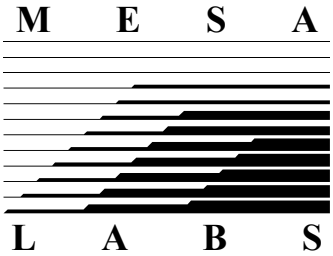


OPERATION MANUAL

MODEL CM800 SONIC FLOWMETER

Wetted Transducers

(4/14/96)

Mesa Laboratories, Inc.
12100 W. 6th Avenue
Lakewood, Colorado 80228

(800) 628-8393
(303) 987-8000
FAX: (303) 987-8989

Part Number 600135-001, Rev. B

Warranty

All products manufactured by the seller are warranted against defects in materials and workmanship for a period of one (1) year from the date of shipment to the original purchaser. Any Mesa Laboratories product which proves to be defective during the warranty period will be repaired or replaced free of charge, provided that the product is returned freight prepaid to Mesa Laboratories, Inc. factory from which original shipment was made. The customer will also pay return freight costs following the repair or replacement of the product.

This warranty will become void if the product is used for other purposes or in environments other than those for which it was designed, or if its circuits or mechanisms are tampered with except as normally required for installation purposes. Products of other manufacturers which are supplied by Mesa Laboratories, Inc. will be covered by the original equipment manufacturer's warranty.

Materials of construction are warranted to be compositions stated by Mesa Laboratories, Inc. and warranted as to their integrity. Conditions in the medium to be analyzed are beyond the control of Mesa Laboratories, Inc. and, hence, resistance to corrosion/erosion is specifically not warranted.

No other warranty is expressed or implied.

Table of Contents

Section 1 INTRODUCTION

Thank you for selecting Mesa Laboratories, Inc. Model CM800 Sonic Flowmeter for your flow monitoring requirements.

The CM800 consists of a transmitter , usually mounted in a NEMA 4X thermoplastic enclosure, a pair of transducers, mounting bosses which accommodate the transducers and attach to the pipe wall, and a set of cables to connect the transmitter to the transducers. Depending on your order, the transducer may be supplied unmounted, mounted on factory supplied saddles, or premounted in a factory fabricated flowtube. To check the configuration of your flowmeter, consult **APPENDIX B, START UP INFORMATION SHEET.** This sheet identifies the options provided and has a list of recommended spare parts.

The CM800 works with wetted ultrasonic transducers installed in a flowtube to determine the flowrate of an acoustically transparent liquid through a variety of pipe sizes. Sizes range from 2 inches through 140 inches. For satisfactory operation the CM800 requires that the liquid be relatively free from entrained bubbles or suspended solids. While the most common application is monitoring the flow of water, Mesa Laboratories, Inc. flowmeters are used in hydrocarbon pipelines as well as in applications ranging from Freons to molten sulfur.

The ultrasonic transducers convert an electrical signal into a burst of high frequency sound. The two transducers are positioned on opposite sides of the pipe in a diagonal configuration or on the same side of the pipe in a bounce configuration. The CM800 measures the time it takes for a sound wave to travel between the two transducers (the transit time). It does so in both directions: from the upstream transducer to the downstream transducer and also from the downstream transducer to the upstream transducer. When there is zero flow, the two transit times will be identical. When there is flow, the two transit times will be different, and that difference will increase as the flowrate increases. The sign of the difference (i.e. "+" or "-") will depend on the direction of the flow.

This Manual is applicable to the CM800 Software Revision F.

1-1 RECEIVING and HANDLING

Each CM800 is given a thorough functional and cosmetic inspection before shipment. Carefully examine each item for damages that may have occurred during shipment. If damage has been sustained during shipment, a claim should be immediately filed against the carrier. Please contact Mesa Laboratories with a description of the damages, and the instrument serial number located on the chassis tag, and the project number shown in Appendix B.

