INSTRUCTION MANUAL

120 FLOW RATE & TOTAL INDICATOR

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Manual to improve performance, reliability, or manufacturability. Consequently, contact
MMI for the latest available specifications and performance data.

Although every effort has been made to ensure accuracy of the information contained in this
Instruction Manual, MMI assumes no responsibility for inadvertent errors.
**General Description**

The *Max 120 Flow Rate & Total Indicator* performs two basic functions. It totalizes all flow and calculates flow rate.

*Totalizer*

The totalizer has a ten digit display, and is equipped with a scaler to accept flow meter K-factor values from 0.0001 to 99999. The Reset key can be programmed to reset the totalizer count. The totalizer inhibit input can be used to stop the count. The totalizer is unidirectional; it counts up only.

Two transistor outputs are available from the totalizer. Transistor 1 provides a scaled output pulse for each count of the totalizer display. The pulse output duration can be programmed for Fast (125\(\mu\)sec), Medium (2 msec.) or Slow (50msec.). The totalizer has a buffer capable of storing 255 scaled counts if the totalizer count rate temporarily exceeds the scaled output rate. If the buffer capacity is exceeded, pulses will be lost from the scaled pulse output, and the message PULSE OVERFLOW will appear on the display. The contents of this buffer are saved if the power is removed from the unit before all of the counts have been output. This buffer is reset when the totalizer is reset.

Transistor 2 is the totalizer setpoint output which turns on when the totalizer count reaches the totalizer setpoint. The output can be programmed to time out (turn off) from 0.01 to 99.99 seconds after it turns on. Programming the timer to a value of 0.00 disables the timer and causes the output to remain on until an input or keyboard command unlatches it. This setpoint can be used to perform a batching function.

*Rate Indicator*

The rate meter has six digits of display and calculates flow by measuring the time interval between input pulses or average time between groups of pulses and then reciprocating the time. The reciprocated time is multiplied by the flow meter K-factor and a rate multiplier (Rm) to provide rate readings in the desired units of measure.

The smoothing function allows the rate indicator to average rate readings from 1.0 seconds to 7.5 seconds in 0.5 second steps. There is no smoothing when programmed for 0.5 seconds.

The rate hi and lo setpoints are used to set rate values at which the rate alarm outputs turn on. The hi output is turned on if the rate is greater than the hi setpoint, the lo output is turned on if the rate is lower than the lo setpoint. The outputs can be programmed to follow, time out, or to latch until a keyboard or input signal is received. In the follow mode of operation, the rate is compared to the hi and lo setpoints after each rate update. If an output is turned on, it remains on until the next rate update occurs and then is either left on or turned off depending on the comparison of the new rate reading with the setpoints. In the time out mode of operation, the outputs can be programmed to turn on for 0.01 to 99.99 seconds. Programming a value of 0.00 disables the timer and causes the outputs to latch until unlatched by a keyboard or input signal.
General Description (cont.)

The rate meter displays zero rate when the time interval between input pulses exceeds the programmed rate zero time. The timer can be set from 1 to 15 seconds.

The rate units of measure (up to three characters) can be programmed into the unit and will be shown along with the rate value and rate setpoints on the display. If the rate data exceeds four digits, the rate header will be shifted off the display one character for each additional digit.

The analog rate output range can be programmed at both the 4 mA and 20 mA points. This permits analog rate indications from 0 to full scale rate or a portion of the rate range. The analog output can be digitally calibrated in the program mode. The analog output goes to a value of 4 mA when the unit is being programmed and during power-up diagnostic tests.

Note: This device has a maximum output of 20mA and therefore will not indicate an overrange condition.

Specifications

- Environmental
  - Temperature: Operating: 0 to 55°C
    Storage: -40 to 70°C
  - Humidity: 0 to 85% RH non-condensing
  - Pollution: Pollution Degree II
  - Front Panel: Sealed to NEMA 4X

- Inputs
  - Power: 115/230V 50/60 Hz 0.2/0.1 A
    or 18 to 27 VDC @ 0.4 A max. 5 W max.
  - Control Inputs (5)
    Type: Requires current sinking device such as contact closure to ground or NPN transistor to ground.
    Impedance: 5.8kΩ to +5 VDC
    Voltage: High 3.5 to 24 VDC Low 0.0 to 1.0 VDC
    Response Min. Low 30 mS, min. high 30 mS
  - Flow Input/Totalizer Inhibit
    Type: Requires current sinking device such as contact closure to ground or NPN transistor to ground.
    Impedance: 5.8kΩ to +5 VDC
    Voltage: High 2.8 to 24 VDC Low 0.0 to 1.3 VDC
    Response: High 0 - 7.5 kHz, min. pulse width 50 µS
    Med. 0 - 400 Hz, min. pulse width 1.25 mS
    Low 0 - 40 Hz, min. pulse width 10 mS
Specifications (cont.)

- Outputs
  Accessory Power: 24VDC ±5%, 100 mA max
  Totalizer Setpoint
    Type: 1 NPN transistor
    Rating: 150 mA maximum, 30 VDC maximum
    Operation: Latched or timed from 0.01 to 99.99 seconds
  Rate Alarms:
    Type: 2 NPN transistors for indicating Rate outside Hi/Low setpoints.
    Rating: 150 mA maximum, 30 VDC maximum.
    Operation: Follows, latched or timed from 0.01 to 99.99 sec
  Scaled Pulse:
    Type: 1 NPN transistor for remote totalizing, 255 bit buffer
    Rating: 150 mA maximum, 30 VDC maximum
    Operation: Outputs pulse for every increment of the totalizer display.
    Output pulse width selectable from:
      Fast - 125 µS pulse width, 1.5 kHz max. frequency.
      Med - 2 mS pulse width, 200 Hz max. frequency.
      Slow - 50 mS pulse width, 10 Hz max. frequency.
  Flow Rate:
    Type: 4-20 mA current loop, optically isolated.
    Voltage: Compliance voltage 12 - 27 VDC
    Response: 2 Hz
    Accuracy: ± 0.1% @ 25°C, ± 0.25% over temp.
    Resolution: 11 bits
- Totalizer
  Display 10 Digits, up to 5 D.P. (no units of measure)
- K-Factor
  Range: 0.0001 to 99999.
- Rate Indicator
  Type: 1/Period (Reciprocal)
  Display: 6 digits, up to 5 D.P.; with 3 character units-of-measure identifier.
  Accuracy: ± 0.05%
  Rate Multiplier: 0.00001 to 999999.
  Rate Smoothing 0.5 to 7.5 seconds in 0.5 second steps
- Communication
  Type: RS-485 multi-drop, 2-wire
  Baud Rate: 300, 600, 1200, 2400, 4800, 9600, 19200
  Parity: Space, Even, Odd
DISPLAY & SETPOINT FUNCTIONS

DISPLAY TOTAL (HOLDS DISPLAY FOR 1 SECOND, COUNTING NOT AFFECTED)
DISPLAY K-FACTOR: PRESS THE ▲ KEY, THEN THIS KEY *

DISPLAY TOTALIZER SETPOINT
CHANGE SETPOINT: PRESS "CLEAR" KEY, ENTER NUMBER, PRESS "ENTER" **
DISPLAY KM PER HOUR: PRESS THE ▲ KEY, THEN THIS KEY *

DISPLAY RATE (HOLDS DISPLAY FOR 1 SECOND)
DISPLAY KM PER LOW PRESS THE ▲ KEY, THEN THIS KEY *

DISPLAY LOW ALARM RATE
CHANGE SETPOINT: PRESS "CLEAR" KEY, ENTER NUMBER, PRESS "ENTER" **
DISPLAY RATE MULTIPLIER: PRESS THE ▲ KEY, THEN THIS KEY *

DISPLAY HIGH ALARM RATE
CHANGE SETPOINT: PRESS "CLEAR" KEY, ENTER NUMBER, PRESS "ENTER" **
DISPLAY ANALOG OUT % PRESS THE ▲ KEY, THEN THIS KEY *

DISPLAY TWO ITEMS SIMULTANEOUSLY (HOLDS DISPLAY FOR 1 SECOND)
DISPLAY SOFTWARE VERSION PRESS THE ▲ KEY, THEN THIS KEY *

Press together to access programming menu (enter password) enter sub menu # -or-
▲ step thru main menus ▼ step thru sub menus to exit press together ▲ ▼ then "reset"

To view the full identifiers for the items displayed press ▲ to change the items hold ▲ until the display blinks.
▲ steps thru choices ▼ switches sides

TOTAL (T) / RATE (UNITS)
RATE (UNITS) / RATE (UNITS)
LO RATE (L) / LO RATE (L)
HI RATE (H) / HI RATE (H)
ANALOG OUT (A) / ANALOG OUT (A)

*DISPLAY* OR ANY NUMERIC KEY EXITS

DISPLAY ERROR MESSAGES

* INV* = INPUT INVALID
*A NA OUTPUT ERROR* = 4mA OUTPUT GREATER THAN 20mA OUTPUT
*OVERFLOW* = RATE GREATER THAN 999999
*PULSE ERROR* = PULSE OUTPUT BUFFER FULL
*STORE ERROR* = SEE SUBMENU 41

*DISPLAY HOLDS FOR 5 SEC. THEN RETURNS TO PREVIOUS STATE
**ACCESS MAY BE DENIED VIA PROGRAM SUB MENU 41
**AC Power Wiring**

A disconnect switch shall be included in the building installation. It shall be located in close proximity to the equipment and within easy reach of the operator. (All switches and circuit breakers must comply with IEC 947. Use a minimum of 18 gauge (1mm², 600V) and a maximum of 14 gauge (1.6mm², 600V) wire for AC power wiring.

