INSTRUCTION MANUAL

120 FLOW RATE & TOTAL INDICATOR

Table of Contents

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 (125μsec), 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.
	115/230V〰 devices to be installed as category II over voltage.

  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

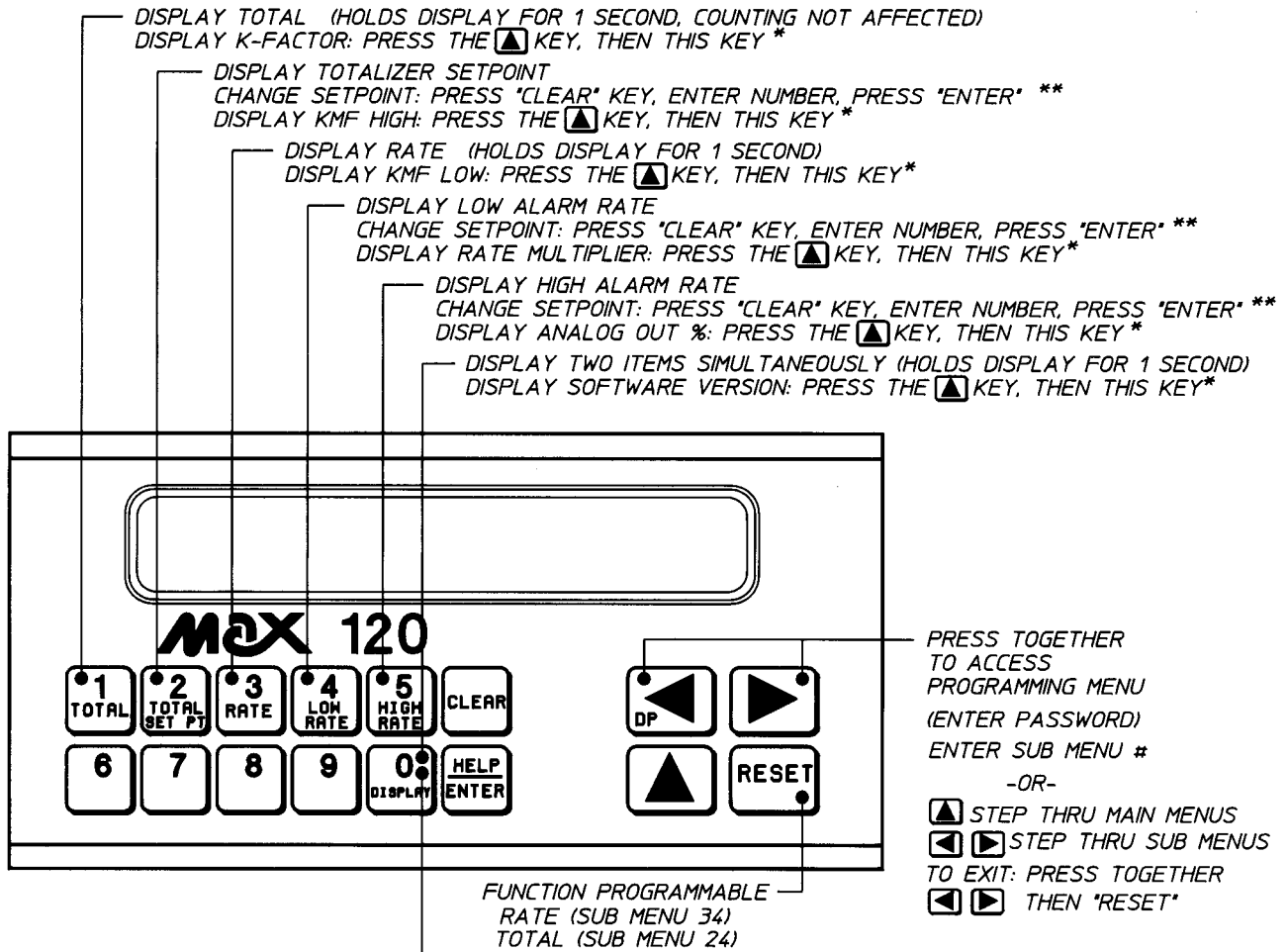 | | |
  |---|---|
  | Type: | Requires current sinking device such as contact closure to ground or NPN transistor to ground. |
  | Impedance: | 5.8kΩ to +5 VDC |
  | Voltage: | High 2.8 to 24 VDC   Low 0.0 to 1.3 VDC |
  | Response: | High 0 - 7.5 kHz, min. pulse width 50 μS |
  | | Med. 0 - 400 Hz, 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 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 KMF HIGH: PRESS THE ▲ KEY, THEN THIS KEY *

DISPLAY RATE (HOLDS DISPLAY FOR 1 SECOND)
DISPLAY KMF 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 *

MΩX 120

Keys: 1 TOTAL | 2 TOTAL SET PT | 3 RATE | 4 LOW RATE | 5 HIGH RATE | CLEAR
6 | 7 | 8 | 9 | 0 DISPLAY | HELP ENTER
◄ DP | ► | ▲ | RESET

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"

FUNCTION PROGRAMMABLE
RATE (SUB MENU 34)
TOTAL (SUB MENU 24)

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
"ANA OUTPUT ERROR" = 4mA OUTPUT GREATER THAN 20mA OUTPUT
"OVERFLOW" = RATE GREATER THAN 999999
"PULSE ERROR" = PULSE OUTPUT BUFFER FULL
"STORE ERROR" = SEE SUBMENU 15

