flow units

read V16(cr) or *[aa]V16(cr)

Sample reply: 0.2686(s)SLM(cr)>

write V4= ddd(cr) or *[aa]V4= ddd(cr)

This is the flow units representation of the “trckg alarm limit”. When enabled, tracking errors above this settable value that persist longer than the tracking alarm delay will set the tracking alarm bit in the Alarm Word.

item 17: trckg alarm limit: % of full scale

read V17(cr) or *[aa]V17(cr)

Sample reply: 0.2686%(cr)>

write V17= d.dd(cr) or *[aa]V17= d.dd(cr)

This is the %FS representation of the “trckg alarm limit”. When enabled, tracking errors above this settable value that persist longer than the tracking alarm delay will set the tracking alarm bit in the Alarm Word.

item 18: trckg alm enable:

read V18(cr) or *[aa]V18(cr)

Sample reply: 1(cr)>

write V18= d(cr) or *[aa]V17= d(cr)

Clearing this bit will disable tracking errors from setting bits in the Alarm word.

item 19: trckg alarm delay:

read V19(cr) or *[aa]V19(cr)

Sample reply: 0.2(s)S(cr)>

write V19= 2.0(cr) or *[aa]V19= 2.0(cr)

This is the amount of time that must occur after a tracking error exceeds the alarm setpoint before an alarm is activated. This will allow the valve to stabilize after changes in command without triggering the alarm.

item 20: trckg warn limit: flow units

read V20(cr) or *[aa]V20(cr)

Sample reply: 1.361(s)SLM(cr)>

write V20=d.dd(cr) or *[aa]V20=d.dd(cr)

If the tracking warning enable is set (V22) and the tracking error remains above this limit for longer than the time specified by the tracking warning delay (V23) the tracking warning bit will be set in the warning status word. Writing to this item will affect the value reported back by V21 below.

item 21: trckg warn limit: % of full scale

read V21(cr) or *[aa]V21(cr)

Sample reply: 1.361%(cr)>

write V21=d.dd(cr) or *[aa]V21=d.dd(cr)

When enabled, tracking errors above this settable value that persist longer than the tracking warning delay will set the tracking alarm bit in the Warning Word.

item 22: trckg warn enable:

read V22(cr) or *[aa]V22(cr)

Sample reply: 1(cr)>

write V22= 0(cr) or *[aa]V22= 0(cr)

Clearing this bit will disable tracking errors from setting bits in the Warning word.

item 23: trckg warn delay:

read V23(cr) or *[aa]V23(cr)

Sample reply: 2(s)S(cr)>

write V23=dd(cr) *[aa]V23=dd(cr)

This is the amount of time that must occur after a tracking error exceeds the warning setpoint before an alarm is activated. This will allow the valve to stabilize after changes in command without triggering the warning.

item 24: PID propor coeff:

read V24(cr) or *[aa]V24(cr)

Sample reply: 50(cr)>

write V24=dddd or *[aa]V24=dddd

This is the PID gain/proportional value. Increasing this value will increase the instantaneous response of the loop to changes in the command signal. Increasing this too much will create valve instabilities. Decreasing this will tend to stabilize unstable control loops.

item 25: PID rate coeff:

read V25(cr) or *[aa]V25(cr)

Sample reply: 500(cr)>

write V25=dddd(cr) or *[aa]V25=dddd(cr)

This is the PID differential/rate term. It changes the valve drive when there are large changes in the setpoint or the process variable. Typically this does not have a primary effect, however if this value gets too large the valve will drop into a high frequency oscillation.

item 26: PID intg coeff:

read V26(cr) or *[aa]V26(cr)

Sample reply: 200(cr)>

write V26=dddd or *[aa]V26=dddd

This is the PID integration/reset term. This value integrates the error between the desired process variable and the indicated variable and increases or decreases the valve drive to attempt to bring this integrated error value to zero. A larger value shortens the integration time and speeds up system response. If the value gets too large the system will oscillate. Lower values will slow down system response. A properly functioning controller in a system with adequate flow channels should not require a value lower than 50 for stability.

item 27: valve drive: (read only)

read V27(cr) or *[aa]V27(cr)

Sample reply: 0(cr)>

This is a read only value between 8 and 40000 that correspond to valve drive voltages between 0 – 24 volts.

item 28: valve set:

read V28(cr) or *[aa]V28(cr)

Sample reply: 14000(cr)>

write V28=ddddd(cr) or *[aa]V28=ddddd(cr)

This is the value that may be set between 0 - 64000 to set the pulse width modulator voltage whenever the controller has been set variable/manual control by the MFC Mode word.

item 29: valve crackg: (read only)

read V29(cr) or *[aa]V29(cr)

Sample reply: 16000(cr)>

This is the integer value between 0 – 64000 (typically around 30000) required to set the pulse width modulator voltage equal to the 2 volt reference signal that corresponds to zero flow.

item 30: valve shut: (read only)

read V30(cr) or *[aa]V30(cr)

Sample reply: 0(cr)>

This informs the user the valve is fully shut.

item 31: valve lim: (read only)

read V31(cr) or *[aa]V31(cr)

Sample reply: 40000(cr)>

This is the integer value between 0 – 64000 (typically around 43000) required to set the pulse width modulator voltage equal to the full scale flow value listed in the active gas record.

item 32: MFC intgratr: (read only)

read V32(cr) or *[aa]V32(cr)

Sample reply: 2454453(cr)>

This value is for factory use only.