**Case Size & Panel Mounting**

To panel mount the Model 120, a hole 5.43" x 2.67" is required. Position the rubber gasket in back of the indicator bezel. Place the indicator in the mounting hole. Noting the screw orientation molded into the center of the mounting clips, start the four screws. Snap the two clips into the case indentations. Tighten the screws until the indicator is secure.
REAR PANEL CONNECTIONS

**REAR PANEL CONNECTIONS**

RS-232 +
RS-232 -
RS-232 COMMON
COMMON
FLOW METER SIGNAL
COMMON
TOTALIZER INHIBIT
4-20mA OUT -
**4-20mA OUT +**

**POWER**

L1 230 L2

**OUTPUTS**

1 2 3 4 5 6 7 8 9 10

**24VDC OUT**

18 to 27 VDC in

COMMON

OUTPUT & RATE HIGH ALARM
OUTPUT & RATE LOW ALARM
OUTPUT 2 TOTALIZER SETPOINT
OUTPUT 1 TOTALIZER SCALED PULSE

**MAX INPUT 27VDC, MIN 12VDC + LOAD DROP AT 20mA**

**24VDC AVAILABLE ONLY WHEN UNIT IS AC POWERED**

**GFCI CONNECTION**

**AMPHENOL PINOUT (OPT)**

12345

24VDC OUT

RED

BLACK

FLOWSIGNAL

WHITE

GROUND

GREEN

**CONNECTION FOR 24VDC POWER**

AC POWER

115VAC 50/60Hz

T110 mA 250V

220VAC N

230VAC L

GROUND

115VAC 115VAC N

GROUND

115VAC 250V

1200 mA 250V

T500 mA 250V

1500 mA 250V

1750 mA 250V

DC POWER INPUT OPTION

T500 mA 250V

+18 to 37 VDC

COMMON

**Note:** ---> Red is brown on 294 cables

**Note:** ---> Green is blue on 294 cables

**!! ALL AC CONNECTIONS REQUIRE JUMPERS AS SHOWN TO AVOID UNIT DAMAGE!!**

REAR PANEL CONNECTIONS (CONT.)

CONTROL INPUTS, SETPOINT & TOTALIZER OUTPUTS

INHIBIT INPUT
CLOSED = INHIBIT
OPEN = RUN

INPUTS REQUIRE CONTACT CLOSURE TO GROUND
FOR ACTIVATION

CONTROL INPUTS 1-5 (FUNCTION PROGRAMMABLE)
CLOSED = INPUT ACTIVE

ANY INPUT CAN ALSO BE CONTROLLED BY A
SWITCH OR NPN TRANSISTOR

TYPICAL OUTPUT LOADS

4 RATE HIGH ALARM
3 RATE LOW ALARM
2 TOTALIZER SETPOINT
1 TOTALIZER SCALED PULSE

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PROGRAMMING MENUS (CONT.)

SUB MENSUS

44  45
ID & RESPONSE DELAY  MAXIMUM COUNT SPEED
-  -
ID 000 TIME 0  COUNT SPEED PAST (7.5 kHz)
ID 001 TIME 10  COUNT SPEED MED (400 kHz)
ID 002 TIME 100  COUNT SPEED SLOW (40 Hz)
ID 003 TIME 500

34  35  36  37
RATEMETER RESET KEY  RATEREMETER DECIMAL POINT  RATEMETER ZERO TIMEOUT  RATEMETER DISPLAY HEADER
-  -  -  -
RESET UNL. N/D  DEC PT. 000000  RATE AT ZERO 00  RATE HEADER XXX
RESET NONE  (0-5 KEYS)  (RANGE 1-5 SECONDS)  (RANGE A-Z & BLANK)

24  25
TOTALIZER RESET KEY  TOTALIZER DECIMAL POINT
-  -
RESET PST. COUNT  DEC PT. 000000000
RESET UNL. OUTPUT  (0-5 KEYS)
RESET NONE

14  15
4-20mA OUTPUT RANGE  DIAGNOSTICS
-  -
70 MA RATE 000100  8.8.8.8.8.8.8.8.8.8
4 MA RATE 000000  TEST IN PROCESS

SCROLLS THRU CHOICES WITHIN SUBMENUS

HELP: "HELP" DISPLAYS PROGRAMMING INFORMATION, ANY KEY EXITS

CLEAR: USE "ENTER" TO INPUT NEW NUMBERS

USE TO CLEAR NUMERIC DISPLAY PRIOR TO ENTERING NEW NUMBER

ALL INPUT FUNCTIONS ARE INHIBITED IN THE PROGRAM MODE.
**Programming**

*PROGRAM CALIBRATE*

**SubMenu 11 - K-factor**

Clear key enables entry of new K-factor (up to 5 figures).  
0 to 9 and DP keys are used to write the number of flow meter pulses per unit volume to the display.  
Enter key writes the new K-factor to memory.  
The reciprocal of K-factor is Kmf low (To read: press up arrow key, then 3 while in the run mode).  
The K-factor is the number of flow meter pulses per unit of volume (cc, liter, gallon) required to increment the totalizer display one digit.  (See the calibration sheet supplied with your flow meter). It may be desirable to program a decimal point on the counter’s display in order to read totals to the nearest tenth, hundredth, etc. of a whole unit.  The counter logic does not account for the displayed decimal point location, therefore, the user must account for the decimal point when K-factor is entered.  If the totalizer is intended to count in increments of tenths of units, the K-factor to be programmed is the flow meter factor divided by ten; for hundredths of units, the K-factor to be programmed is the flow meter factor divided by 100, etc.

For example:

Using a sample Model 213 flow meter with a K-factor of 111.373 pulses/cc (421546 pulses/gallon)
1. If total is to read to 0.1 cc then the K-factor = 11.137 (111.373 x 0.1)
2. If total is to read to 0.0001 gallon then the K-factor = 42.155 (421,546 x 0.0001)

**SubMenu 12 - Rate Multiplier**

The rate multiplier is used to program the rate indicator display in units/time.  
Clear key enables entry of new rate multiplier (Rm) (up to 6 figures).  
0 to 9 and DP keys are used to write the rate multiplier to the display.  
Enter key writes the new rate multiplier to memory.

The rate multiplier is calculated by the formula:

\[ Rm = \frac{\text{# of seconds in time unit} \times \text{totalizer decimal location}}{\text{desired rate decimal location}} \]

For example:

1. If rate is to read to 0.1 cc/min (total displays 0.1 cc)
   \[ Rm = \frac{60 \text{ sec/min} \times 0.1 \text{ total decimal}}{0.1 \text{ rate decimal location}} = 60 \]
2. a. If rate is to read to 0.001 gal/min (total displays 0.0001 gallons)
   \[ Rm = \frac{60 \text{ sec/min} \times 0.0001 \text{ total decimal}}{0.001 \text{ rate decimal location}} = 6 \]
   b. If rate is to read to 0.1 gal/hr (total displays 0.0001 gallons)
   \[ Rm = \frac{3600 \text{ sec/hr} \times 0.0001 \text{ total decimal}}{0.1 \text{ rate decimal location}} = 3.6 \]
**Programming (cont.)**

- **Example 1:** Program a system consisting of Model 213 Flow Meter, Model 284 Transmitter.