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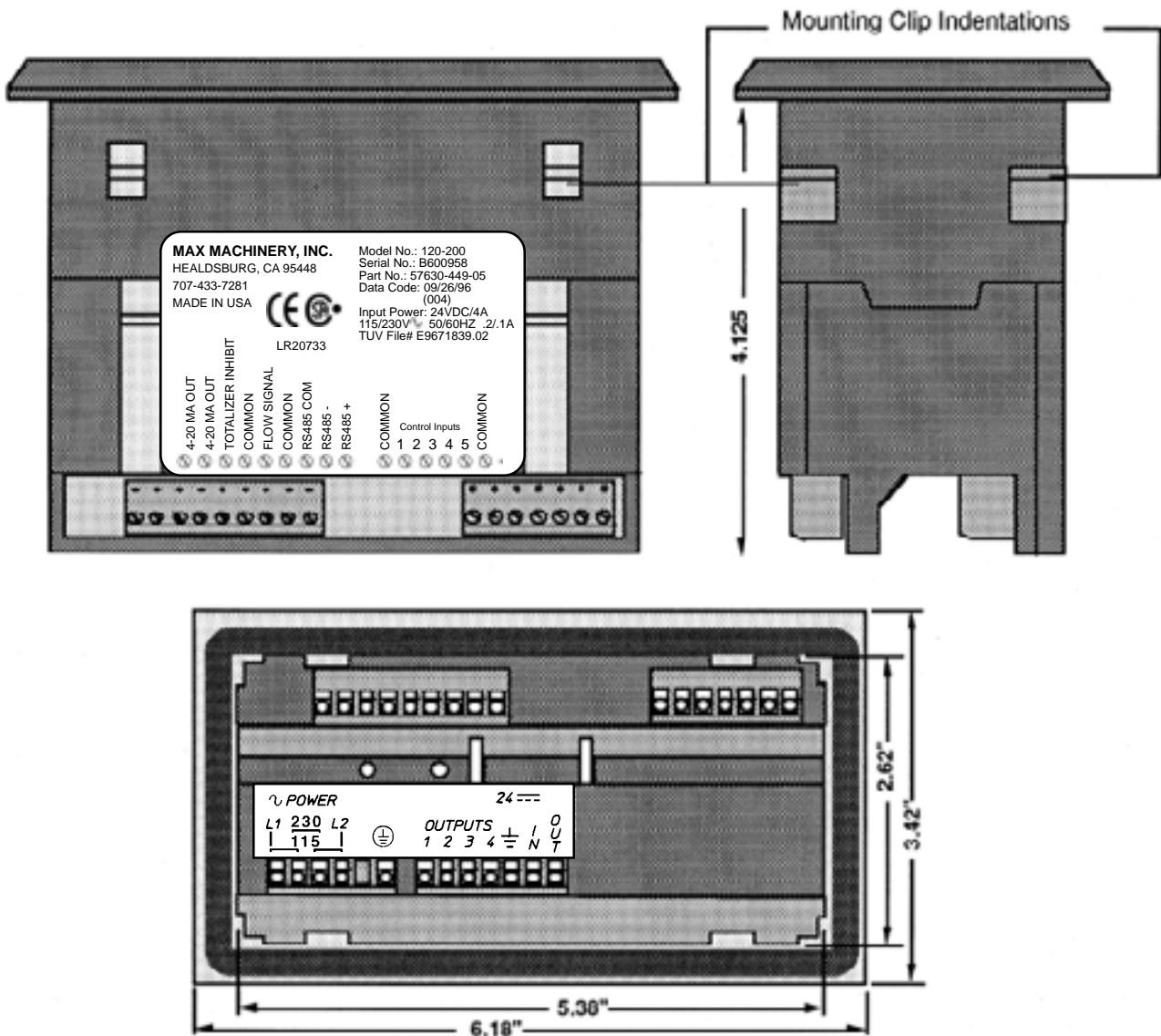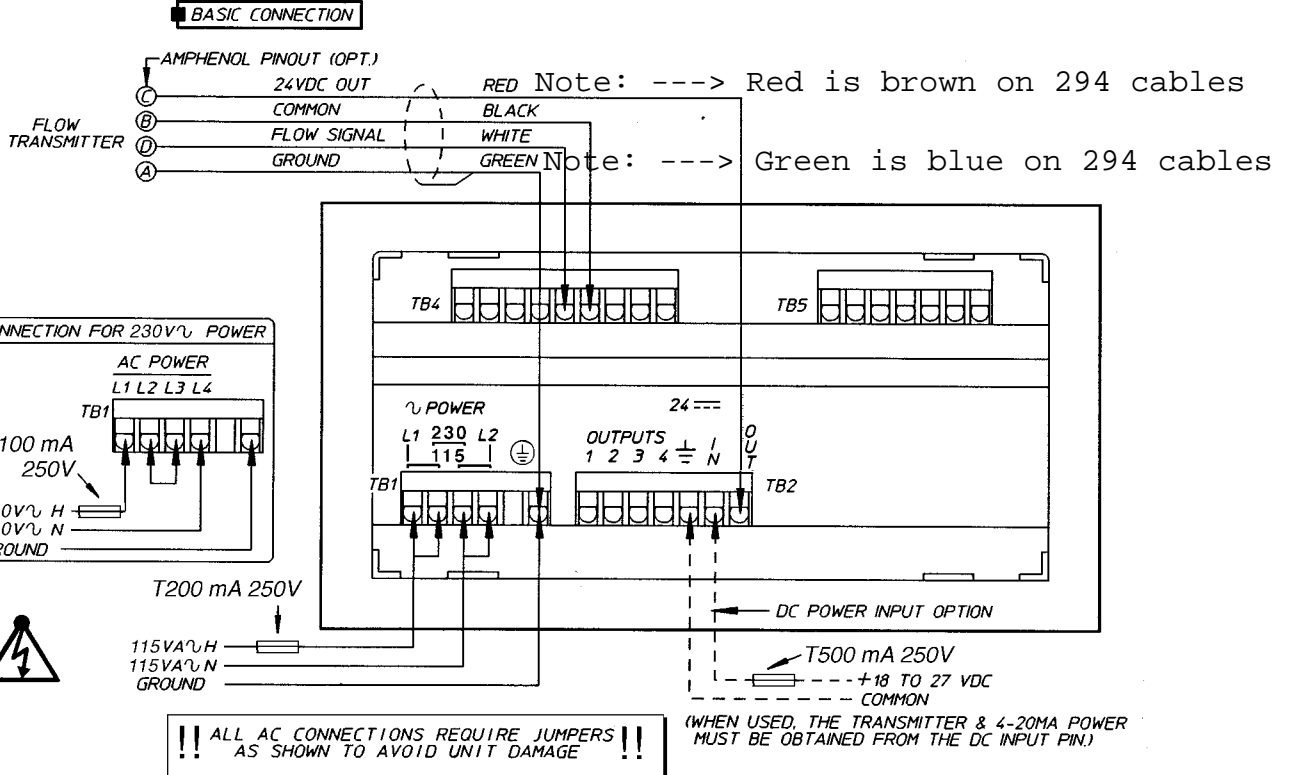** ACCESS MAY BE DENIED VIA PROGRAM SUB MENU 41