If the CM800 is to be stored prior to installation, it should be stored in its original packing, in a dry indoor location. Each major component (transmitter, hand-held terminal, in-line mounting fixture, etc.) is surrounded by packing material. Should it become necessary to return the CM800, the use of similar packing materials will minimize the risk of damage in shipment.
The CM800 is a precision electronic device and should be handled with care.

*** * * CAUTION * * ***
The transmitter printed-circuit board (PCB) contains devices which may be damaged by electrostatic discharges. Avoid touching the PCB while handling the CM800.

1-2 FIGURES AND APPENDICES

This instruction manual contains several appendices and figures that address specific topics.

Appendices include:

Appendix A: Flowmeter Specifications.
A technical description of the CM800.

Appendix B: Start-Up Information Sheet.
This sheet provides specific information on the flowmeter as originally manufactured, including the serial number of the transmitter and its transducer pair, the options provided, transducer type, and information specific to the application.

Appendix C: Software Flowchart.
A graphical representation of the software useful for quickly finding a desired menu item.

Appendix D: Error Codes.
A description of error messages generated by the CM800. Useful when troubleshooting problems.

Appendix E: Pipe Schedules.
A table of pipe schedules, sizes and inner diameters. Also includes viscosity and sound velocity data.

Appendix F: RS232C Communications Syntax.
A technical description of codes, hardware and software required to interface with the CM800 via RS232 or RS485.

Appendix G: PC Interface Software
A description of the DOS based PC software available for interface with the CM800.

Appendix H: Serial Printer Operation
Details of serial printer operation are given.

Appendix I: PC Board Jumpers
Details on user adjustable board jumpers are given

Figures include:

Fig. 1 Field Wiring Diagram
A drawing that identifies user pertinent controls and indicators on the main board of the flowmeter. This figure also provides the information required by the user to properly wire AC power to the transmitter, to connect the transducers to the transmitter, as well as wiring for the outputs.

Fig. 2A and 2B Flowtube Dimensions (Diagonal or Bounce Configurations)
This figure provides information useful when installing flowtubes or kits. It should be referred to when reading the text dealing with flowtube installation. Fig. 2 also includes standard flowtube laying lengths, along with other useful dimensional information.

Fig. 3 NEMA 4X Enclosure
This is a dimensional drawing outlining the standard NEMA 4X thermoplastic enclosure.

1-3 FACTORY ASSISTANCE

If you have technical questions pertaining to meter installation, start-up or operation, contact Mesa Laboratories, Inc. NuSonics Field Service Department:

Mesa Laboratories, Inc.
NuSonics Division
12100 W. 6th Avenue
Lakewood Colorado 80228

Phone: (800) 628-8393 or (303) 987-8000
Fax: (303) 987-8989

Section 2: INSTALLATION PLANNING

2-1 METER LOCATION

The CM800 is designed for use in full pipe, liquid flow applications on pipe sizes ranging from 2 inches to 140 inches. In order to transmit the acoustic signal between transducers the pipe must be full of liquid. Signal strength will be decreased by entrained solids or gas bubbles in the liquid.

The flowmeter will operate best under a fully developed flow profile condition. Ordinarily, the best metering locations are those at which the flow velocity is highest and viscosity is lowest. Flow profile is affected by piping configurations and obstructions, valves or pumps. These are perhaps the easiest factors to take into account when selecting a metering location. A straight run of at least ten (10) pipe diameters should be allowed upstream and three (3) pipe diameters allowed downstream between 45° or 90° elbows or "tees" and the transducers. Even greater lengths of straight pipe should be allowed for partially opened valves or pumps, both of which have a strong influence on the flow profile. If the inside diameter of a metering run is reduced in order to increase flow, concentric reducers should be used.

Figure 2 indicates typical laying lengths of Mesa Laboratories-fabricated flowtubes that use wetted transducers, as well as wall clearance distances required for installation or removal of the transducers. The latter is useful in applications where space is limited.