4.11.Polynomial List

There are provisions for 10 different sets of 5th order polynomial coefficients for linearization of in these flow instruments. Linearization instance 0 is locked to prevent accidental corruption. Each instance has 5 values (numbered 1 – 5) that correspond to the coefficients of a 5th order normalized polynomial. Each polynomial has had the offset value removed and each value normalized by dividing by the sum of all of the coefficients. The indicated flow reading is corrected for known errors using a set of these polynomials. The current sensor power (as reported by the FR command) is divided by the full scale power (reported by item 20 of the cal instance). This ratio (P) is mapped by the active polynomial (z1 – z5) into a corrected indicated flow rate (F) as a percentage of calibration instance flow (item 11 of the active cal instance). $F = z1*P + z2*P^2 + z3*P^3 + z4*P^4 + z5*P^5$

Typically record 0 is set to be a straight linear pass-through of the indicated flow. This will have values of 1,0,0,0,0 for the 5 coefficients and is used during a coefficient derivation calibration to determine the values that will correct for system non-linearities. Normally record 1 will be used by the active gas record to correct for measured non-linearities. Multiple polynomials may be present, if multiple calibrations have been performed on the instrument using different calibration gases. Item 23 of the gas record will indicate which polynomial is currently active and items 24 – 28 will list all of coefficients of the active polynomial.

zil [d] List all polynomial coefficients for instance "i".

zil [d](cr) or *[aa]ZIL [d](cr)

linz coef 1: 1.050972

linz coef 2: -0.1380501

linz coef 3: 0.1573215

linz coef 4: -0.0702436

linz coef 5: 0

Polynomial Coefficient:

read Zi[i] [d](cr) or *[aa]Zi[i] [d](cr)

Sample reply: 1.050972(cr)>

write Zi[i] [d]= d(cr) or *[aa]Zi[i] [d]= d(cr)

Set/read polynomial coefficients for instance "i" by item code d. A blank space is necessary between the instance code and the item code. Other blanks are ignored. The commands may be received in upper case or lower case. In RS485 mode the "zi" command must be preceded by an asterisk* and the address (macid).

Example

Zi 2 1 =1 set x coefficient of second set of coefficients to 1
Zi 2 2 =0 x2 coefficient of second set of coefficients to 0
Zi 2 3 =0 x3 coefficient of second set of coefficients to 0
Zi 2 4 =0 x4 coefficient of second set of coefficients to 0
Zi 2 5 =0 x5 coefficient of second set of coefficients to 0

This is the equation of a straight line and is linearization set that must be used in an initial calibration run to collect the data to generate a new set of linearization values that would be used to correct the errors for this particular gas and flow.

4.12.Mode List (Status and Alarms)

See the information on the ML command and the alarms and status section for more information on these.

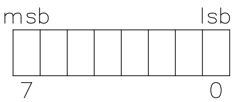
ML List all values individually accessible from the MS, MSC, MA, MAA, MF, MFA, MW and MWA commands

ML(cr) or *[aa]ML(cr)

Mode List (ML)
state: 2
mfm status: x0080
alarms: x0000
unacked alarms: x0000
flow status: x0001
unacked flow status: x0001
warnings: x0004
unacked warnings: x0004

4.13.MFM STATE WORD

The MFM State Word is queried by network command "MS". It is read-only and cannot be changed directly by network command; rather, the "SS n" command is used to request (if permissible) a desired state. Cal, Test & Tune states can only be set if the present state is Idle. If the instrument is setup to automatically drop from Idle to Operate, setting the state to 2 will automatically bring up state 4.
Refer to sections "SS" Set State Command" and "Automatic OPERATE Mode" for further information.

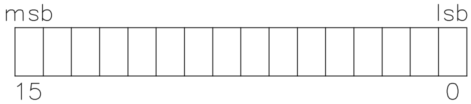


This byte-wide value is set to one of ten values indicating the instrument major state as follows:

Value	State	State Attributes
1	INIT	Initialization in progress, disables auto flow control, disables MFM alarms. This clears all alarms when beginning INIT state.
2	IDLE	MFM alarms are cleared and disabled (certain alarms such as instrument failures are not cleared and remain enabled). Indicated flow values are available. Flow totalizing is disabled. MFC flow control stopped, valve goes to user-defined default position. Many configuration commands are only allowed in the IDLE state
3	RESERVED	
4	OPERATE	Executing; MFM and MFC alarms and flow totalizing are enabled. Automatic flow control enabled if otherwise permitted.
5	ABORT	Network command sets ABORT state to permit diagnosis and recovery commands to be entered if/as necessary before restoring instrument to IDLE, OPERATE or INIT state. MFC flow control stopped, valve set to user-defined default position.
6	SFAIL	Recoverable error detected such as critical data not set, missing, or out of range. Reset using power down, the reset button, or setting state to INIT (=1) are the only escapes.
7	CAL	Calibration state disables auto flow control, clears and disables MFM and MFC alarms. Network commands to perform flow calibration are permitted.
8	TEST	Network commands to perform certain tests are permitted. May disable alarms, may disable auto flow control, depending upon specific test invoked. Tests in TEST state are generally factory-only.
9	RECOVER	Setting RECOVER state while in ABORT state initiates return to IDLE state.
10	TUNE	Network command to perform certain flow and flow control tests are permitted. May disable alarms, may disable auto flow control, depending upon specific test invoked.