  Total display engineering units = xxxxxxxxx.x gal (set D.P. in sub menu 25)
  Rate display engineering units = xxxx.xx gpm (set D.P. in sub menu 35, units in sub menu 37)
  K-factor = 111.373 pulses/cc

  **Sub Menu 11**
  111.373 pulses/cc x 3785 cc/gal = 421,547 pulses/gal
  K-factor (with decimal place) = 421,547 x 0.1 = 42,155
  Program sub menu 11 with the value 42,155
  
  ```
  [ Clear ] [ 4 ] [ 2 ] [ 1 ] [ 5 ] [ 5 ] [ Enter ]
  ```

  **Sub Menu 12**
  Rm = 60 sec/min x 0.1 (total decimal) = 600
  0.01 (rate display decimal)
  Program sub menu 12 with the value 600
  
  ```
  [ Clear ] [ 6 ] [ 0 ] [ 0 ] [ Enter ]
  ```

- **Example 2:** Program a system consisting of Model 241 Flow Meter, Model 284 Transmitter.

  Total display engineering units = xxxxxxxxx.x kg (set D.P. in sub menu 25)
  Rate display engineering units = xxxxx.x kg/hr (set D.P. in sub menu 35, units in sub menu 37)
  K-factor = 402.9 pulses/liter
  Specific gravity = 0.84 at process temperature *

  **Sub Menu 11**
  402.9 pulses/liter = 479.64 pulses/kg
  0.84 kg/liter
  K-factor (with decimal place) = 479.64 pulses/kg x 0.1 = 47.964
  Program sub menu 11 with the value 47.964
  
  ```
  [ Clear ] [ 4 ] [ 7 ] [ < ] [ 9 ] [ 6 ] [ 4 ] [ Enter ]
  ```

  **Sub Menu 12**
  Rm = 3600 sec/hr x 0.1 (total decimal) = 3600
  0.1 (rate display decimal)
  Program sub menu 12 with the value 3600
  
  ```
  [ Clear ] [ 3 ] [ 6 ] [ 0 ] [ 0 ] [ Enter ]
  ```

* Accurate mass displays can be obtained with the 120 if the process temperature remains relatively constant. For applications where the temperature varies, better accuracy will be obtained with a temperature compensated Max Indicator.
Sub Menu 13 - 4-20 mA Output Calibration

To calibrate the analog output signal, first turn off all power and then connect the analog output “+” terminal to the 24 VDC out terminal of the control. Connect the analog output “-” terminal to a current meter and connect the other end of the current meter to the 24 VDC ground terminal. Turn power back on and select menu 13. Press the Clear key to start the calibration process and use the Left / Right arrow keys to adjust the current to 4 mA, then press the Enter key to enter the 4 mA calibration point. Use the up arrow key to select the 20 mA setpoint. Press the Clear key to start the calibration process and use the Left / Right arrow keys to adjust the current to 20 mA, then press the Enter key to enter the 20 mA calibration point.

Sub Menu 14 - Rate 4 - 20 mA Output Range

The rate output range is programmed at both the 4 mA and 20 mA points. This permits analog rate indications from 0 to full scale of the digitally displayed rate or a portion of the rate range. Use the up arrow key to select the 4 mA or 20 mA setpoints and then use the Clear, number and Enter keys to enter a rate value at each setpoint.

Sub Menu 15 - Diagnostics

The diagnostics allow the user to test the indicator display and internal memory. Press the up arrow key for display test 1. Each of the display’s 16 characters will go to 8 with the decimal point lit. Press the up arrow key for display test 2. Each character will go to *. Press the up arrow key for the internal memory test. The display will read TEST IN PROCESS for three seconds while the tests are being run. The display will read SYSTEM TEST OK for two seconds, then go back to DIAGNOSTICS if no memory errors were detected. If the unit detects a memory error, the display will hold an error message. The error messages are:

ROM ERROR
INTERNAL ERROR
EXTERNAL ERROR

These errors are non-recoverable. It is possible that electrical noise caused the diagnostic failure, so the power to the unit should be cycled (turned off and then turned back on). The memory tests are always performed at power up. If the same test fails at power up, the unit likely needs repair. If a different test fails, or if the unit powers up normally, it is likely that the unit is experiencing electrical noise problems. Note that the error messages for the power up memory tests may be different than the error messages for the program mode diagnostic memory tests. The following table lists each test failure and its associated error message in each test mode.

<table>
<thead>
<tr>
<th>Test Failure</th>
<th>Error Message</th>
<th>Program Diagnostics</th>
<th>Power Up Diagnostics</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROM checksum error</td>
<td>ROM ERROR</td>
<td></td>
<td>ROM ERROR</td>
</tr>
<tr>
<td>Int. RAM bit error</td>
<td>INTERNAL ERROR</td>
<td></td>
<td>RAM ERROR</td>
</tr>
<tr>
<td>Ext. RAM bit error</td>
<td>EXTERNAL ERROR</td>
<td></td>
<td>EXT RAM ERROR</td>
</tr>
<tr>
<td>EXT. RAM checksum error</td>
<td>N/A</td>
<td></td>
<td>STORE ERROR</td>
</tr>
</tbody>
</table>

Note that the power up diagnostic memory test performs an additional test, the external RAM checksum. If the calculated checksum of the external RAM (the memory which holds the user program) does not match the stored checksum, the user program has been corrupted and the message STORE ERROR appears on the display. This error is recoverable by pressing the Reset key. The message VERIFY PGM DATA then appears on the display for one second to prompt the user to locate and correct program mode item(s) which may have been altered.
PROGRAM TOTALIZER

Sub Menu 21 - Totalizer Remote Control Inputs
Any of the five rear terminal control inputs can be programmed to perform a function in the totalizing operation. A control input is selected by pressing front panel keys 1, 2, 3, 4 or 5. Key 1 selects control input 1, key 2 selects control input 2, etc. When a control input terminal has been selected, it is shown on the left hand side of the display and its function is shown on the right hand side of the display. The function that a control input terminal performs can be changed by pressing the up arrow key. The functions that can be assigned to an input are None, Reset Count, Unlatch Output, or Reset Count & Unlatch Output. Note: an input assigned to perform a function to the totalizer can also be assigned to perform additional functions to the rate meter in the rate meter menu row. A chart is shown on page 12 to provide a convenient means of recording the tasks each control input has been assigned.

Sub Menu 22 - Totalizer Pulse Output
The totalizer pulse output transistor can be programmed for fast, medium, or slow pulse widths. It can also be programmed to not output pulses.
Frequency Range of Output
Fast - 125 µsec, 1500 Hz max. output frequency. (Typical factory setting).
Medium - 2 msec on, 200 Hz max. output frequency
Slow - 50 msec on, 10 Hz max output frequency
No Pulse - Off Continuously
This output has a 255 count buffer. The buffer is saved at power down, and is reset when the totalizer is reset. Use the up arrow key to select the mode of operation of the scaled pulse output.

Sub Menu 23 - Totalizer Setpoint Time-Out
The totalizer setpoint output transistor can be programmed to time out in the range of 0.01 to 99.99 seconds. To enter a time value, press the Clear key, enter the time with the 0 through 9 keys, and press the Enter key. The timer can be disabled by setting a time value of 0.00 seconds. When the timer is disabled, the output remains latched until an input or keyboard command unlatches it. (The typical factory setting is 0.00 seconds).

Sub Menu 24 - Reset Key
The Reset key can be programmed to perform various functions on the totalizer operation. The name of the key is shown on the left side of the display and the function it performs is shown on the right hand side of the display. The options are: Reset Count, Unlatch Output, Reset & Unlatch, or None. The function can be changed by pressing the up arrow key. Keys assigned to perform a function on the totalizing operation may also be assigned to perform additional functions to the rate meter. A chart is shown on page 12 to provide a convenient means of recording the tasks of the Reset key. (The typical factory setting is reset and unlatch).

Sub Menu 25 - Totalizer Decimal Point
The totalizer display can have a decimal point programmed in any of six positions. Use the 0-5 keys to select the desired position. The decimal point selected here is shown in the total count and totalizer setpoint displays. Please note: Placement of the decimal point on the display does not rescale the programmed K-factors. See Sub Menu 11.
PROGRAM RATE METER

Sub Menu 31 - Smoothing

Rate is calculated and the rate display is updated every 0.5 seconds. When rate smoothing is selected to be greater than 0.5 seconds, the most recent rate calculation is averaged with the previous rate calculations that were made in the smoothing period. Use the up arrow key to select the amount of smoothing desired. Optimum smoothing is normally obtained by setting the smoothing while the flow rate is at its lowest normal value.