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

RS485 +
RS485 −
RS485 COMMON
COMMON
FLOW METER SIGNAL
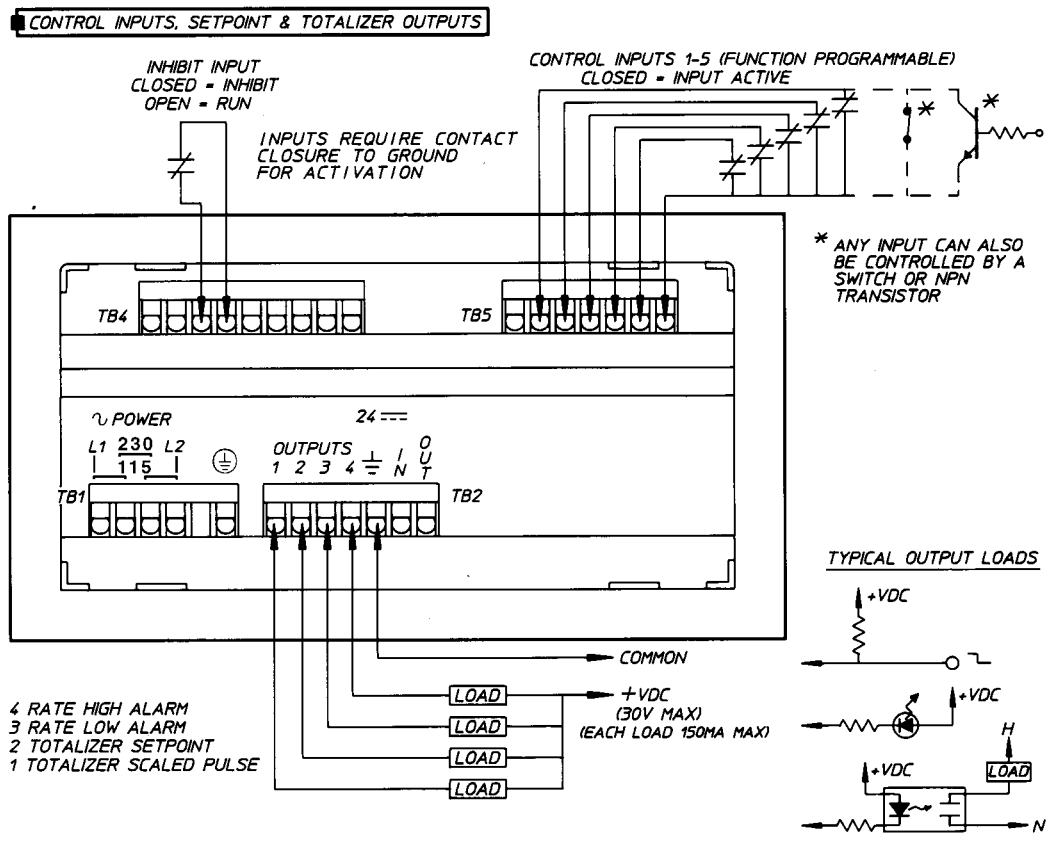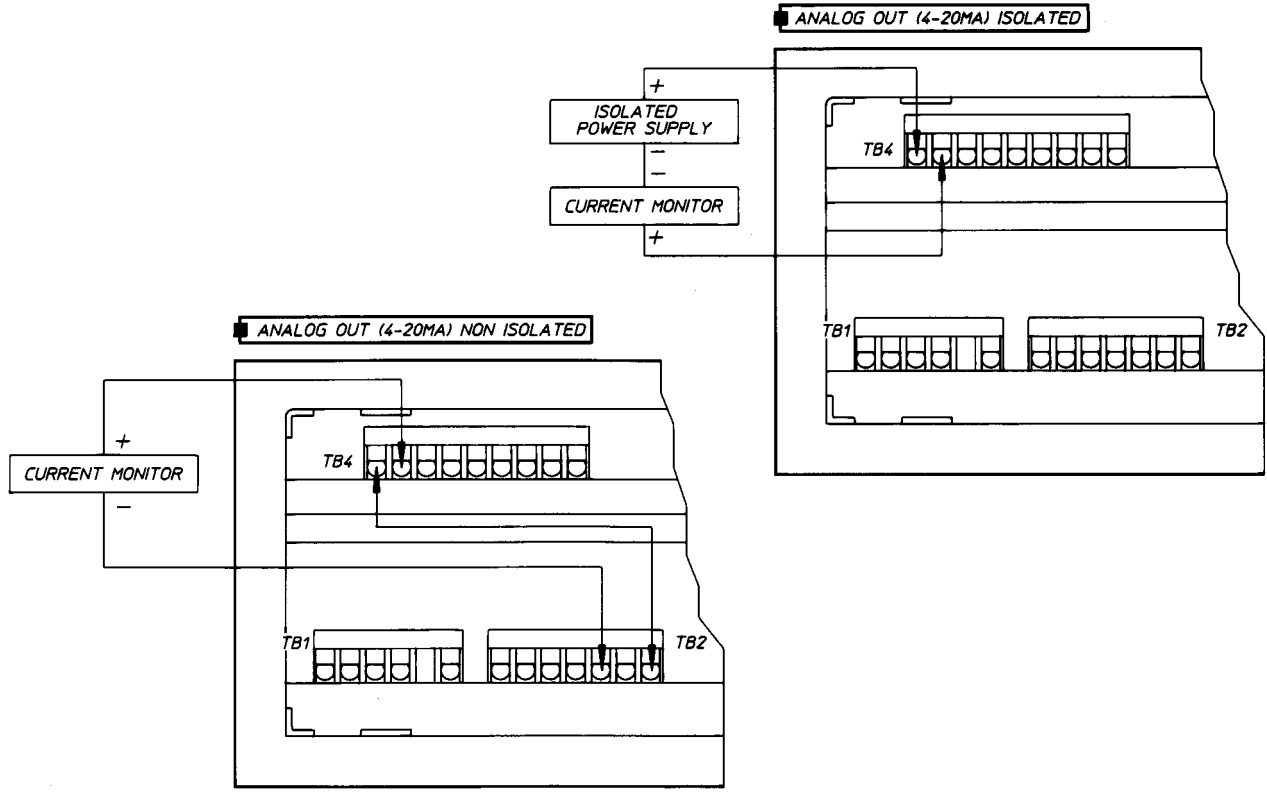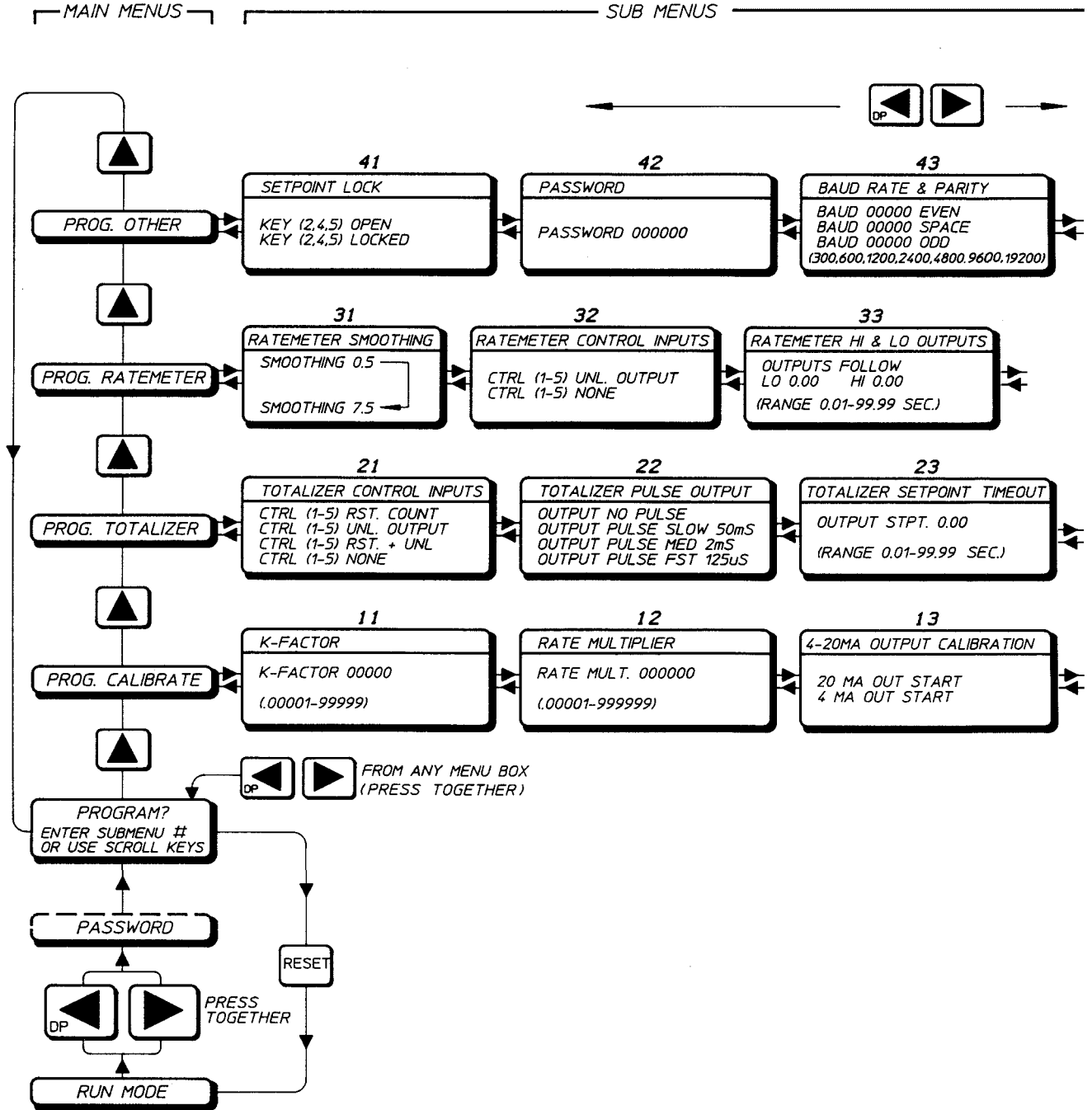COMMON
TOTALIZER INHIBIT
4-20MA OUT −
** 4-20MA OUT +