4.14.MFM STATUS WORD

The MFM Status Word is queried by network command "MSC". It is read-only and cannot be changed by network command.



bit 15(msb): Set when flow rate > 1% of full scale.

bit 14 – 13: Reserved.

bit 12: Set if detected flow measurement error. Use this for summarized queries, use bits in alarm flags and flow status for details. (inclusive OR of bits in flow status word) This flag is not latched/retained.

bit 11: Set if a flow measurement error is detected. Inclusive-OR summary of bits in flow status

bit 10: Set if a flow measurement error has not been acknowledged. Inclusive-OR summary of bits in flowstatus

bit 9: Set if a flow alarm has been triggered. Inclusive-OR summary of bits in alarm flags

bit 8: Set if a flow alarm has not been acknowledged. Inclusive-OR summary of acknowledge bits in alarm flags

bit 7: Set if a flow warning has been triggered. Inclusive-OR summary of warning flags bits

bit 6: Set if a flow warning has not been acknowledged. Inclusive-OR summary of acknowledge bits in warning flags.

bit 5: Set if periodic autorezeroing is presently active.

bit 4: Set or cleared when the ABORT state is asserted so as to indicate the subsequent action when the RECOVER state is asserted. If set, RECOVER state will cause a transition to the OPERATE state. If clear, RECOVER state will cause a transition to the IDLE state

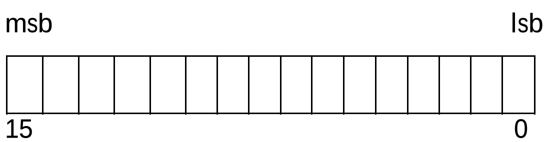
bit 3: Set if unit is allowed to respond to addressed network commands (eg., "*nn" as first three characters of command string), If clear, addressed network commands are not supported, and if used will return an error.

bit 2: Set while ZRO and FZRO commands are in process, or when automatic periodic zeroing is active measuring and computing a new offset (latter condition lasts about 35 milliseconds). See bit 2 for flag that indicates when periodic autorezeroing is enabled

bit 1 - 0(lsb): Reserved

4.15. ALARMS STATUS WORD

Read using MA network command. It is read-only and cannot be changed by network command.



bit 15(msb): Set if flow above high alarm limit. Only set when MFM state = OPERATE, cleared when not OPERATE.

bit 14: Set if flow below alarm limit. Only set when MFM state = OPERATE, cleared when not OPERATE.

bit 13: Set if indicated flow reading invalid. (Examine flow status). Only set when MFM state = OPERATE, cleared when not OPERATE.

bit 12: Set if sensor failure detected. Set in any MFM state.

bit 11: Reserved

bit 10: Set if CPU powerup restart or a network command initiated the INIT state. Remains set for duration of INIT state. Cleared at end of INIT state, but corresponding bit in ALARMS ACKNOWLEDGE WORD persists set until cleared by network command (Check Acknowledged

Alarm Status). This action allows users to detect re-initialization even if state or alarm status is not polled timely during the INIT state.

bit 9: Set if MFC flow control failure detected. (Only set when MFM state = OPERATE and MFC mode = AUTO. On occurrence, the MFC mode is automatically disabled by setting to ERROR). This flag will be cleared when MFM state is changed out of OPERATE, except if MFM state is changed to ABORT or to TEST in order that the error flag will persist for post-error detection . Subsequent setting of MFM state to RECOVER will clear all alarm flags. Unused if MFC not configured.

bit 8: Set if tracking error (indicated flow minus implemented setpoint) exceeds tracking error alarm limit. (Only set when MFM state = OPERATE and MFC mode = AUTO.).

Unused if MFC not configured.

bit 7: Reserved

bit 6: Reserved

bit 5: Set if error detected in sensor numeric data

bit 4: Set if error detected in sensor linearization coefficients

bit 3: Set if no valid ready active gas instance selected, or if an error is detected in the selected gas instance data.

bit 2: Set if errored or uninitialized digital filter value exists

bit 1: Set if internal data or hardware error detected. Not all such possible errors are detectable. Instrument should be deemed untrustworthy if set.

bit 0: Reserved

4.16. ALARMS ACKNOWLEDGE WORD

msb lsb

15 0

Read or read then clear using MAA network command. Read once more to see result of clearing.

The format of this word is identical to the Alarms Status Word (eg., bits have same meaning). This Alarms Acknowledge Word retains bits that are set to 1 in the Alarms Status Word until each is cleared by network command.

4.17. WARNINGS STATUS WORD

msb lsb

15 0

Read using MW network command. It is read-only and cannot be changed by network command.

Read using MW network command. It is read-only and cannot be changed by network command.

bit 15(msb): Set if indicated flow above high flow warning limit. Only set when MFM state = OPERATE, cleared when not OPERATE.

bit 14: Set if indicated flow below warning limit. Only set when MFM state = OPERATE, cleared when not OPERATE.

bit 13: Set if tracking error (indicated flow minus implemented setpoint) exceeds tracking error warning limit. (Only set when MFM state = OPERATE and MFC mode = AUTO.

Unused if MFC not configured.

bits 12 through 6: Reserved

bit 5: Set if DAC output temporarily zeroed, or forced to non-realtime value.

bit 4: Set if no valid cal instance associated with active gas instance. This is not necessarily an error or problem, and the lack of an association may be intended.

bit 3 – 0: Reserved

4.18. WARNINGS ACKNOWLEDGE WORD

msb lsb

15 0

Read or read then clear using MWA network command. Read once more to see result of clearing.

The format of this word is identical to the Warnings Status Word (eg., bits have same meaning). This Warnings Acknowledge Word retains bits that are set to 1 in the Warnings Status Word until each is cleared by network command.