Sub Menu 32 - Rate Meter Control Inputs

Any of the five rear terminal control inputs can be programmed to perform a function on the rate meter operation. A control input is selected by pressing front panel keys 1, 2, 3, 4 or 5. Key 1 selects control input 1, key 2 control input 2 etc. When a control input terminal has been selected, it is shown on the left hand side of the display and its function is shown on the right hand side of the display. The function that a control input terminal performs can be changed by pressing the up arrow key. The functions that can be assigned to an input are: None, Unlatch Hi/Lo Alarm Outputs. Note: an input assigned to perform a function to the rate meter can also be assigned to perform additional functions to the totalizer in the Totalizer Program menu row. A chart is shown on page 12 to provide a convenient means of recording the tasks each control input has been assigned.

Sub Menu 33 - Rate Meter High and Low Outputs

The rate hi and lo setpoints are used to set rate values at which the rate alarm outputs turn on. The hi output is turned on if the rate is greater than the high setpoint, the lo output is turned on if the rate is lower than the lo setpoint. The outputs can be programmed to follow, time out, or to latch until a keyboard or input signal is received. In the follow mode of operation, the rate is compared to the hi and lo setpoints after each rate update. If an output is turned on, it remains on until the next rate update occurs and then the output is either left on or turned off depending on the comparison of the new rate reading with the setpoints. In the time out mode of operation, the outputs can be programmed to turn on for 0.01 to 99.99 seconds. Programming a value of 0.00 disables the timer and causes the outputs to latch until unlatched by the keyboard or input signal. Use the up arrow key to select the output mode of operation. The lo setpoint can be programmed greater than the hi setpoint, if desired.

Use the < or > key to select the high or low output. The word Lo or Hi will flash when selected. Use the Clear, number and Enter keys to enter timer values for both outputs. (The factory default is follow.)

Sub Menu 34 - Reset Key

The Reset key can be programmed to unlatch the rate meter high and low alarms, or it can be programmed to have no effect on the alarms. Select the function of the reset key on the rate meter operation by pressing the up arrow key. The Reset key can be programmed for additional functions on the totalizer operation. A chart is shown on page 12 to provide a convenient means of recording the tasks of the Reset key. (The typical factory setting is unlatch).

Sub Menu 35 - Rate Meter Decimal Point

The rate meter can have a decimal point set in any of six positions. Use the 0-5 keys to select the desired decimal point position. The decimal point selected here is shown in the rate display, the rate hi/lo setpoints and the rate 4-20 mA output setpoints. Using 4 or 5 decimal places will truncate 1 or 2 letters from the rate display header. Please Note: Placement of the decimal point on the display does not rescale the programmed rate multiplier value. See Sub Menu 12.
PROGRAM RATE METER (cont.)

**Sub Menu 36 - Rate Meter Zero Time-out**

The rate meter displays zero rate when the time interval between input pulses exceed the programmed rate zero time. The timer can be set from 1 to 15 seconds. Use the Clear, number and Enter keys to enter a new timer value.

**Sub Menu 37 - Rate Display Header**

The rate units of measure (up to three characters) can be programmed into the unit and will be shown along with the rate value and rate setpoints on the display. (The totalizer display does not show a unit of measure.) If the rate data exceeds four digits, the rate header will be shifted off the display one character for each additional digit.

Use the < and > keys to cause the selected character to blink. Then use the ^ key to scroll through the alphabet. Blank (no character) is between Z and A.

**PROGRAM OTHER**

**Sub Menu 41 - Setpoint Lock**

The totalizer and rate meter hi/lo setpoints can be selectively locked to their current value by locking them in the program mode. Use number keys 2, 4 and 5 to select a setpoint (total, low alarm or high alarm, respectively). Use the up arrow key to select if the setpoint should be locked to it's current value or left open for operator changeability. (The factory default is all keys open.)

**Sub Menu 42 - Password**

A password can be programmed into the unit to provide password access to the program mode. The unit as it comes from the factory does not require the entry of a password to gain access to the program mode. This is accomplished by programming all zeros into the password data field. Entering a number from 1 to 6 digits in length into the password data field activates the password access to the program mode.

In the run mode of operation, a means of entering into the program mode is provided if the password was lost. When the unit prompts the user for PASSWORD, key in 1111111111 Enter.

**Sub Menu 43 - Communication Baud Rate and Parity**

The baud rate and parity are set in this menu. Enter a baud rate of 300, 600, 1200, 2400, 4800, 9600 or 19200 by using the Clear, number and Enter keys. Enter EVEN, ODD or SPACE parity by using the up arrow key.

**Sub Menu 44 - Unit ID number and Response Delay Time**

The unit identification number is set in this menu. Each unit on the communication bus must have a unique identifying number, 1 through 255. Enter the units ID by using the Clear, number and Enter keys. The length of time before the control response to communication requests can set to accommodate various types of computer equipment. Delay times of 0, 10, 100 and 500 milliseconds can be selected by using the up arrow key.

**Sub Menu 45 - Maximum Count Input Speed**

The maximum count input speed is selected in this menu. Use the up arrow key to select from: FAST (7.5 kHz), MED (400 Hz), SLOW (40 Hz). (The factory default is fast.)
**RESET KEY & CONTROL INPUT REFERENCE**

*Reset Key*

The Reset key is programmable to perform different tasks for the totalizer and rate meter functions of the unit. The Reset key can perform one task under each of the two major control functions shown below. The following table lists the tasks that can be selected. The boxes to the left are to mark your current settings.

<table>
<thead>
<tr>
<th>RESET KEY CONTROL FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>RATE</td>
</tr>
<tr>
<td>None</td>
</tr>
<tr>
<td>Unlatch Hi/Lo Alarms</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

*Control Inputs*

There are five control inputs which can be programmed to any of the functions shown in the chart below. An input can be assigned up to two tasks but only one task can be assigned under each of the two control functions shown below. The following table lists the tasks that can be selected.

<table>
<thead>
<tr>
<th>CONTROL FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL INPUT</td>
</tr>
<tr>
<td>RATE</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
**RS-485 SERIAL COMMUNICATIONS**

The Max 120 Indicator is equipped with an RS-485 serial communication port for the purpose of allowing a computer to:

1. Issue control commands such as reset.
2. Query run mode data such as count, rate, setpoints, etc.
3. Load setpoints.
4. Query and program all program mode sub menus except numbers 13, 15, 42, 43 & 44.

*Communicating with the Max 120 Indicator via RS-485 2-Wire Bus*

The Max 120 Indicator is equipped to communicate with a host computer via a 2-wire, differential, half duplex, multi-drop RS-485 bus.

1. All devices (like MAX 120) on the bus wait in the receive mode.
2. The host computer will, as needed, send a command to a specific device on the bus. The commands are several characters long, length being determined by how much data must be sent as part of the command.
   The second and third characters in a command are unit ID number.
3. When a device recognizes its ID number, it interprets the command, waits a 0 to 500 millisecond time interval which commences with receipt of the last command character’s stop bit and transmits a response. Then the device goes back to the receive mode and waits.
4. The host computer transmits a command as required and then switches to the receive mode to await the response from the device to which the command was transmitted.

*Communicating with the Max 120 Indicator via RS-232-C Bus*

RS-232-C equipped computers can be interfaced to the 120 by using a communications converter. See page 15.

*Programming Examples*

Starting on page 24 are examples of the code necessary to communicate with the MAX 120 over the RS-485 port. There is a version for Mircosoft Quick Basic and a version for HP Rocky Mountain Basic. These programs are just one of many ways to write a driver to communicate with the MAX 120. These programs are intended as examples and are a guide, but are not intended to be complete communications package.
RS-485 SERIAL COMMUNICATIONS (cont.)

Description Of Data Format

The serial data format consists of a start character (>), a two character unit ID number, a three character command, data for the command (if applicable), a two character checksum and a termination character.

The unit ID number and the checksum are in ASCII hexadecimal and have a range of 00 to FF. The checksum is the two least significant hexadecimal digits of the sum of the ASCII values of the unit ID number, the command and the data. All hexadecimal characters A through F must be in upper case. All leading zeroes in data fields must be sent. Decimal points within the data field are indicated by an ASCII comma. The termination character may be an ASCII carriage return or an ASCII decimal point.

Each character within the string is made up of ten serial bits. The first bit is the start bit, followed by seven data bits (ASCII code), followed by the parity bit and the tenth bit is the stop bit. If the unit is programmed to space parity, the unit ignores the received parity and transmits space parity.

Responses by the indicator consist of three possibilities:
1. A (acknowledge)
2. Ad..cc (acknowledge with data, d..., and checksum of the data, cc)
3. Nee (not acknowledge with a two digit error code, ee)

Example:
Command sent to indicator: >01RST18B.