2-2 TRANSDUCER ORIENTATION

The flowtube or kit should be installed so that the "A" transducer is upstream from the "B" transducer, with respect to flow. The flowtube may be installed in either a horizontal or vertical pipe. When installing the flowtube in a horizontal run of pipe the transducer should be mounted in the horizontal plane, i.e. at 3 o'clock and 9 o'clock as shown in Figure 2. The maximum offset from the horizontal plane should not exceed 30 degrees.

2-3 The TRANSMITTER

The CM800 printed-circuit board and chassis are called the transmitter. It is usually installed in a NEMA 4X enclosure and powered by 115 VAC. The PCB has terminals for the connections to the transducers, 4/20 milliamp output, fault or relay contacts, RS232C communication port and a status LED. Optionally, the following changes or additions may have been made:

a. A control and information display hand held terminal may be supplied to interface with the flowmeter.
b. The 4/20 ma circuit may use external power (32 volt DC max.).
c. The 4/20 ma output may be replaced by a 0 to 10 volt output.
d. RS485 may substitute for RS232C
e. 24 volt DC or 115 volts AC or 230 volts AC power supply.
f. A heater may be included.

Figure 1 shows the location of these components, while Appendix B lists the supplied options.

*** * * CAUTION * * ***

Do not pick up the transmitter by placing your hands between the circuit board and the chassis. Damage to components on the PCB could result. If it should become necessary to remove the board or chassis from the enclosure, always disconnect the AC power wiring first. The transmitter should be moved by handling the enclosure or chassis, never the main board.

Figure 3 shows the NEMA 4X thermoplastic enclosure. Four (4) 1/4 inch bolts are required to mount this enclosure. These bolts are not supplied with the enclosure.

If the air-purge option has been specified, the air line connection should be made after the enclosure has been mounted to the wall.

2-4 INSTALLATION AND WIRING

1. Install the transmitter enclosure to the wall.

2. Make sure that the AC power switch is turned OFF.

3. Transducer cable should be installed in metal conduit joining the transducer connector heads to the transmitter enclosure.

4. Transducer to transmitter cables are marked with a label at each end. Two cables are provided, one for each transducer. They are connected to terminal block TB1 on the printed-circuit board. The transducer ends are marked "XDCR A" (upstream XDCR) and "XDCR B". The cables should be matched to the transducers as marked. See Figure 1.

*** * * CAUTION * * ***

Do not attempt to splice transducer cables to extend cable length. Splicing cables increases flowmeter susceptibility to electrical noise. Use only factory supplied cables. If cable length must be extended, contact Mesa Laboratories for a replacement set.

5. Install conduit between any peripheral equipment (recorder, remote indicator, etc.) and the CM800. Refer to Figure 1 for connection locations and the allowable loop resistances. Improper loading of an analog output may result in non-linear performance, and could stop the output signal entirely.

6. Install metal conduit between the AC power source and the CM800. Connect AC power to the AC wiring terminal mounted on the chassis.

*** * * WARNING! * * ***

The CM800 uses 115 VAC or 230 VAC power. Serious injury or electrocution could result from the failure of personnel to observe safety precautions while wiring AC power to the flowmeter. A chassis plate label to the left of the AC wiring block identifies the required input voltage. The NEMA 4X enclosure does not provide grounding between conduit connections. Grounding in accordance with the National Electrical Code must be provided by the user as a part of power and signal wiring.

The CM800 is now ready to be turned ON.

Section 3: OPERATION and MENUS

Who Should Read This Section?

This section provides a step-by-step description of the CM800 menu items. It should be read by all users who are not familiar with the CM800 and will be performing an on-site set-up, calibration, or are troubleshooting a problem. If an operator wants only to locate a particular step within a menu and is familiar with the hand held terminal functions, refer to the Menu Flowchart in Appendix C. Since this section provides much more detail than the Menu Flowchart, it should be read by all operators that will be interfacing with the CM800.