4.19. MFM FLOW STATUS WORD

msb lsb

15 0

Query by network command "MF". The Flow Status word indicates exception conditions detected that affect MFM flow readings. Not all possible conditions that affect accuracy of flow are detectable. Certain bits are summarized into alarms or warnings. Querying the Flow Status word can provide details regarding the cause of alarms and warnings.

bits 15(msb) through 8: Reserved

bit 7: Set if error detected during computation of runtime data for active gas instance. Check validity of gas instance and all related data (including linearization coefficients). Causes alarm when set.

bit 6: Set if indicated flow computation experienced detected overflow. Usually this will be caused by indicated flow exceeding +199% or -199% of the full scale value due to excess gas flow rate. Causes alarm when set.

bit 5: Set if upstream bridge sensor failure is detected. Causes alarm when set.

bit 4: Set if downstream bridge sensor failure is detected. Causes alarm when set.

bit 3: Set if full scale indicated flow range exceeds specified maximum. This applies to the calibrated range, and not to actual indicated flow. Measurements of indicated flow would continue to be made, but may be in error due to exceeding sensor range. A warning bit is also set.

bit 2: Set if full scale indicated flow range is less than specified minimum. This applies to the calibrated range, and not to actual indicated flow. Measurements of indicated flow will continue to be made, but may be in error due to operation below minimum sensor range. A warning bit is also set.

bits 1, 0(lsb): Reserved

The bits 7-4 of the Flow Status word will cause an 'X" to be suffixed to indicated flow values when any bit(s) is/are set.

4.20.MFM FLOW STATUS ACKNOWLEDGE WORD

msb lsb

15 0

Read or read then clear using MFA network command. Read again to see result of clearing.

The format of this word is identical to the Flow Status Word (eg.. bit positions have same meaning). This Flow Status Acknowledge Word retains bits that are set to 1 in the Flow Status Word until each is cleared by network command.

Bits in this Flow Status Acknowledge Word are not summarized into either the alarms or warnings words, so clearing them will not affect bits in the Alarms Status Word, Alarms Acknowledge Word, Warnings Status Word or the Warnings Acknowledge Word

4.21.System Full List

SFL Lists all of the data in all of the following active lists. This includes the sensor list the active gas list, the active calibration instance list, the valve list and the mode list. The information in the active polynomial list will be presented in the gas list. This is information that is useful when troubleshooting errors in the instrument. If possible generate this list when the instrument has a fault and copy it into an email when corresponding with the factory about an operational problem.

SFL(cr) or *[aa]SFL(cr)

The items documented below can only be read with the SFL command or after successful reception of the FLOK command. Items that list write capability can only be written to after the successful reception of the FLOK command. These items are typically useful for troubleshooting instrument faults.

Sensor List

item 19: filter#1 lpf delay:

read S19(cr) or *[aa]S19(cr)

Sample reply: 0.15(cr)>

write S19=0.15(cr) or *[aa]S19=0.15(cr)

Nominal value is about 0.15. A lower value results in more noise and a higher value results in longer ramp time. Changing this value from the default value is NOT recommended.

item 20: filter#2 hpf gain:

read S20(cr) or *[aa]S20(cr)

Sample reply: 0.20(cr)>

write S20=0.20(cr) or *[aa]S20=0.20(cr)

This is the amplification level applied to the 1st digital speedup filter. Different nominal values are set depending on the sensor installed in the instrument. The table below can be used to determine the sensor size by the full scale range of the instrument.

0.45 is the nominal value for units with the 0.014 tube Sensor.
0.41 is the nominal value for units with the 0.017 tube Sensor
0.20 is the nominal value for units with the 0.026 tube Sensor

Sensor Tube Size	**0.026**		**0.017**		**0.014**	
All flow rates in SLM (standard liter/min)	**min**	**max**	**min**	**max**	**min**	**max**
HFM-D-300 / HFC-D-302 Series units	.005	10			10	25
HFM-D-301 / HFC-D-303 Series units	10	120	120	500	500	1100
HFM-D-305 / HFC-D-307 Series units	100	375	375	1300	1300	3000

item 21: filter#2 hpf delay:

read S21(cr) or *[aa]S21(cr)

Sample reply: 0.20(cr)>

write S21=1.00(cr) or *[aa]S21=1.00(cr)

This is one over the break frequency in Herz of the 1st digital speedup filter. Different nominal values are set depending on the sensor installed in the instrument. The table above can be used to determine the sensor size by the full scale range of the instrument.

1.00 is the nominal value for units with the 0.014 tube Sensor.
0.90 is the nominal value for units with the 0.017 tube Sensor
1.00 is the nominal value for units with the 0.026 tube Sensor

item 22: filter#3 hpf gain:

read S22(cr) or *[aa]S22(cr)

Sample reply: 0.34(cr)>

write S22=0.34(cr) or *[aa]S22=0.34(cr)

This is the amplification level applied to the 2nd digital speedup filter. Different nominal values are set depending on the sensor installed in the instrument. The table in the documentation for item 20 above can be used to determine the sensor size by the full scale range of the instrument.

0.34 is the nominal value for units with the 0.014 tube Sensor.
0.46 is the nominal value for units with the 0.017 tube Sensor
0.18 is the nominal value for units with the 0.026 tube Sensor

item 23: filter#3 hpf delay:

read S23(cr) or *[aa]S23(cr)

Sample reply: 0.20(cr)>

write S23=1.00(cr) or *[aa]S23=1.00(cr)

This is one over the break frequency in Herz of the 2nd digital speedup filter.