Where:
> is the start character,
01 is the unit ID number,
RST is the three character command (reset),
1 is applicable data (reset option - reset only),
8B is the two least significant digits of the hexadecimal checksum,

```
0 1 R S T 1
```

30 +31 +52 +53 +54 +31 (hex) = 18B hexadecimal
and . is the termination character.

Error Codes:
01 Invalid Command
02 Communication Checksum Error
03 Buffer Overrun Error
05 Data Format Error
08 Parity or Framing Error
10 In Run Mode, Command not Allowed
12 In Program Mode, Command not Allowed
13 Mode Already Active. Command not Allowed
21 Data out of Range
RS-232-C TO RS-485 CONVERTER

If you have a computer which has a RS-232-C port and no RS-485 port, it is possible to communicate with a Max 120 Indicator using a RS-232-C to RS-485 converter. If you have tried to interface two pieces of equipment from different manufacturers, you know that the serial communications can be a hassle because there are so many ways to do it while still meeting (or almost meeting) the standard. RS-232-C communications can be done with as few as three wires (lines), or more if handshaking is used. Our objective here is to show you how this version of the RS-232-C and RS-485 standards works.

A RS-232-C to RS-485 converter is available from Max (P/N 1-490-38050) which has a 9-pin RS-232-C connector on one end and a terminal block on the other end. In the transmit mode, a Maxim 232 integrated circuit converts RS-232-C to TTL logic levels and a SN 75176 differential bus transceiver converts the TTL logic level signals to balanced transmission line outputs for RS-485. The reverse happens in the receive mode.

The RTS signal is used by the host computer to select transmit vs receive mode.
To send a command: RTS = 1 (string is sent out serial port).
To receive a response: RTS = 0 (string is received in serial port).

Specifications
Power Input: 120 VAC +/- 15%
RS-485: Conforms to the EIA RS-485 standard. RS-485 is a differential, half duplex, multi-drop protocol requiring a total of two wires. All voltage specifications are for terminal 1 (COMM+) with respect to terminal 2 (COMM-). Communication direction is controlled by the RS-232 RTS signal.

Input (RTS low):
1 condition (mark): -200mV max.
0 condition (space): 200 mV min.
Impedance: 12 K ohms
Hysteresis: 50 mV typ.

Output (RTS high):
1 condition (mark): -1.5 V max.
0 condition (space): 1.5 V min.
(into 54 ohm load.)

Maximum communication rate: 19200 baud
RS-485 SERIAL COMMANDS

Classifications
All serial commands fall into one of five classifications. These classifications are:
1. Control Commands
2. Query Run Data
3. Load Run Data
4. Query Program Data
5. Load Program Data

The Max 120 Indicator has two modes of operation: run mode and program mode. The indicator will respond to specific commands only if the command is valid for the mode of operation the unit is in when the command is received. Command validity is addressed in the following section and all specific commands are described in detail in the following tables.

Using The Control Commands
There are three control commands. Two of them, Enter Program Mode and Exit Program Mode are used to change the indicator’s mode of operation. The following flow chart illustrates the validity and function of each control command and the validity of the other four command classifications in each mode of operation. Note that the indicator goes into the run mode when it powers up.

The third control command, Reset, does not change the indicator’s mode of operation, but merely performs a reset and/or unlatch function while leaving the indicator in the run mode. The Reset control command is suffixed by one digit (a) which allows for secondary functions to occur along with the Reset function. All secondary functions are listed in the following control command table.
RS-485 SERIAL COMMANDS

Control Commands

All commands in the following tables are preceded by the start character (>) and unit number and succeeded by the two character checksum and carriage return.

<table>
<thead>
<tr>
<th>Command</th>
<th>Response</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSTa</td>
<td>A</td>
<td>RESET COMMAND where “a” determines functions to be performed.</td>
</tr>
</tbody>
</table>

Digit “a”
- = 1 - Reset Totalizer
- = 2 - Unlatch Totalizer Output
- = 3 - Reset Totalizer and Unlatch Totalizer Output
- = 4 - Unlatch Rate Alarms
- = 5 - Reset Totalizer & Unlatch Rate Alarms
- = 6 - Unlatch Totalizer Output & Rate Alarms
- = 7 - Reset Totalizer, and Unlatch Totalizer Output and Rate Alarm

EPM A ENTER PROGRAM MODE
PEX A EXIT PROGRAM MODE

Query Run Data Commands

This classification of commands allows the computer to read run data information such as status, count, rate, setpoint, etc. These commands are valid in run mode only, except for QST (query status), which is valid in all modes of operation.

The following Query Run Data commands are supported:

<table>
<thead>
<tr>
<th>Command</th>
<th>Response</th>
<th>Description</th>
</tr>
</thead>
</table>
| QST     | ASTabcd  | QUERY STATUS where
|         |          | a = Current Mode
|         |          | = R - Run Mode
|         |          | = P - Program Mode
|         |          | b = Totalizer Output Status
|         |          | = A - Output On
|         |          | = N - Output Off
|         |          | c = Rate High Alarm Status
|         |          | = A - Alarm On
|         |          | = N - No Alarm
|         |          | d = Rate Low Alarm Status
|         |          | = A - Alarm On
|         |          | = N - No Alarm
| QRT     | ARTaaaaaa| QUERY RATE where aaaaaaa = Rate
### Command | Response | Description |
|---|---|---|
| QTC | ATCaaaaaaaaaa | QUERY TOTALIZER COUNT  
where aaaaaaaaa = Totalizer Count |
| QRH | ARHaaaaaa | QUERY RATE HI SETPOINT  
where aaaaaa = Rate Hi Setpoint |
| QRL | ARLaaaaaa | QUERY RATE LO SETPOINT  
where aaaaaa = Rate Lo Setpoint |
| QTS | ATSaaaaaaaaaa | QUERY TOTALIZER SETPOINT  
where aaaaaaaaaa = Totalizer Setpoint |
| QMD | Aa... | QUERY MENU DATA  
where a... = Data Specified in Current Menu |
| QAP | Aab c... ab c... ... | QUERY ALL PROGRAM DATA  
where a = Program Menu Row  
b = Program Menu Column  
c = Applicable Data |

**Load Run Data Commands**

This classification of commands allows the computer to write setpoints to the indicator and specify the indicators response to the QMD command. These commands are valid only in the run mode. The following Load Run Data Commands are supported:

<table>
<thead>
<tr>
<th>Command</th>
<th>Response</th>
<th>Description</th>
</tr>
</thead>
</table>
| LRHaaaaaa | A | LOAD RATE HI SETPOINT  
where aaaaaa = Rate Hi Setpoint |
| LRLaaaaaa | A | LOAD RATE LO SETPOINT  
where aaaaaa = Rate Lo Setpoint |
| LTSaaaaaaaaaa | A | LOAD TOTALIZER SETPOINT  
where aaaaaaaaaa = Totalizer Setpoint |
| LCMab | A | LOAD COMMUNICATION MENU  
where ab determine the information that will be sent by the control when it is issued a QMD command. The following table illustrates the bit assignments for the available data. Setting the appropriate bits will cause that data to be sent. |

**Digit “a”**

<table>
<thead>
<tr>
<th>Bit</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Status</td>
</tr>
<tr>
<td>1</td>
<td>Flow Rate</td>
</tr>
<tr>
<td>2</td>
<td>Rate Low Setpoint</td>
</tr>
<tr>
<td>3</td>
<td>Rate High Setpoint</td>
</tr>
</tbody>
</table>

**Digit “b”**

<table>
<thead>
<tr>
<th>Bit</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Totalizer Count</td>
</tr>
<tr>
<td>1</td>
<td>Totalizer Setpoint</td>
</tr>
<tr>
<td>2</td>
<td>K-factor</td>
</tr>
<tr>
<td>3</td>
<td>Rate Multiplier</td>
</tr>
</tbody>
</table>
**Query Program Data / Load Program Data Commands**

Query commands allow the computer to read program data from the indicator and load commands allow the computer to write program data to the indicator. Each command consists of an L(load) or a Q(query) and the two digit submenu number of the program mode sub menu illustrated on page 6. All program mode sub menus are serially accessible except numbers 13, 15, 42, 43 and 44. These commands are valid only in the program mode.

Decimal Points are not required by the command except for those program blocks which allow for a floating decimal point. All other program blocks will insert the decimal point in the correct location.