COMMON
CONTROL INPUT 1
CONTROL INPUT 2
CONTROL INPUT 3
CONTROL INPUT 4
CONTROL INPUT 5
COMMON

TB4   TB5

∿ POWER   24 ⎓

L1 230 L2   OUTPUTS   ⎓ I   O
   115   ⊕   1 2 3 4   N   U
                                    T
TB1   TB2

AC INPUT

GROUND

24VDC OUT *
18 TO 27 VDC IN
COMMON
OUTPUT 4 RATE HIGH ALARM
OUTPUT 3 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

■ BASIC CONNECTION

AMPHENOL PINOUT (OPT.)

Ⓒ   24VDC OUT   RED Note: ---> Red is brown on 294 cables
FLOW   Ⓑ   COMMON   BLACK
TRANSMITTER Ⓓ   FLOW SIGNAL   WHITE
Ⓐ   GROUND   GREEN Note: ---> Green is blue on 294 cables

TB4   TB5

CONNECTION FOR 230V∿ POWER

AC POWER
L1 L2 L3 L4
TB1

T100 mA
250V

230V∿ H
230V∿ N
GROUND

∿ POWER   24 ⎓

L1 230 L2   OUTPUTS   ⎓ I   O
   115   ⊕   1 2 3 4   N   U
                                    T
TB1   TB2

T200 mA 250V

DC POWER INPUT OPTION

115VA∿ H
115VA∿ N
GROUND

T500 mA 250V
+18 TO 27 VDC
COMMON

(WHEN USED, THE TRANSMITTER & 4-20MA POWER
MUST BE OBTAINED FROM THE DC INPUT PIN.)

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

■ ANALOG OUT (4-20MA) ISOLATED

ISOLATED POWER SUPPLY
+
−
−
CURRENT MONITOR
+

TB4

TB1   TB2

■ ANALOG OUT (4-20MA) NON ISOLATED

CURRENT MONITOR
+
−

TB4

TB1   TB2

■ 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

TB4   TB5

∿ POWER   24 ⎓

L1 230 L2   OUTPUTS   ⏚ I O
⎯⎯⎯⎯⎯⎯   1 2 3 4 ⎯ N U
   115   T
TB1   TB2

COMMON

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

LOAD   +VDC
LOAD   (30V MAX)
LOAD   (EACH LOAD 150MA MAX)
LOAD

TYPICAL OUTPUT LOADS

+VDC

+VDC

+VDC

H
LOAD
N

■ PROGRAMMING MENUS

─ MAIN MENUS ─   ───────────────── SUB MENUS ─────────────────

◀DP ▶

41
SETPOINT LOCK

PROG. OTHER   KEY (2,4,5) OPEN
KEY (2,4,5) LOCKED

42
PASSWORD

PASSWORD 000000

43
BAUD RATE & PARITY
BAUD 00000 EVEN
BAUD 00000 SPACE
BAUD 00000 ODD
(300,600,1200,2400,4800,9600,19200)

31
RATEMETER SMOOTHING
SMOOTHING 0.5

PROG. RATEMETER   SMOOTHING 7.5

32
RATEMETER CONTROL INPUTS

CTRL (1-5) UNL. OUTPUT
CTRL (1-5) NONE

33
RATEMETER HI & LO OUTPUTS
OUTPUTS FOLLOW
LO 0.00   HI 0.00
(RANGE 0.01-99.99 SEC.)

21
TOTALIZER CONTROL INPUTS
CTRL (1-5) RST. COUNT
CTRL (1-5) UNL. OUTPUT
CTRL (1-5) RST. + UNL
CTRL (1-5) NONE

PROG. TOTALIZER

22
TOTALIZER PULSE OUTPUT
OUTPUT NO PULSE
OUTPUT PULSE SLOW 50mS
OUTPUT PULSE MED 2mS
OUTPUT PULSE FST 125uS

23
TOTALIZER SETPOINT TIMEOUT
OUTPUT STPT. 0.00

(RANGE 0.01-99.99 SEC.)