5.00 is the nominal value for all sensor sizes.

item 24: A/D#0 FS factor:

read S24(cr) or *[aa]S24(cr)

Sample reply: 22130(cr)>

write S24=ddd(cr) or *[aa]S24= ddd(cr)

This is the counts value that is used to adjust the value read on A/D#0 when the analog signal is at its full scale value. Typically it is close to 18000.

item 25: A/D#1 FS factor:

read S25(cr) or *[aa]S25(cr)

Sample reply: 22130(cr)>

write S25=ddd(cr) or *[aa]S25= ddd(cr)

This is the counts value that is used to adjust the value read on A/D#1 when the analog signal is at its full scale value. Typically it is close to 18000. This is typically the setpoint command input signal.

item 28: sensor spec full scale:

read S28(cr) or *[aa]S28(cr)

Sample reply: .040(cr)>

write S28=dd.d(cr) or *[aa]S28=dd.d(cr)

This is the output of the sensor when the instrument is at the maximum flow value that was measured during the generation of the linearization coefficients. Changing this value will invalidate all calibrations.

item 40: ub sense: (read only)

read S40(cr) or *[aa]S40(cr)

Sample reply: 2.20034(s)V(cr)>

This is voltage read across the 150 ohm resistor in series with the upstream heater coil in the sensor. Normally this value is around 1 – 3 volts. This should be fairly close to the value in time 42 (db sense) when there is no flow through the instrument.

item 41: ub comm: (read only)

read S41(cr) or *[aa]S41(cr)

Sample reply: 7.230254(s)V(cr)>

This is voltage read across the upstream heater coil in the sensor. Normally this value is around 4 – 8 volts. This should be fairly close to the value in time 43 (db comm) when there is no flow through the instrument.

item 42: db sense: (read only)

read S42(cr) or *[aa]S42(cr)

Sample reply: 2.201561(s)V(cr)>

This is voltage read across the 150 ohm resistor in series with the downstream heater coil in the sensor. Normally this value is around 1 – 3 volts. This should be fairly close to the value in time 40 (ub sense) when there is no flow through the instrument.

item 43: db comm: (read only)

read S43(cr) or *[aa]S43(cr)

Sample reply: 7.475676(s)V(cr)>

This is voltage read across the downstream heater coil in the sensor. Normally this value is around 4 – 8 volts. This should be fairly close to the value in time 41 (ub comm) when there is no flow through the instrument.

item 46: ub power: (read only)

read S46(cr) or *[aa]S46(cr)

Sample reply: 0.1033083(s)W(cr)>

This is the upstream power value that is calculated from the voltages measured in items 40 & 41. ub comm x ub sense / 150. This will normally range from 0.030 to 0.120 depending on sensor tube. This power should be fairly close to the power level in item 47 below when there is no flow through the sensor. This power level will increase when flow exists.

item 47: db power: (read only)

read S47(cr) or *[aa]S47(cr)

Sample reply: 0.1097534(s)W(cr)>

This is the downstream power value that is calculated from the voltages measured in items 42 & 43. db comm x db sense / 150. This will normally range from 0.030 to 0.120 depending on sensor tube. This power should be fairly close to the power level in item 46 above when there is no flow through the sensor. This power level will decrease when flow exists.

item 51: DAC zero code:

read S51(cr) or *[aa]S51(cr)

Sample reply: 189(cr)>

write S51=ddd(cr) or *[aa]S51= ddd(cr)

This is a counts value that is used to adjust the analog output signal when the flow reading is 0.00. This value can be anywhere between 0 and 32767. Typically it's around 185 for voltage units and 770 for 4-20 ma units.

item 52: DAC FS code:

read S52(cr) or *[aa]S52(cr)

Sample reply: 3905(cr)>

write S52=dddd(cr) or *[aa]S52= dddd(cr)

This is a counts value that is used to adjust the analog output signal when the flow reading is equal to the full scale flow rate. This value can be anywhere between 0 and 32767. Typically it's around 3900 for 5 volt units and 8000 for 10 volt and 4-20 ma units.

item 53: noise thresh:

read S53(cr) or *[aa]S53(cr)

Sample reply: 4200(cr)>

This item controls the counts value of that is used to filter out low amplitude noise. Decreasing this value can lead to increased amounts of noise during the no-flow condition. This value should not be changed.

item 69: A/D#0 offset:

read S69(cr) or *[aa]S69(cr)

Sample reply: -1(cr)>

write S69=ddd(cr) or *[aa]S69= ddd(cr)

This is the counts value that is used to adjust the value read on A/D#0 when the analog signal is at its minimum value. Typically it is close to zero.

item 70: A/D#1 offset:

read S70(cr) or *[aa]S70(cr)

Sample reply: -1(cr)>

write S70=ddd(cr) or *[aa]S70= ddd(cr)

This is the counts value that is used to adjust the value read on A/D#1 when the analog signal is at its minimum value. Typically it is close to zero. This is typically the setpoint command input signal.