Interface with the CM800 is typically performed by using a hand held terminal. Alternatively, a DOS based PC computer may be used in conjunction with a Mesa Laboratories supplied software package which duplicates all the functions of the hand held terminal.

3-1 Set-Up and Calibration

The Set-up process involves programming the CM800 with the specifics of the application, such as pipe size, liquid type and temperature, analog output scaling, and other such items. The calibration process is the fine tuning required to achieve the best accuracy possible.

If the CM800 has been supplied with a Mesa Laboratories-fabricated flowtube, all setup and calibration has already been performed and the unit is ready to operate.

If the unit has been supplied with a transducer kit for field installation, the setup was performed, and the CM800 was calibrated using a similar flowtube at the factory. The CM800 will operate, but for best accuracy a calibration should be performed.

The user should refer to Appendix B, Start Up Information Sheet, and verify that the parameters used for set-up and calibration at the factory match the actual application conditions, and that the analog output and relay are scaled and set as desired.

Set-up and/or calibration may be required whenever the application conditions are changed; e.g., the CM800 is moved to a different pipe size or is used to measure a different liquid type. Accessing the set-up menus is also necessary if it is desirable to change any of the user selectable variables, such as units of measure or 4 to 20 milliamp output scaling. Finally, the menus also provide access to features such as setting and resetting the totalizer or enabling continuous data printout.

When the CM800 is first powered up, it will first perform an INTERNAL SETUP before updating the analog output or LED (See Section 3-3); therefore, there will usually be a 5 to 10 second delay between turning the unit ON and beginning normal operation.

3-2 The Status LED (Light Emitting Diode)

The Status LED, mounted on the cover of the NEMA 4X enclosure, is an indicator of proper function. The LED communicates information in three ways: It can be steadily illuminated, blinking or extinguished. Each condition has a different meaning.

A steadily lit LED indicates that all functions and operations are normal. Any other condition is a sign of potential trouble.

A blinking LED indicates either an unsuccessful INTERNAL SETUP or bad transit time (i.e. flowrate) measurements. The problem could be in the application, such as excessive entrained solids or gas bubbles in the liquid, or could be caused by an improper set-up or wiring.

An extinguished LED indicates hardware failure such as component malfunction or memory loss. The problem may be field-correctable, but it may be necessary to return the unit to Mesa Laboratories.

3-3 The CM800 Control Modes

The CM800 can operate in one of four modes: Terminal mode, Analog mode, Computer mode, and Printer mode.

Terminal mode utilizes the hand-held terminal. This mode allows display of all information and control over all the CM800 features and menus. It is the ideal human interface mode. In addition to the terminal LCD display, the 4 to 20 milliamp (ma) signal, relay and status LED are simultaneously updated.

Analog mode is the standard operating mode. When nothing is connected to the J1 connector the CM800 operates in Analog mode, continuously updating the 4 to 20 ma output, relay and status LED. None of the control or setup selections last made in Terminal or Computer mode can be changed.

Computer mode is used when the model CM800 is to be interrogated by a computer of other control device via RS-232C. In this mode no English language statements are used. Instead the computer receives and sends information to the CM800 using code numbers. There is a menu item in the Terminal mode which can activate Computer mode. The analog output, relay and status LED are also updated in this mode.

Printer mode is used when a serial printer is connected to the CM800 at the J1 connector. Date, time, flowrate, totalizer value and error codes are printed at regular user-defined intervals. The date, time and print interval are input by the operator in Terminal mode before entry into Printer mode. The analog output, relay and status LED are also updated while in Printer mode (see Appendix H).
Once the CM800 has been placed in computer mode or Printer mode, the hand-held Terminal will not function. The CM800 may be returned to Terminal mode by turning on the power while nothing is connected to the J1 connector. After waiting 3 seconds, connect the hand-held terminal. Press OPERATE to access the Output Display screen.