11
K-FACTOR

PROG. CALIBRATE   K-FACTOR 00000

(.00001-99999)

12
RATE MULTIPLIER

RATE MULT. 000000

(.00001-999999)

13
4-20MA OUTPUT CALIBRATION

20 MA OUT START
4 MA OUT START

◀DP ▶   FROM ANY MENU BOX
(PRESS TOGETHER)

PROGRAM?
ENTER SUBMENU #
OR USE SCROLL KEYS

PASSWORD

◀DP ▶   PRESS
TOGETHER

RESET

RUN MODE

—————————————— SUB MENUS ——————————————————

44

ID# & RESPONSE DELAY

ID 000 TIME   0
ID 000 TIME   10
ID 000 TIME 100   (ID 1-255)
ID 000 TIME 500

45

MAXIMUM COUNT SPEED

COUNT SPEED FAST (7.5kHz)
COUNT SPEED MED (400 kHz)
COUNT SPEED SLOW (40 Hz)

34

RATEMETER RESET KEY

RESET UNL. HI/LO
RESET NONE

35

RATEMETER DECIMAL POINT

DEC. PT. 000000

(0-5 KEYS)

36

RATEMETER ZERO TIMEOUT

RATE AT ZERO 00

(RANGE 1-15 SECONDS)

37

RATEMETER DISPLAY HEADER

RATE HEADER XXX

(RANGE A-Z & BLANK)

24

TOTALIZER RESET KEY

RESET RST. COUNT
RESET UNL. OUTPUT
RESET RST. + UNL.
RESET NONE

25

TOTALIZER DECIMAL POINT

DEC. PT. 0000000000

(0-5 KEYS)

14

4-20MA OUTPUT RANGE

20 MA RATE 000000
4 MA RATE 000000

15

DIAGNOSTICS

8.8.8.8.8.8.8.8.8.8.8.8.8.8.8.8
****
TEST IN PROCESS
SYSTEM TEST OK

▲ SCROLLS THRU CHOICES WITHIN SUBMENUS

HELP/ENTER "HELP" DISPLAYS PROGRAMMING INFORMATION; ANY KEY EXITS
USE "ENTER" TO INPUT NEW NUMBERS

CLEAR USE TO CLEAR NUMERIC DISPLAY PRIOR TO ENTERING NEW NUMBER

ALL INPUT FUNCTIONS ARE INHIBITED IN THE PROGRAM MODE.

Programming

PROGRAM CALIBRATE

Sub Menu 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)

Sub Menu 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:

$$Rm = \frac{\text{\# of seconds in time unit x totalizer decimal location}}{\text{Desired rate decimal location}}$$

For Example:

1.   If rate is to read to 0.1 cc/min (total displays 0.1 cc)

$$Rm = \frac{60 \text{ sec/min x 0.1 total decimal}}{0.1 \text{ rate decimal location}} = 60$$

2. a. If rate is to read to 0.001 gal/min (total displays 0.0001 gallons)

$$Rm = \frac{60 \text{ sec/min x 0.0001 total decimal}}{0.001 \text{ rate decimal location}} = 6$$

   b. If rate is to read to 0.1 gal/hr (total displays 0.0001 gallons)

$$Rm = \frac{3600 \text{ sec/hr x 0.0001 total decimal}}{0.1 \text{ rate decimal location}} = 3.6$$

Programming (cont.)

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

Total display engineering units = xxxxxxxx.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

$$Rm = \frac{60 \text{ sec/min x 0.1 (total decimal)}}{0.01 \text{ (rate display decimal)}} = 600$$

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 = xxxxxxxx.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

$$\frac{402.9 \text{ pulses/liter}}{0.84 \text{ kg/liter}} = 479.64 \text{ pulses/kg}$$

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

$$Rm = \frac{3600 \text{ sec/hr x 0.1 (total decimal)}}{0.1 \text{ (rate display decimal)}} = 3600$$

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.

Test Failure	Error Message	
	Program Diagnostics	Power Up Diagnostics
ROM checksum error Int. RAM bit error Ext. RAM bit error EXT. RAM checksum error	ROM ERROR INTERNAL ERROR EXTERNAL ERROR N/A	ROM ERROR RAM ERROR EXT RAM ERROR STORE ERROR

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 µ sec, 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.

RESET KEY CONTROL FUNCTION	
RATE	TOTAL
☐ None ☐ Unlatch Hi/Lo Alarms	☐ None ☐ Reset Count ☐ Unlatch Output ☐ Reset & Unlatch

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.

| CONTROL INPUT	CONTROL FUNCTION	
	RATE	TOTAL
1	☐ None ☐ Unlatch Alarms	☐ None ☐ Reset Count ☐ Unlatch Output ☐ Reset & Unlatch
2	☐ None ☐ Unlatch Alarms	☐ None ☐ Reset Count ☐ Unlatch Output ☐ Reset & Unlatch
3	☐ None ☐ Unlatch Alarms	☐ None ☐ Reset Count ☐ Unlatch Output ☐ Reset & Unlatch
4	☐ None ☐ Unlatch Alarms	☐ None ☐ Reset Count ☐ Unlatch Output ☐ Reset & Unlatch
5	☐ None ☐ Unlatch Alarms	☐ None ☐ Reset Count ☐ Unlatch Output ☐ Reset & Unlatch

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.

RS-485 LINE
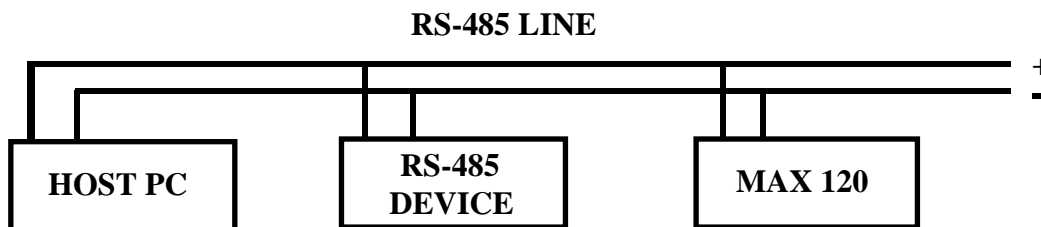
1. All devices (like MAX 120) on the bus wait in the receive mode.

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.
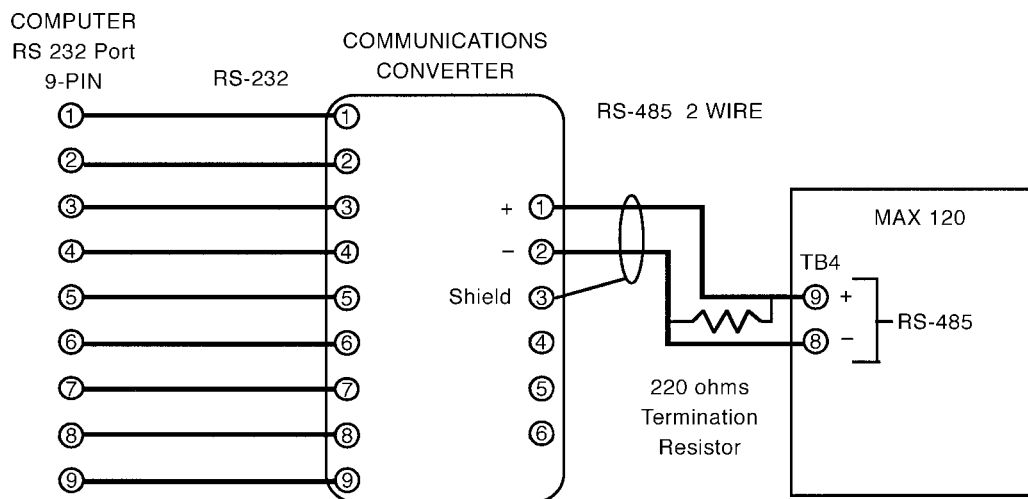
The RTS signal is used by the host computer to select transmit vs receive mode.