<table>
<thead>
<tr>
<th>Command</th>
<th>Response</th>
<th>Description</th>
</tr>
</thead>
</table>
| L11 aaaaa | A | Load K-factor  
where aaaaa = K-factor  
(D.P. valid) |
| Q11 | A11 aaaaa | Query K-factor  
where aaaaa = K-factor |
| L12 aaaaaa | A | Load Rate Multiplier  
where aaaaaa = Multiplier  
(D.P. valid) |
| Q12 | A12 aaaaaa | Query Rate Multiplier  
where aaaaaa = Multiplier |
| L14 aaaaaa bbbbbb | A | Load Analog Rate  
where aaaaaa = 4 mA rate  
bbbbbbb = 20 mA Rate |
| Q14 | A14 aaaaaa bbbbbb | Query Analog Rate  
where aaaaaa = 4 mA rate  
bbbbbbb = 20 mA rate |
| L21 a b | A | Load Totalizer Control Input  
where a = Control Input (1-5)  
b = 0 - No function  
= 1 - Reset Totalizer  
= 2 - Unlatch Output  
= 3 - Reset and Unlatch |
| Q21 | A21 a b ... | Query All Totalizer Control Inputs  
where a = Control Input (1-5)  
b = 0 - No function  
= 1 - Reset Totalizer  
= 2 - Unlatch Output  
= 3 - Reset and Unlatch |
| L22 a | A | Load Totalizer Pulse Output Speed  
where a = 0 - No Pulse  
= 1 - Pulse Fast  
= 2 - Pulse Medium  
= 3 - Pulse Slow |
## RS-485 SERIAL COMMANDS

<table>
<thead>
<tr>
<th>Command</th>
<th>Response</th>
<th>Description</th>
</tr>
</thead>
</table>
| Q22     | A22 a    | Query Totalizer Pulse Output Speed  
  where a = 0 - No Pulse  
  = 1 - Pulse Fast  
  = 2 - Pulse Medium  
  = 3 - Pulse Slow |
| L23 aaaa| A        | Load Totalizer Output Time  
  where aaaa = Output Time |
| Q23     | A23 aaaa | Query Totalizer Output Time  
  where aaaa = Output Time |
| L24 a   | A        | Load Totalizer Reset Key Function  
  where a = Reset Key Function  
  = 0 - No Function  
  = 1 - Reset Totalizer  
  = 2 - Unlatch Output  
  = 3 - Reset and Unlatch |
| Q24     | A24 a    | Query Totalizer Reset Key Function  
  where a = Reset Key Function  
  = 0 - No Function  
  = 1 - Reset Totalizer  
  = 2 - Unlatch Output  
  = 3 - Reset and Unlatch |
| L25 a   | A        | Load Totalizer D.P. Location  
  where a = 0 - No Dec. Pt.  
  = 1 - XXXXXXXXXX.X  
  = 2 - XXXXXXXXX.XX  
  = 3 - XXXXXXXX.XXX  
  = 4 - XXXXX.XXXXX  
  = 5 - XXXX.XXXXXX |
| Q25     | A25 a    | Query Totalizer D.P. Location  
  where a = 0 - No Dec. Pt.  
  = 1 - XXXXXXXXXX.X  
  = 2 - XXXXXXXXX.XX  
  = 3 - XXXXXXXX.XXX  
  = 4 - XXXXX.XXXXX  
  = 5 - XXXX.XXXXXX |
| L31 aa  | A        | Load Rate meter Smoothing  
  where aa = Smoothing Fact. (05 - 75)  
  (Must be in steps of 5) |
| Q31     | A31 aa   | Query Rate meter Smoothing  
  where aa = Smoothing Factor |
## RS-485 SERIAL COMMANDS

<table>
<thead>
<tr>
<th>Command</th>
<th>Response</th>
<th>Description</th>
</tr>
</thead>
</table>
| L32 a b   | A          | Load Rate meter Control Input  
|           |            | where  
|           | a = Control Input (1-5)  
|           | b = 0 - No function  
|           | = 1 - Unlatch Alarms |
| Q32       | A32 a b ...| Query All Rate meter Control Inputs  
|           |            | where  
|           | a = Control Input (1-5)  
|           | b = 0 - No Function  
|           | = 1 - Unlatch Alarms |
| L33 a bbb cccc | A | Load Rate meter Output Function  
|             |            | where  
|             | a = 0 - Timed Outputs  
|             | bbb = Low Rate Output Time  
|             | cccc = High Rate Output Time |
| - or -    |            |  
| L33 a     |            | a = 1 - Outputs Follow |
| Q33       | A33 a bbb cccc | Query Rate meter Output Function  
|           |            | where  
|           | a = 0 - Timed Outputs  
|           | bbb = Low Rate Output Time  
|           | cccc = High Rate Output Time |
| - or -    |            |  
| Q33       | A33 a      | where  
|           | a = 1 - Outputs Follow |
| L34 a     | A          | Load Rate meter Reset Key Function  
|           |            | where  
|           | a = Reset Key Function  
|           | = 0 - No Function  
|           | = 1 - Unlatch Outputs |
| Q34       | A34 a      | Query Rate meter Reset Key Function  
|           |            | where  
|           | a = Reset Key Function  
|           | = 0 - No Function  
|           | = 1 - Unlatch Outputs |
| L35 a     | A          | Load Rate meter D.P. Location  
|           |            | where  
|           | a = 0 - No Dec. Pt.  
|           | = 1 - XXXXX.X  
|           | = 2 - XXXX.XX  
|           | = 3 - XXX.XXX  
|           | = 4 - XX.XXXX  
|           | = 5 - X.XXXXX |
| Q35       | A35 a      | Query Rate meter D.P. Location  
|           |            | where  
|           | a = 0 - No Dec. Pt.  
|           | = 1 - XXXXX.X  
|           | = 2 - XXXX.XX  
|           | = 3 - XXX.XXX  
|           | = 4 - XX.XXXX  
|           | = 5 - X.XXXXX |
### RS-485 SERIAL COMMANDS

<table>
<thead>
<tr>
<th>Command</th>
<th>Response</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>L36 aa</td>
<td>A</td>
<td>Load Zero Rate Time where aa = Zero Time (01 - 15)</td>
</tr>
<tr>
<td>Q36</td>
<td>A36 aa</td>
<td>Query Zero Rate Time where aa = Zero Time</td>
</tr>
<tr>
<td>L37 aaa</td>
<td>A</td>
<td>Load Rate Display Header where aaa = Rate Display Header (Space or Uppercase letters)</td>
</tr>
<tr>
<td>Q37</td>
<td>A37 aaa</td>
<td>Query Rate Display Header where aaa = Rate Display Header</td>
</tr>
<tr>
<td>L41 a b</td>
<td>A</td>
<td>Load Key Lock (Keys 2, 4, 5) where a = Key Number (2, 4, 5) b = 0 - Unlocked = 1 - Locked</td>
</tr>
<tr>
<td>Q41</td>
<td>A41 a b ...</td>
<td>Query Key Lock (Keys 2, 4, 5) where a = Key Number (2, 4, 5) b = 0 - Unlocked = 1 - Locked</td>
</tr>
<tr>
<td>L45 a</td>
<td>A</td>
<td>Load Count Speed where a = 0 - Low - 40 Hz Max. = 1 - Med. - 400 Hz Max. = 2 - High - 7500 Hz Max.</td>
</tr>
<tr>
<td>Q45</td>
<td>A45 a</td>
<td>Query Count Speed where a = 0 - Low - 40 Hz Max. = 1 - Med. - 400 Hz Max. = 2 - High - 7500 Hz Max.</td>
</tr>
</tbody>
</table>
MICROSOFT QUICK BASIC PROGRAM

REM EQUIPMENT:
REM COMPUTER WITH A RS-232 STANDARD SERIAL INTERFACE
REM RS-232 TO RS-485 COMMUNICATIONS CONVERTER
REM RS-232 CONFORMING TO EIA RS-232 RS-232D STANDARD
REM RS-485 CONFORMING TO EIA RS-485 STANDARD, DIFFERENTIAL,
REM HALF DUPLEX, MULTI-DROP PROTOCOL REQUIRING A TOTAL OF
REM TWO WIRES.
REM THIS PROGRAM IS IN MICROSOFT QUICK-BASIC
REM THE SERIAL INTERFACE PROGRAMMING TECHNIQUE IS SIMILAR TO
REM MOST GENERAL I/O APPLICATIONS, WITH THE EXCEPTION OF THE
REM RS-232 TO RS-485 COMMUNICATIONS CONVERTER. THE DIRECTION
REM IS CONTROLLED BY THE RTS SIGNAL.
COLOR 15, 9
CLS
KEY(1) ON
COMPORT$ = "COM1:": PARITY$ = "E": BAUD$ = "9600": HEADER$ = ">01": BITS$ = "7"
PT = &H3FC: PT1 = &H3FD
REM init communication variable
COMM$ = COMPORT$ + BAUD$ + ";" + PARITY$ + ";" + BITS$ + ";,,RS"
DO
GOSUB START
LOOP UNTIL SELECT$ = "Q"
CLS
PRINT " ENDING MAX MACHINERY INC. 120 METER SAMPLE PROGRAM"
END