3-4 The Hand-held Terminal and Menus

The hand-held terminal is shown on the following page. It has a 4 line by 20 character LCD (liquid crystal) display and a keypad for data entry.

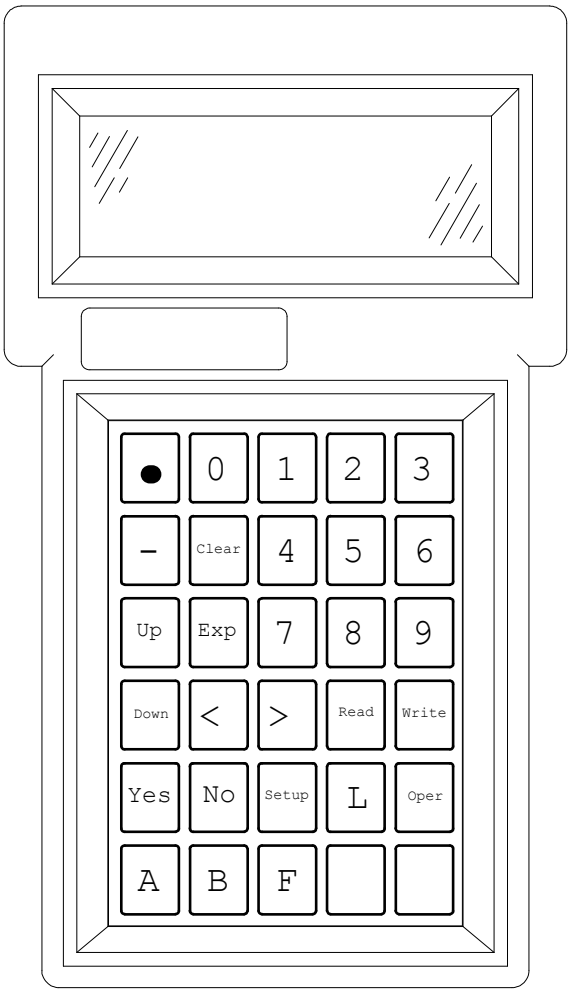
The terminal is connected to a telephone type jack (RJ12 - 6 conductor). It may connected either to the jack on the PCB, labeled J1, or to the connector provided on the exterior of the NEMA 4X enclosure.

Information and user-selectable items are accessed and may be changed via the hand-held terminal. The Data screen is the display which shows the measured variables such as flowrate or totalizer value. The Menu Loops consisting of Menus 1 through 4 are accessed by pressing the SETUP key. The "UP" and "DOWN" keys are used to select a menu, and the ">" and "<" keys are used to move through the individual steps of any menu. The ">" and "<" keys may be used to scroll through any menu and view the current settings without changing them. The Data screen can be accessed by pressing the "OPER" key. The Data screen and Menus are described in detail later in this section.

Both the menus and individual items within a menu are arranged in a loop format. Continuously entering "UP", "DOWN", "<" or ">" will eventually return the operator to the same menu item.

Most of the values that appear in these menus can be either read or overwritten using the RS-232C communications link and associated syntax (see Appendix F, CM800 RS-232C Communications Syntax). Since the majority of operators use the Hand-held Terminal exclusively, the text appearing in this section describes the menus and data entry for Hand-held Terminal access.

When a menu is invoked by pressing the Setup key, the steps that appear always follow the same sequence. In this section, the steps are discussed in the sequence that they appear at CM800 power-up and subsequently scrolling through the menus using the ">" or "Up" keys. If "<" or "Down" were used, the order would be reversed.



3-5 The Display Format

The Terminal includes a four-line liquid crystal display (LCD) with a 20-character length. Menu steps are shown in the manual as they appear on the LCD. For illustrative purposes the letter X may be used to indicate a variable value. This is an example step from Menu 1:

MENU 1 SETUP
PIPE SIZE UNITS = 1
1 = inches 2 = mm

The display at this step tells the user that "inches" is the current pipe size unit. The choices are also shown. Entering a new number will change the units, proceeding to the next or previous menu item by pressing ">" or "<" will leave the selection unchanged.