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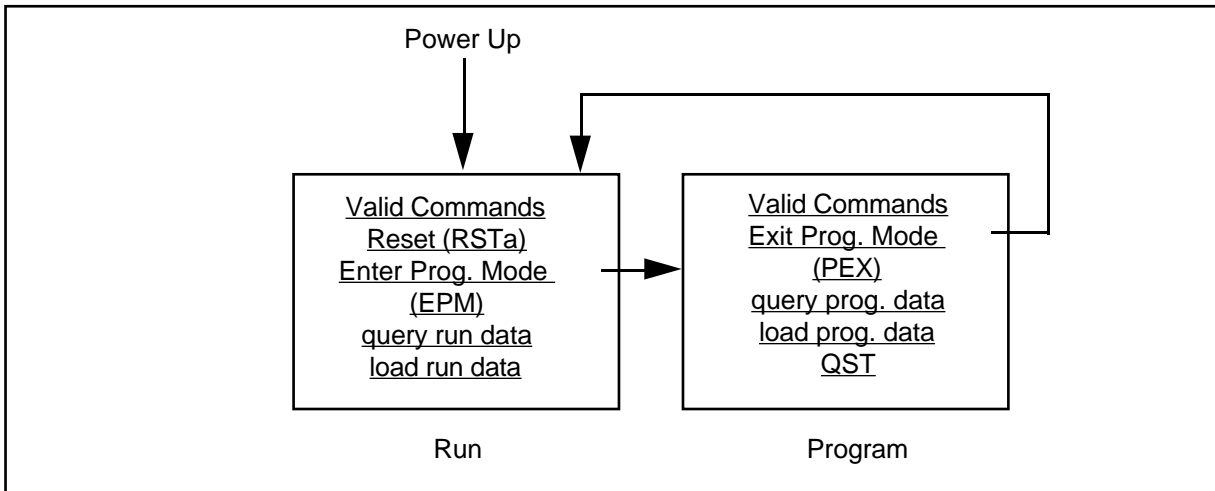
The third control command, Reset, does not change the indicator's mode of operation, but merely performs a reset and/or unlatch function while leaving the indicator in the run mode. The Reset control command is suffixed by one digit (a) which allows for secondary functions to occur along with the Reset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

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.

Command	Response	Description
RSTa	A	RESET COMMAND where "a" determines functions to be performed.

	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

Command	Response	Description
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:

Command	Response	Description

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 aaaaaa = Rate

Command	Response	Description
QTC	ATCaaaaaaaaaa	QUERY TOTALIZER COUNT
		where aaaaaaaaaa = 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:

Command	Response	Description
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"	Bit 0	Status
(0-F)	Bit 1	Flow Rate
	Bit 2	Rate Low Setpoint
	Bit 3	Rate High Setpoint
Digit "b"	Bit 0	Totalizer Count
(0-F)	Bit 1	Totalizer Setpoint
	Bit 2	K-factor
	Bit 3	Rate Multiplier

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.

Command	Response	Description
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 bbbbbb = 20 mA Rate
Q14	A14 aaaaaa bbbbbb	Query Analog Rate where aaaaaa = 4 mA rate bbbbbb = 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

| Command	Response	Description

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 - XXXXXXXX.X
		    = 2 - XXXXXXXX.XX
		    = 3 - XXXXXXX.XXX
		    = 4 - XXXXXX.XXXX
		    = 5 - XXXXX.XXXXX

Q25	A25 a	Query Totalizer D.P. Location
		where a = 0 - No Dec. Pt.
		    = 1 - XXXXXXXX.X
		    = 2 - XXXXXXXX.XX
		    = 3 - XXXXXXX.XXX
		    = 4 - XXXXXX.XXXX
		    = 5 - XXXXX.XXXXX

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

Command	Response	Description

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 bbbb cccc	A	Load Rate meter Output Function
		where a = 0 - Timed Outputs
		         bbbb = Low Rate Output Time
		         cccc = High Rate Output Time

- or - L33 a		a = 1 - Outputs Follow

Q33	A33 a bbbb cccc	Query Rate meter Output Function
		where a = 0 - Timed Outputs
		         bbbb = 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

Command	Response	Description
L36 aa	A	Load Zero Rate Time where aa = Zero Time (01 - 15)
Q36	A36 aa	Query Zero Rate Time where aa = Zero Time
L37 aaa	A	Load Rate Display Header where aaa = Rate Display Header (Space or Uppercase letters)
Q37	A37 aaa	Query Rate Display Header where aaa = Rate Display Header

L41 a b	A	Load Key Lock (Keys 2, 4, 5)
		where a = Key Number (2, 4, 5)
		     b = 0 - Unlocked
		     = 1 - Locked

Q41	A41 a b ...	Query Key Lock (Keys 2, 4, 5)
		where a = Key Number (2, 4, 5)
		     b = 0 - Unlocked
		     = 1 - Locked

L45 a	A	Load Count Speed
		where a = 0 - Low - 40 Hz Max.
		     = 1 - Med. - 400 Hz Max.
		     = 2 - High - 7500 Hz Max.