5. Appendix

5.1. ERROR MESSAGES

Error messages exist as follows:

#001:ERR: COMMAND NOT IMPLEMENTED
#002:ERR: VALUE OUT OF RANGE
#003:ERR: BAD CMMD
#004:ERR: BAD CHARACTER
#005:ERR: OVERRUN, CMD LOST
#006:ERR: MISSING OR BAD ARGUMENT
#007:ERR: TOO MANY ARGUMENTS
#008:ERR: ACCESS DENIED
#009:ERR: FLOW SETPOINT > FULLSCALE OR NEGATIVE
#010:ERR: INSTANCE INVALID OR NOT SET
#011:ERR: NO ACTIVE INSTANCE ASSIGNED
#012:ERR: INSTANCE NOT READY //Essential values not yet set
#013:ERR: INSTANCE READ ONLY
#014:ERR: INSTANCE INVALID OR DELETED
#015:ERR: INSTANCE IN USE
#016:ERR: USE IN TEST MODE
#017:ERR: COMMAND READ ONLY
#018:ERR: NEGATIVE VALUE
#019:ERR: BAD DATA ITEM CODE
#020 ERR: CHANGE DENIED
#021:ERR: WRONG STATE
#022:ERR: SET ZERO FIRST
#023:ERR: INVALID UNIT
#024:ERR: USE OTHER CMD
#025:ERR: USE '='
#026:ERR: INTERNAL DATA ERROR
#027:ERR: INSTANCE DELETED
#028:ERR: ACTIVE GAS INSTANCE INVALID
#029:ERR: CANT ASSIGN UNITS
#030:ERR: CANNOT DELETE INSTANCE
#031:ERR: INSTANCE NOT DELETED
#032:ERR: FULL SCALE POWER OUT OF RANGE
#033:ERR: ONE OR MORE LIN COEFFICIENTS TOO LARGE
#034:ERR: ACCESS LOCK
#035:ERR: CAL INSTANCE ASSIGNED

Certain error messages may be emitted when making seemingly innocuous changes. Most of these happen because the reasonableness checks against sensor limits are using uninitialized values for the sensor range.

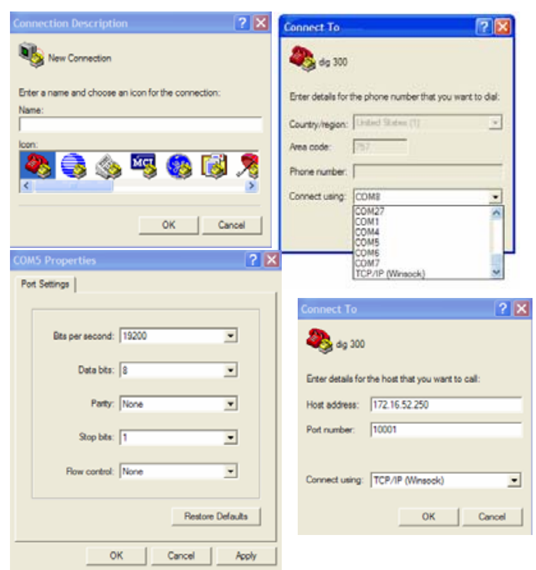
Appearance of error message #032:ERR: FULL SCALE POWER OUT OF RANGE probably means the power difference value is too small, causing internal numeric overflow. In that case the gas or cal rec will be set NOT READY. There is not an explicit check for power difference value is too small (although there could be, perhaps based on sensor range values), this error message appears if computational overflow is detected when the conversion factor from raw counts to "corrected" power difference is computed.

5.2. Units Data

Example "LUNT" network command output, lists unit codes by ODVA code scheme (with Hastings proprietary units as well)

>LUNT
code 0: std.cubic cm/minute: SCCM: 1000.
code 1: std.liter/minute: SLM: 1.
code 2: percent: %:
code 3: volt: V:
code 4: millivolt: MV:
code 5: counts: CNT:
code 64: normal liter/minute: NLM: 1.
code 65: std.liter/second: SLS: 60.
code 66: normal liter/second: NLS: 60.
code 67: std.liter/hour: SLH: .016667
code 68: normal liter/hour: NLH: .016667
code 69: std.milliliter/minute: SMLM: 1000.
code 70: normal milliliter/minute: NMLM: 1000.
code 71: std.milliliter/second: SMLS: 60000.
code 72: normal milliliter/second: NMLS: 60000.
code 73: std.milliliter/hour: SMLH: 16.667
code 74: normal milliliter/hour: NMLH: 16.667
code 75: normal cubic cm/minute: NCCM: 1000.
code 76: std.cubic cm/second: SCCS: 60000.
code 77: normal cubic cm/second: NCCS: 60000.
code 78: std.cubic cm/hour: SCCH: 16.667
code 79: normal cubic cm/hour: NCCH: 16.667
code 80: std.cubic foot/minute: SCFM: .035335
code 81: normal cubic foot/minute: NCFM: .035335
code 82: std.cubic foot/second: SCFS: 2.1201
code 83: normal cubic foot/second: NCFS: 2.1201
code 84: std.cubic foot/hour: SCFH: 5.8894e-04
code 85: normal cubic foot/hour: NCFH: 5.8894e-04
code 86: std.cubic meter/minute: SM^3M: 1.e-03
code 87: normal cubic meter/minute: NM^3M: 1.e-03
code 88: std.cubic meter/second: SM^3S: .06
code 89: normal cubic meter/second: NM^3S: .06
code 90: std.cubic meter/hour: SM^3H: 1.6667e-05
code 91: normal cubic meter/hour: NM^3H: 1.6667e-05
code 92: std.cubic inch/minute: SCIM: 16.388
code 93: normal cubic inch/minute: NCIM: 16.388
code 94: std.cubic inch/second: SCIS: 983.28
code 95: normal cubic inch/second: NCIS: 983.28
code 96: std.cubic inch/hour: SCIH: .27314
code 97: normal cubic inch/hour: NCIH: .27314
code 98: pound/minute: LBM: 2.2026e-03
code 99: pound/second: LBS: .13215
code 100: pound/hour: LBH: 3.6711e-05
code 101: kilogram/minute: KgM: 1.e-03
code 102: kilogram/second: KgS: .06
code 103: kilogram/hour: KgH: 1.6667e-05
code 104: gram/minute: GRM: 1.
code 105: gram/second: GRS: 60.
code 106: gram/hour: GRH: .016667
code 107: mole/minute: MolM: .044614
code 108: mole/second: MolS: 2.6768
code 109: mole/hour: MolH: 7.4359e-04
code 110: KgMole/minute: KMolM: 4.4614e-05
code 111: KgMole/second: KMolS: 2.6768e-03
code 112: KgMole/hour: KMolH: 7.4359e-07
code 113: counts: CNT:
code 114: watt: W:
code 115: bits/s: BPS:
code 116: second: S:
code 117: minute: M:
code 118: hour: H:
code 119: watt-hours: WH:

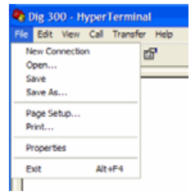
5.3. Hyperterminal Configuration instructions.



When Hyperterminal starts, a New Connection menu appears similar to the one at the immediate right. Enter a name for the connection and click OK.

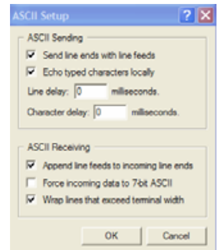
Next, a port selection menu appears similar to the one at the far right. Choose the proper Com Port if the instrument is connected via a traditional serial port (RS232/RS485). If the instrument has a direct TCP/IP connection then the TCP/IP should be selected (at the bottom).

Once the OK button is depressed, the either the Serial Port menu appears (immediate right) or the TCP menu appears (far right). The instrument cannot communicate until the port is properly configured. For the serial ports select the proper baud rate [19200], Data bits [8], Parity [none], stop bits [1] and flow control [none]. Depress OK. (The typical values are shown in square brackets after each item.). For the TCP versions, set the TCP/IP address (Default for 400 Series is 172.16.52.250) and port (400 Series is 10001).



At this point commands can be sent to the instrument and responses will be received but default port setup will only show instrument responses. Since most instruments do not echo the typed commands back to the transmitter, the user will be typing blind when sending commands. If line feeds are not sent with responses, the responses from subsequent commands will over-write each other. This can be changed to maintain a record of transmissions and receptions.

Select the Properties menu item under the File heading. When the "Properties" menu appears then select the Settings Tab (far right). Click the ASCII Setup button. In the ASCII Sending box of the ASCII setup menu (immediate right) select the "Send Line Ends …" option and select "Echo type characters …". In the ASCII Receiving box select "Append line Feeds …" option. Click OK in ASCII setup box followed by OK in the Properties box.



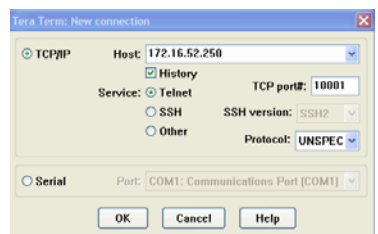
The terminal program is now ready for transmission and reception. The configuration can be saved for use later using the Save As menu item under File heading.

Once a connection has been established, the baud rate, com port etc. cannot be modified until the connection is "Disconnected" (under the Call heading). Once the call is disconnected, a new connection can be established using the "Properties" item under the File heading. Select the Port number and then setup the serial port using the "Configure" button.

5.4. Tera Term Configuration instructions.

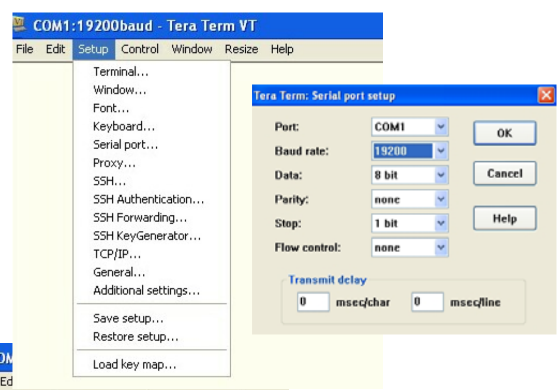
When Tera Term starts, a port selection menu appears similar to the one at the right.

Choose Serial option if the instrument is connected via a traditional serial port (RS232/RS485) and select the Com port number or TCP/IP connection. Click OK.

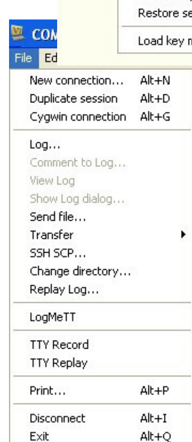


If TCP/IP option was selected, the TCP/IP port menu will appear. Set the TCP/IP address (Default for 400 Series is 172.16.52.250) and port (400 Series is 10001). Select the Telnet service.

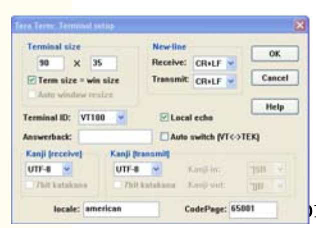
Once the OK button is depressed, the main menu appears. The instrument cannot communicate until the port is properly configured. Select the Serial Port menu item under the Setup heading. See image at the far right. Select the proper baud rate [19200], Data bits [8], Parity [none], stop bits [1] and flow control [none]. Depress OK. (The typical values are shown in square brackets after each item.).