START:
CLOSE : CLS : LOCATE , , 0
PRINT " MAX MACHINERY INC. 120 METER SAMPLE PROGRAM"
PRINT : PRINT " COMM PORT = "; COMPORT$;
PRINT " BAUD RATE = "; BAUD$; " PARITY = "; PARITY$; " UNIT NUMBER = ";
RIGHTS(HEADER$, 2)
PRINT " = SELECT COMMUNICATION PORT"
PRINT " 2 = RUN COMMUNICATIONS"
PRINT " Q = QUIT"
PRINT : PRINT " MAKE A SELECTION - ": PRINT : SELECT$ = INPUT$(1)
SELECT$ = UCASE$(SEND$)
IF SELECT$ = "Q" THEN RETURN
SELECTION = VAL(SELECT$)
REM*****KEY CHECK*****
IF SELECTION = 0 OR SELECTION > 2 THEN GOTO START
INITFLAG = 1
EXITFLAG = 0
ON SELECTION GOSUB PORT, SENDCOMM
INITFLAG = 0
DO
IF EXITFLAG = 0 THEN
GOSUB SENDCOMM
END IF
LOOP UNTIL EXITFLAG = 1
RETURN

PORT:
EXITFLAG = 1
CLOSE
PRINT " SELECT COMMUNICATION PORT"
PRINT " 1 = PORT 1"
PRINT " 2 = PORT 2"
PRINT : PRINT " PICK COMMUNICATION PORT OPTION - " : SELECT$ = INPUT$(1)
REM CHECK FOR VALID KEY
PORTSEL = VAL(SELECT$): IF PORTSEL = 0 OR PORTSEL > 2 THEN GOTO PORT
ON PORTSEL GOSUB PORT1, PORT2
GOSUB SETCOMM
RETURN
PORT1:
REM*****SET PORT 1 ADDRESS*****
COMPORT$ = "COM1:": PT = &H3FC: PT1 = &H3FD
RETURN
PORT2:
REM*****SET PORT 2 ADDRESS*****
COMPORT$ = "COM2:": PT = &H2FC: PT1 = &H2FD
RETURN
SETCOMM:
REM*****ASSEMBLE COMMS*****
COMMS = COMPORT$ + BAUD$ + "," + PARITY$ + "," + BITS$ + ",",RS"
RETURN
SENDCOMM:
IF INITFLAG = 1 THEN
KEY(2) ON
CLS
END IF
A$ = ""
INITFLAG = 0
LOCATE , , 1: PRINT
PRINT " ENTER COMMUNICATION COMMAND - (E = EXIT TO MENU): ";
ENTKEY:
SEND$ = INPUT$(1)
SEND$ = UCASE$(SEND$)
R = CSRLIN: C = POS(0)
IF ASC(SEND$) = 8 THEN
IF LEN(A$) > 0 THEN
A$ = LEFT$(A$, LEN(A$) - 1)
LOCATE , C - 1: PRINT " "; : LOCATE , C - 1
END IF
GOTO ENTKEY
END IF
REM*****IF A "PERIOD" IS IN THE STRING CHANGE IT TO COMMA*****
IF SEND$ = "." THEN
A$ = A$ + ","
PRINT "."; : LOCATE , , 1
GOTO ENTKEY
END IF
IF ASC(SEND$) <> 13 THEN
A$ = A$ + SEND$: PRINT SEND$; : LOCATE , , 1
GOTO ENTKEY
END IF
IF A$ = "" THEN
IF BUFF$ = "" THEN RETURN
END IF
CLS
REM*****CHECK FOR EXIT TO MAIN MENU*****
IF A$ = "E" THEN  
   EXITFLAG = 1  
RETURN  
END IF  
REM*****BUILD CHECKSUM FOR BUFFER*****  
BUFF$ = HEADERS$ + A$  
Y = 0  
FOR X = 2 TO LEN(BUFF$)  
   Y = Y + ASC(MID$(BUFF$, X, 1))  
NEXT X  
Y = Y MOD 256: CS$ = HEX$(Y)  
IF LEN(CS$) = 0 THEN CS$ = "00"  
IF LEN(CS$) = 1 THEN CS$ = "0" + CS$  
BUFF$ = BUFF$ + CS$  
LOCATE , , 1: PRINT  
PRINT : PRINT "COMMAND SENT = "; BUFF$  
REM*****SEND BUFFER OUTPUT*****  
CLOSE  
OPEN COMM$ FOR RANDOM AS #1  
OUT PT, 11  
PRINT #1, BUFF$  
DO  
   A = INP(PT1) - (INP(PT1) MOD 96)  
LOOP UNTIL A = 96  
OUT PT, 9  
C$ = ""  
REM*****FIND END OF TRANSFER*****  
DO  
   C$ = C$ + INPUT$(1, #1)  
LOOP UNTIL ASC(RIGHT$(C$, 1)) = 13  
C$ = LEFT$(C$, LEN(C$) - 1)  
OUT PT, 11  
Y = 0  
REM*****CHECK FOR ERROR CODE*****  
IF LEFT$(C$, 1) = "N" THEN  
   GOSUB RESPONSE  
   RETURN  
END IF  
REM*****CHECK FOR OK TRANSFER*****  
IF LEN(C$) = 1 AND C$ = "A" THEN  
   GOSUB RESPONSE  
   RETURN  
END IF  
REM*****CHECK FOR RETURN DATA CHECKSUM*****  
FOR X = 2 TO (LEN(C$) - 2)  
   Y = Y + ASC(MID$(C$, X, 1))  
NEXT X  
CSS = HEX$(Y MOD 256)  
IF LEN(CSS) = 0 THEN CSS = "00"  
IF LEN(CSS) = 1 THEN CSS = "0" + CSS  
IF CSS = RIGHT$(C$, 2) THEN  
   GOSUB RESPONSE  
   RETURN  
*** END OF MICRO SOFT QUICK BASIC PROGRAM ***
HP ROCKY MOUNTAIN BASIC PROGRAM