Q45	A45 a	Query Count Speed
		where a = 0 - Low - 40 Hz Max.
		     = 1 - Med. - 400 Hz Max.
		     = 2 - High - 7500 Hz Max.
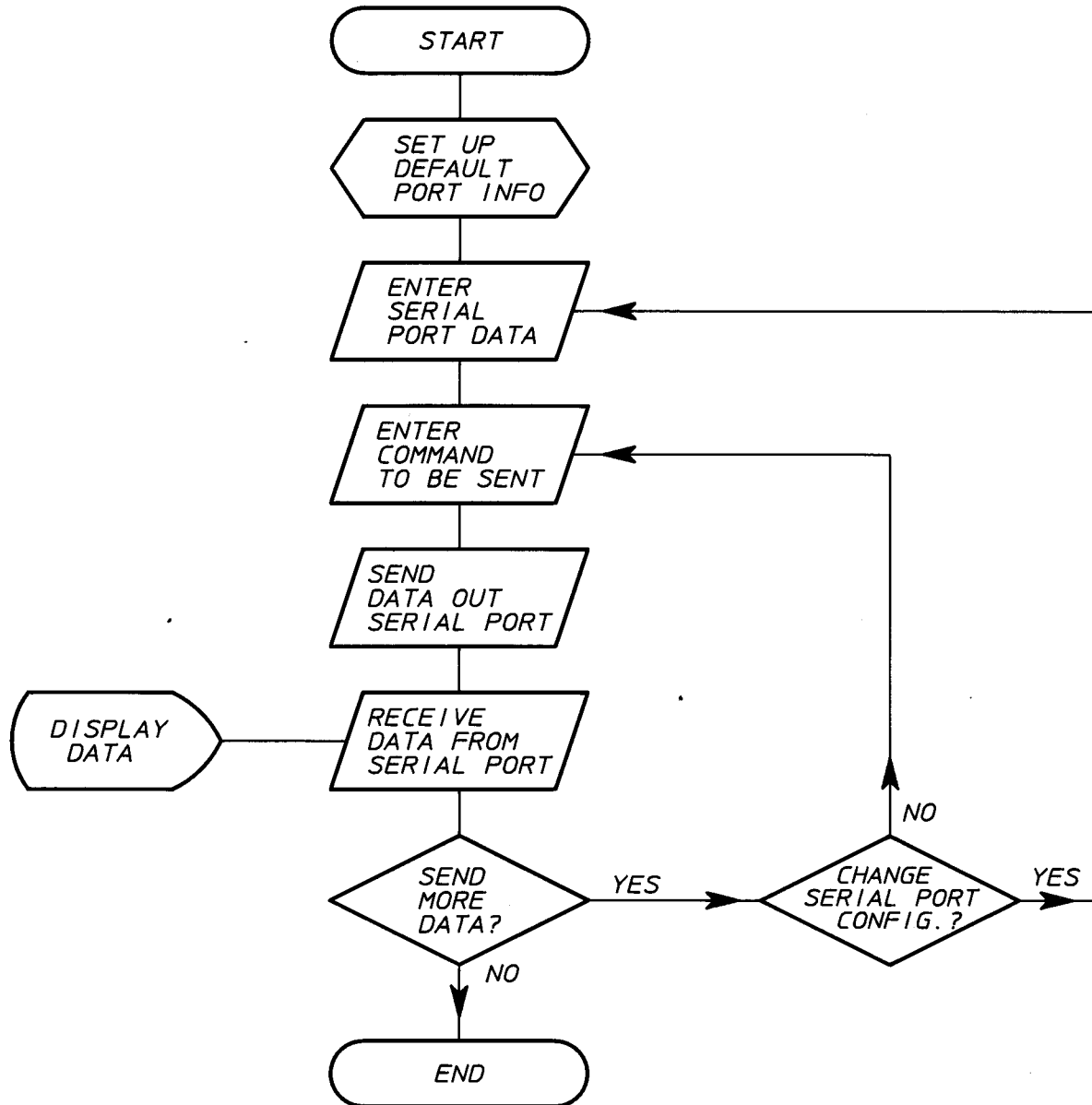
MICROSOFT QUICK BASIC PROGRAM

```
        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$; " UNIT NUMBER = ";
        RIGHT$(HEADER$, 2)
        PRINT : PRINT " 1 = SELECT COMMUNICATION PORT"
        PRINT " 2 = RUN COMMUNICATIONS"
        PRINT " Q = QUIT"
        PRINT : PRINT " MAKE A SELECTION - ": PRINT : SELECT$ = 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
        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 COMM$*****
        COMM$ = 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$ = HEADER$ + 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$, X, 1))
        NEXT X
        CS$ = HEX$(Y MOD 256)
        IF LEN(CS$) = 0 THEN CS$ = "00"
        IF LEN(CS$) = 1 THEN CS$ = "0" + CS$
        IF CS$ = RIGHT$(C$, 2) THEN
         GOSUB RESPONSE
         RETURN
        *** END OF MICRO SOFT QUICK BASIC PROGRAM ***
```

```
12      !
13      ! EQUIPMENT:
14      !
15      !   HP9000 MODEL 310 COMPUTER
16      !
18      !   HP98626 SERIAL INTERFACE, SELECT CODE = 9
19      !
21      !   RS-232 TO RS-485 COMMUNICATIONS CONVERTER
22      !   RS-232 CONFORMING TO EIA RS-232-D STANDARD
23      !   RS-485 CONFORMING TO EIA RS-485 STANDARD, DIFFERENTIAL, HALF DUPLEX,
24      !   MULTI-DROP PROTOCOL REQUIRING A TOTAL OF TWO WIRES.
25      !
26      !   THIS SERIAL INTERFACE PROGRAMMING TECHNIQUE IS SIMILAR TO MOST GENERAL
27      !   I/O APPLICATIONS, WITH THE EXCEPTION OF THE RS-232 TO RS-485
28      !   COMMUNICATIONS CONVERTER. THE DIRECTION OF THIS CONVERTER IS
29      !   CONTROLLED BY THE RS-232 RTS SIGNAL.
30      !
32      DIM Id number$[2],Command$[20],Unit_parity$[4],Return dat$(50)[1]
33      DIM Send more$[1],Variable$[160]
34      INTEGER Baud_rate,Id number
35      PRINTER IS CRT
36      KEY LABELS OFF
38      Id_number$="01"
39      Command$="RSTl''
40      Unit_parity$="EVEN"
41      Baud_rate=9600
42      Error=0
44      CLEAR SCREEN
45      ON ERROR CALL Message
46      Change port:DISP "ENTER UNIT ID NUMBER, RANGE 00-FF HEX, DEFAULT = ";Id number$;
47      LINPUT "",Variable$
48      IF LEN(Variable$) THEN
49          Id_number$=Variable$
50      END IF
51      DISP "ENTER UNIT BAUD RATE 300,600,1200,2400,4800,9600,19200, DEFAULT = ";Baud_rate;
52      LINPUT " ",Variable$
53      IF LEN(Variable$) THEN
54          Baud_rate=VAL(Variable$)
55      END IF
56      DISP "ENTER UNIT PARITY ODD OR EVEN, DEFAULT = ";Unit parity$;
57      LINPUT " ",Variable$
58      IF LEN(Variable$) THEN
59          Unit_parity$=Variable$
60      END IF
61      New send:DISP "ENTER UNIT COMMAND, DEFAULT = ";Command$;
62      LINPUT " ",Variable$
63      IF LEN(Variable$) THEN
64          Command$=Variable$
65      END IF
68      CALL RS485(Id_number$,Command$,Unitt_parity$,Baud rate,Return dat$(*))
71      PRINT "RETURN DATA FROM RS485 = ";
72      I=0
73      REPEAT
```

```
74          I=I+1
75          PRINT Return dat$(I);
76      UNTIL Return_dat$(I)=CHR$(13)   ! FIND END OF DATA CARRIAGE RETURN
78      Send more$="Y"
79      DISP "DO YOU WANT TO SEND MORE DATA Y/N, DEFAULT = ";Send_more$;
80      LINPUT " ",Variable$
81      IF LEN(VariableS) THEN
82          Send_more$=Variable$
83      END IF
84      CLEAR SCREEN
85      IF Send_more$="Y" THEN
86          Send_more$="N"
87          DISP "DO YOU WANT TO CHANGE THE SERIAL FORMAT Y/N, DEFAULT = ";Send_more$ ;
88          LINPUT "",Variable$
89          IF LEN(Variable$) THEN
90              Send_more$=VariableS
91          END IF
92          IF Send_more$="Y" THEN GOTO Change_port
93          GOTO New_send
94      END IF
97      END
98      SUB Message
99      !
100     !************************ERROR MESSAGE************************
101     !
102         OFF ERROR
104         CLEAR SCREEN
105         PRINT " "
106         PRINT " "
108         Sc=9
109         SELECT ERRN
110         CASE 167
111             STATUS Sc,10;Uart_error  !GET UART ERROR INFO
112             IF BIT(Uart_error,1) THEN
113                 PRINT "UART HAS A OVERRUN ERROR"
114             END IF
115         IF BIT(Uart_error,2) THEN
116             PRINT "UART HAS A PARITY ERROR"
117         END IF
118         IF BIT(Uart error,3) THEN
119             PRINT "UART HAS A FRAMING ERROR"
120         END IF
121         IF BIT(Uart_error,4) THEN
122             PRINT "UART BREAK RECEIVED"