At this point commands can be sent to the instrument and responses will be received but default port setup will only show instrument responses. Since most instruments do not echo the typed commands back to the transmitter, the user will be typing blind when sending commands. If line feeds are not sent with responses, the responses from subsequent commands will over-write each other. This can be changed to maintain a record of transmissions and receptions.



Select the Terminal menu item under the setup port. Select the Local Echo option and select CR+LF under both the Receive and Transmit



choices as shown in the image at the far right. Click OK.

The terminal program is now ready for transmission and reception. The configuration can be saved for use later using the Save Setup menu item under Setup heading. A new connection can be established with the “New connection” item under the “File” heading.

5.5. Gas Data

```
>LGSY
code 1:  He
code 2:  Ne
code 3:  Rn
code 4:  Ar
code 5:  Kr
code 6:  Xe
code 7:  H2
code 8:  Air
code 9:  CO
code 10:  HBr
code 11:  HCl
code 12:  HF
code 13:  N2
code 14:  D2
code 15:  O2
code 16:  NO
code 17:  HI
code 18:  F2
code 19:  Cl2
code 20:  H2O
code 21:  Br2
code 22:  H2S
code 23:  H2Se
code 24:  HCN
code 25:  CO2
code 26:  NO2
code 27:  N2O
code 28:  CH4
code 29:  NH3
code 30:  O3
code 31:  PH3
code 32:  SO
code 33:  CH3F
code 34:  COS
code 35:  AsH3
code 36:  CH3Cl
code 37:  ClCN
code 38:  C2H4
code 39:  SiH4
code 40:  CS2
code 41:  OF2
code 42:  C2H2
code 43:  GeH4
code 44:  CH3Br
code 45:  C2H4O
code 46:  CF2O
code 47:  CH4S
code 48:  BF3
code 49:  CHF3
code 50:  N2H4
code 51:  C2H3F
code 52:  CH5N
code 53:  NF3
code 54:  C2H6
code 55:  C2H3Cl
code 56:  C2H3Br
code 57:  CHClF2
code 58:  B2H6
code 59:  C2N2
code 60:  CCl2O
code 61:  C3H6
code 62:  PF3
code 63:  CF4
code 64:  C2H2F2
code 65:  CHCl2F
code 66:  C3H4
code 67:  SiH2Cl2
code 68:  C3H4
code 69:  C3H6
code 70:  BCl3
code 71:  CHCl3
code 72:  ClO3F
code 73:  C2H6O
code 74:  CClF3
code 75:  C2H5Cl
code 76:  BrF3
code 77:  ClF3
code 78:  N2O3
code 79:  BBr3
code 80:  CBrF3
code 81:  C3H6O
code 82:  C2H4F2
code 83:  CHBr3
code 84:  CCl2F2
code 85:  C2H7N
code 86:  SF4
code 87:  SO2F2
code 88:  SiF4
code 89:  C3H8
code 90:  ****
code 91:  CCl3F
code 92:  ****
code 93:  C4H6
code 94:  C2F4
code 95:  N2O4
code 96:  AsF5
code 97:  Si2H6
code 98:  C4H8
code 99:  GeF4
code 100:  C4H6
code 101:  CCl4
code 102:  POCl3
code 103:  C2H3ClF2
code 104:  C4H8
code 105:  C2BrF3
code 106:  C4H8
code 107:  C4H8
code 108:  SiCl4
code 109:  C3H9N
code 110:  SF6
code 111:  C4H10
code 112:  C2H3Cl3
code 113:  GeCl4
code 114:  TiCl4
code 115:  IF5
code 116:  BrF5
code 117:  C4H10
code 118:  C2F6
code 119:  C2ClF5
code 120:  C5H10
code 121:  WF6
code 122:  C5H12
code 123:  UF6
code 124:  MoF6
code 125:  C2Cl2F4
code 126:  C2Cl3F3
code 127:  C6H14
code 128:  C3F8
code 129:  C4F8
code 130:  C2Br2F4
code 131:  C3H9BO3
code 132:  C3H9P
code 133:  C3H9PO3
code 134:  SiH2F2
code 135:  C2H6Zn
code 136:  C2H6O
code 137:  C2HBrClF3
code 138:  C3F6
code 139:  C6H18Si2
code 140:  NiC4O4
code 141:  NOCl
code 142:  B5H9
code 143:  PF5
code 144:  C8H20O4Si
code 145:  SnCl4
code 146:  Cl2H27Al
code 147:  SiHCl3
code 148:  C6H15Ga
code 149:  C3H9Al
code 150:  C3H9Sb
code 151:  C3H9As
code 152:  C3H9Ga
code 153:  C3H9In
code 154:  C4H12Si
code 155:  C2HF5
```

code 156: C2H2F4
code 157: N2F4
code 158: C4Hl6Si4O4
code 159: T2
code 160: CH2F2
code 161: C4H11As
code 162: C4H11P
code 163: C6H15O3B
code 164: C2H7Al
code 165: C3H12AlN
code 186: C2HCl2F3

code 166: C4H14NAl
code 167: HNO3
code 168: C2Cl4
code 169: C2H6O2
code 170: C6H14O2
code 171: H2SO4
code 172: C6H5Cl
code 173: C2H3N
code 174: C8H10
code 175: CHN

code 176: CH4O
code 177: C7H14
code 178: C6H12
code 179: C8H10
code 180: C6H6O
code 181: C7H8
code 182: C4H8O
code 183: CH3Cl3Si
code 184: C3H6O
code 185: CH6Si

6. Warranty

6.1. 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.

6.2. 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.teledyne-hi.com

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