12 !
13 ! EQUIPMENT:
14 !
15 ! HP9000 MODEL 310 COMPUTER
16 !
17 ! HP98626 SERIAL INTERFACE, SELECT CODE = 9
18 !
19 ! RS-232 TO RS-485 COMMUNICATIONS CONVERTER
20 ! RS-232 CONFORMING TO EIA RS-232-D STANDARD
21 ! RS-485 CONFORMING TO EIA RS-485 STANDARD, DIFFERENTIAL, HALF DUPLEX,
22 ! MULTI-DROP PROTOCOL REQUIRING A TOTAL OF TWO WIRES.
23 !
24 ! THIS SERIAL INTERFACE PROGRAMMING TECHNIQUE IS SIMILAR TO MOST GENERAL
25 ! I/O APPLICATIONS, WITH THE EXCEPTION OF THE RS-232 TO RS-485
26 ! COMMUNICATIONS CONVERTER. THE DIRECTION OF THIS CONVERTER IS
27 ! CONTROLLED BY THE RS-232 RTS SIGNAL.
28 !
29 DIM Id number$[2],Command$[20],Unit_parity$[4],Return dat$(50)[1]
30 DIM Send more$[1],Variable$[160]
31 INTEGER Baud_rate,Id number
32 PRINTER IS CRT
33 KEY LABELS OFF
34 Id_number$="01"
35 Command$="RST1"
36 Unit_parity$="EVEN"
37 Baud_rate=9600
38 Error=0
39 CLEAR SCREEN
40 ON ERROR CALL Message
41 Change port:DISP "ENTER UNIT ID NUMBER, RANGE 00-FF HEX, DEFAULT = ";Id number$;
42 LINPUT "",Variable$
43 IF LEN(Variable$) THEN
44 Id_number$=Variable$
45 END IF
46 DISP "ENTER UNIT BAUD RATE 300,600,1200,2400,4800,9600,19200, DEFAULT = ";Baud_rate;
47 LINPUT " ",Variable$
48 IF LEN(Variable$) THEN
49 Baud_rate=VAL(Variable$)
50 END IF
51 DISP "ENTER UNIT PARITY ODD OR EVEN, DEFAULT = ";Unit parity$;
52 LINPUT " ",Variable$
53 IF LEN(Variable$) THEN
54 Unit_parity$=Variable$
55 END IF
56 New send:DISP "ENTER UNIT COMMAND, DEFAULT = ";Command$;
57 LINPUT " ",Variable$
58 IF LEN(Variable$) THEN
59 Command$=Variable$
60 END IF
61 CALL RS485(Id_number$,Command$,Unit_parity$,Baud_rate,Return dat$(*)
62 PRINT "RETURN DATA FROM RS485 = ";
63 I=0
64 Repeat
74    I=I+1
75    PRINT Return dat$(I);
76    UNTIL Return_dat$(I)=CHR$(13) ! FIND END OF DATA CARRIAGE RETURN
77    Send_more$="Y"
78    DISP "DO YOU WANT TO SEND MORE DATA Y/N, DEFAULT = ";Send_more$;
79    LINPUT " ",Variable$
80    IF LEN(Variable$) THEN
81        Send_more$=Variable$
82    END IF
83    CLEAR SCREEN
84    IF Send_more$="Y" THEN
85        Send_more$="N"
86        DISP "DO YOU WANT TO CHANGE THE SERIAL FORMAT Y/N, DEFAULT = ";Send_more$ ;
87        LINPUT " ",Variable$
88        IF LEN(Variable$) THEN
89            Send_more$=Variable$
90        END IF
91    IF Send_more$="Y" THEN GOTO Change_port
92    GOTO New_send
93    END IF
94    END
95    SUB Message
96    !
97    OFF ERROR
98    CLEAR SCREEN
99    PRINT " 
100    PRINT " 
101    Sc=9
102    SELECT ERRN
103    CASE 167
104        STATUS Sc,10;Uart_error ! GET UART ERROR INFO
105        IF BIT(Uart_error,1) THEN
106            PRINT "UART HAS A OVERRUN ERROR"
107        END IF
108        IF BIT(Uart_error,2) THEN
109            PRINT "UART HAS A PARITY ERROR"
110        END IF
111        IF BIT(Uart_error,3) THEN
112            PRINT "UART HAS A FRAMING ERROR"
113        END IF
114        IF BIT(Uart_error,4) THEN
115            PRINT "UART BREAK RECEIVED"
116        END IF
117        CASE ELSE
118            PRINT ERRM$
119        END SELECT
120    CLEAR SCREEN
121    END SUB
149 SUB RS485(Id_number$,Command$,Unit_parity$,INTEGER Baud_rate,Return_dat$(*) )
150 !
151 !**************RS485 PORT INTERFACE**********************
152 !
153 INTEGER Rs232_sc,i,Bytes,String_length,Position,Dec_total,Parity_enable
154 INTEGER Unit_parity,Stop_bit,Loop_num
155 DIM Output_format$[50],Return_error$[2]
156 DIM Rs485$[1000] BUFFER,Hex_value$[8],Checksum$[8]
157 DIM Error_code$[20]
158 !
159 ! Id_number$ IS A HEX VALUE 0-255 FOR UNIT ID SELECTION
160 ! THIS MUST MATCH THE UNIT ID NUMBER PRIOR TO
161 ! TALKING OVER THE RS485 PORT.
162 ! Command$ IS THE THREE CHARACTER COMMAND AND QUERY DATA.
163 ! Unit_parity$ IS THE PARITY THAT THE RS485 PORT IS PROGRAMMED TO
164 ! ONLY TWO SELECTIONS ARE AVAILABLE.
165 ! INPUT THE UNIT PARITY AS "ODD" OR "EVEN".
166 ! Baud_rate IS THE RS485 BAUD RATE, SELECTIONS ARE.
167 ! 300,600,1200,2400,4800,9600,19200
168 ! Return_dat$ IS THE DATA RETURNED FROM THE RS485 PORT
169 ! THIS DATA HAS ALL THE QUERY RESPONSE
170 
171 ON ERROR CALL Message
172 Rs232_sc=9 ! RS232 PORT ADDR
173 Parity_enable=8  ! PARITY IS ENABLED
174 Stop_bit=0 ! 1 STOP BIT
175 Data_bits=2  ! 7 DATA BITS
176 IF Unit_parity$="ODD" THEN
177 Unit_parity=0 ! ODD PARITY BIT
178 ELSE
179 Unit_parity=16! EVEN PARITY BIT
180 END IF
181 MAT Return_dat$= ("X")
182 ON ERROR CALL Message
183 !
184 !***************SET UP PORT******************************
185 !
186 CONTROL Rs232_sc,5;0 !NORMAL MODEM LINE HANDSHAKE
187 CONTROL Rs232_sc,3;Baud_rate !SET BAUD RATE
188 CONTROL Rs232_sc,4;Parity_enable+Stop_bit+Unit_parity+Data_bits
189 !
190 !***************SET UP BUFFER********************************
191 !
192 ASSIGN @Rs232path TO Rs232_sc !CREATE PORT PATH
193 ASSIGN @Rs485path TO BUFFER Rs485$;FORMAT ON !CREATE PORT TO BUFFER
194 !
195 !****************************************************************************
196 !CALCULATE CHECKSUM****************************************************************************
197 
198 Dec_total=0
199 Output_format$=Id_number$&Command$
200 String_length=LEN(Output_format$)
201 FOR Position=1 TO String_length
202 Dec_total=Dec_total+(NUM(Output format$[Position]))
203 NEXT Position
Hex_value$=DVAL$(Dec total,16)
Checksum$=Hex_value$[7]

!***********************************************************SEND DATA***********************************************************

PRINT "THE OUTPUT IS = >";Output_format$;
PRINT Checksum$
OUTPUT Rs232_sc;"">&Output_format$&Checksum$&CHR$(13)! SEND MESSAGE
!
!***********************************************************RECIEVE DATA***********************************************************
!
TRANSFER @Rs232path TO @Rs485path;CONT !MOVE DATA FROM PORT TO BUFFER
I=0

Loop_num=0
REPEAT
Loop_num=Loop_num+1
STATUS @Rs485path,4;Bytes ! FIND NUMBER OF BYTES IN BUFFER
IF Bytes>=1 THEN ! ONLY READ IF BYTES ARE AVAILABLE
 I=I+1
 ENTER @Rs485path USING ";K";Return_dat$(I)
 Loop_num=0
END IF
!
IF Loop_num=50 THEN ! SET FOR 5 SEC TIMEOUT
 I=1
 Return_dat$(I)=CHR$(13) ! SEARCH FOR CARRIAGE RETURN
END IF
UNTIL Return_dat$(I)=CHR$(13) ! FIND END OF TRANSFER INTO BUFFER
!
RETURN @Rs232path ! TERMINATE TRANSFER
!
!**********************************************************DETERMINE IF ERROR CODE IS RECEIVED**************************
!
IF Return_dat$(1)="N" THEN
 Return_error$=Return_dat$(2)&Return_dat$(3) ! USE TWO DIGIT ERROR
 ! CODE NUMBER
 CALL Errorl20(Return_error$)
END IF
!
IF Return_dat$(1)=CHR$(13) THEN !SEARCH FOR CARRIAGE RETURN
 Return_error$="20"
 CALL Errorl20(Return_error$)
END IF
SUBEND
!
INTEGER Error_num
Error_num=VAL(Return_error$)
CLEAR SCREEN
PRINT " "
PRINT "RESPONSE BY THE INDICATOR IS AN ERROR CODE"
BEEP
276 PRINT ""
277 SELECT Error_num
278 CASE 1
279 PRINT "INVALID COMMAND WAS SENT"
280 CASE 2
281 PRINT "COMMUNICATION CHECKSUM ERROR"
282 CASE 3
283 PRINT "BUFFER OVERRUN ERROR"
284 CASE 5
285 PRINT "DATA FORMAT ERROR"
286 CASE 8
287 PRINT "PARITY OR FRAMING ERROR"
288 CASE 10
289 PRINT "IN RUN MODE, COMMAND NOT ALLOWED"
290 CASE 12
291 PRINT "IN PROGRAM MODE, COMMAND NOT ALLOWED"
292 CASE 13
293 PRINT "MODE ALREADY ACTIVE. COMMAND NOT ALLOWED"
294 CASE 20
295 PRINT "NO DATA WAS RECEIVED FROM RS485 PORT"
296 CASE 21
297 PRINT "DATA OUT OF RANGE"
298 END SELECT
299 PRINT ""
300 PRINT "DETERMINE SOURCE OF ERROR"
301 DISP "PRESS ENTER TO CONTINUE ";"
302 LINPUT " ",Variable$ 
303 SUBEND 
*** END OF HP BASIC PROGRAM ***