123         END IF
131         CASE ELSE
132             PRINT ERRM$
133         END SELECT
135         PRINT " "
136         PRINT "DETERMINE SOURCE OF ERROR"
137         DISP "PRESS ENTER TO CONTINUE ";" ";
138         LINPUT " ",Variable$
139         CLEAR SCREEN
140     SUBEND
```

```
149    SUB RS485(Id_number$,Command$,Unit_parity$,INTEGER Baud_rate,Return_dat$(*) )
150    !
152    !********************RS485 PORT INTERFACE************************
162    !
167       INTEGER Rs232_sc,I,Bytes,String_length,Position,Dec_total,Parity_enable
168       INTEGER Unit_parity,Stop_bit,Loop_num
169       DIM Output_format$[50],Return_error$[2]
170       DIM Rs485$[1000] BUFFER,Hex_value$[8],Checksum$[8]
171       DIM Error_code$[20]
172    !
173    !   Id_number$ IS A HEX VALUE 0-255 FOR UNIT ID SELECTION
174    !        THIS MUST MATCH THE UNIT ID NUMBER PRIOR TO
175    !        TALKING OVER THE RS485 PORT.
176    !   Command$   IS THE THREE CHARACTER COMMAND AND QUERY DATA.
177    !   Unit_parity$  IS THE PARITY THAT THE RS485 PORT IS PROGRAMMED TO
178    !        ONLY TWO SELECTIONS ARE AVAILABLE.
179    !        INPUT THE UNIT PARITY AS "ODD" OR "EVEN".
180    !   Baud_rate  IS THE RS485 BAUD RATE, SELECTIONS ARE.
181    !        300,600,1200,2400,4800,9600,19200
182    !   Return_dat$   IS THE DATA RETURNED FROM THE RS485 PORT
183    !        THIS DATA HAS ALL THE QUERY RESPONSE
184
185    ON ERROR CALL Message
187    Rs232_sc=9 ! RS232 PORT ADDR
188    Parity_enable=8   ! PARITY IS ENABLED
189    Stop_bit=0 ! 1 STOP BIT
190    Data_bits=2    ! 7 DATA BITS
191    IF Unit_parity$="ODD" THEN
192       Unit_parity=0 ! ODD PARITY BIT
193    ELSE
194       Unit_parity=16! EVEN PARITY BIT
195    END IF
196    MAT Return_dat$= ("X")
197    ON ERROR CALL Message
198    !
199    !*********************SET UP PORT*******************************
200    !
201    CONTROL Rs232_sc,5;0 !NORMAL MODEM LINE HANDSHAKE
202    CONTROL Rs232_sc,3;Baud_rate !SET BAUD RATE
203    CONTROL Rs232_sc,4;Parity_enable+Stop_bit+Unit_parity+Data_bits
204    !
205    !********************SET UP BUFFER******************************
206    !
207    ASSIGN @Rs232path TO Rs232_sc   !CREATE PORT PATH
208    ASSIGN @Rs485path TO BUFFER Rs485$;FORMAT ON              !CREATE PATH TO BUFFER
209    !
210    !*****************CALCULATE CHECKSUM****************************
211    !
212    Dec_total=0
213    Output_format$=Id_number$&Command$
214    String length=LEN(Output_format$)
215    FOR Position=1 TO String_length
216       Dec_total=Dec_total+(NUM(Output format$[Position]))
217    NEXT Position
```

```
218   Hex_value$=DVAL$(Dec total,16)
219   Checksum$=Hex_value$[7]
220   !
221   !********************SEND DATA****************************
222   !
223   PRINT "THE OUTPUT IS = >";Output_format$;
224   PRINT Checksum$
225   OUTPUT Rs232_sc;">"&Output_format$&Checksum$&CHR$(13)! SEND MESSAGE
226   !
227   !********************RECIEVE DATA***************************
228   !
229   TRANSFER @Rs232path TO @Rs485path;CONT !MOVE DATA FROM PORT TO BUFFER
230   I=0
231   Loop_num=0
232   REPEAT
233   WAIT .1
234   Loop_num=Loop_num+l
235   STATUS @Rs485path,4;Bytes   ! FIND NUMBER OF BYTES IN BUFFER
236   IF Bytes>=l THEN  ! ONLY READ IF BYTES ARE AVAILABLE
237       I=I+l
238       ENTER @Rs485path USING "#,K";Return_dat$(I)
239       Loop_num=0
240       END IF
241   IF Loop_num=50 THEN  ! SET FOR 5 SEC TIMEOUT
242       I=l
243       Return_dat$(I)=CHR$(13)  ! SEARCH FOR CARRIAGE RETURN
244   END IF
245   UNTIL Return_dat$(I)=CHR$(13)   ! FIND END OF TRANSFER INTO BUFFER
246          ! END OF TRANSFER IS THE CARRIAGE RETURN
247   ABORTIO @Rs232path   ! TERMINATE TRANSFER
248   !
249   !****************DETERMINE IF ERROR CODE IS RECEIVED*************
250   !
251   IF Return_dat$(1)="N" THEN
252   Return_error$=Return_dat$(2)&Return_dat$(3)            ! USE TWO DIGIT ERROR
253            ! CODE NUMBER
256       CALL Errorl20(Return_error$)
257   END IF
258   IF Return_dat$(1)=CHR$(13) THEN !SEARCH FOR CARRIAGE RETURN
259       Return_error$="20"
262       CALL Errorl20(Return_error$)
263   END IF
264   SUBEND
265   SUB Errorl20(Return_error$)
266   !
267   !********************RS485 ERROR CODE RETURN CODE*****************
268   !
269   INTEGER Error_num
270   Error_num=VAL(Return_error$)
271   CLEAR SCREEN
272   PRINT " "
273   PRINT " "
274   PRINT "RESPONSE BY THE INDICATOR IS AN ERROR CODE"
275   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 ***
```