There are three types of menu steps:

Information Only

The Data screens are information-only, but the information that is displayed (measured variables like flowrate and totalizer value or diagnostic error codes) are continuously updated. It requires no user input.
User Input: YES/NO

Some steps, like the Menu 2 step that allows the user to select flowrate units, offer a choice of YES or NO. Pressing NO repeatedly will cause all possible choices to be displayed in succession. Pressing YES causes the CM800 to accept the new choice, overwriting the previous one.

User Input: Alphabet Letters

When the CM800 requests the user to enter a letter (such as "C" or "F" for centigrade or Fahrenheit), use the letter on the keypad, or if unavailable, the word which starts with that letter (i.e. **C**lear = **C**)

User Input: Numeric Choices

As shown in the preceding MENU 1 SETUP example, when the choices to be made can all be displayed a selection is made by pressing the appropriate number. The display is immediately updated without need of pressing ">" or "<".

User Input: Numeric Values

Some steps require the entry of a value through the Hand-held Terminal. The desired number is input through the keypad and entered by pressing the ">" or "<" keys. Numeric value steps display the present value of a variable. For example, the AVERAGING TIME step in Menu 2 has a default value of 5 seconds. The lower line of the display shows "5". Suppose the user wants to change the value to 10 seconds. When the "10" is entered, the lower line of the display changes to "10". If the user presses the CLEAR key before pressing >, <, UP, DOWN or OPER the previous value is restored. However, once >, <, UP, DOWN or OPER is pressed after entering a new value, the new value replaces the previous one and the menu advances to the next step, previous step or display, depending on which key was used.

3-6 The Data Screen (Output Display)

This message appears on initial power-up in Terminal mode if the CM800 has undergone set-up and calibration procedures:

SOFTWARE REVISION X followed by:
WAIT FOR INTERNAL SETUP

During this time the CM800 is optimizing its performance for the current external conditions such as acoustic signal quality. An unsuccessful attempt will result in a fault message (see Appendix D). The CM800 will repeatedly attempt an INTERNAL SETUP until successful or the operator presses the Setup key. If the CM800 needs the user to enter a numeric value or make some other selection, the display will automatically proceed to Menu 1. Once INTERNAL SETUP is successful, the CM800 will begin operation. The status LED will be lit continuously, the relay and 4/20 output will be updated, and the terminal LCD display will be updated every second. The display will show the Data screen, which contains the flowrate value, flow units, totalizer value and multiplier, and the totalizer units.

When the signal quality is poor, the value displayed for flowrate may occasionally be preceded by a "?" and an error code number or letter (1-9, A-F, See Appendix D: Error Messages).

A second diagnostic Data screen is also available, and is accessed by pressing > or <. Return to the first Data screen is made the same way. The second screen shows the value of the upstream and downstream transit times in microseconds (the time required for the sound to travel from one element of the transducer to the other), error codes, the attenuation and quality factors for each transducer. The meaning of these values is described in Appendix D.

The two Data screens are shown below with typical values.

34.23	UP 146.0647 uSec 0?
GALLON/MIN	ATTEN=8.2 QF=.9772
18340 × 10	DN 139.3341 uSec 0?
GALLONS	ATTEN=7.9 QF=.9801

The Data screens may be accessed at any time from any location within the menus by pressing the OPER (Operate) key. This key also enables any new selections or values entered and stores them in the CM800's memory.

3-7 MENU 1 SETUP

*** * * CAUTION * * ***
Menu 1 contains sensitive set-up information. Changing any of the settings in Menu 1 will necessitate a calibration procedure. When a new value is entered in Menu 1 the CM800 will require the user to perform a calibration procedure (see Section 4) regardless of whether the old value is restored.

Menu 1 is accessed by pressing the SETUP key. Press the "Up" or "Down" keys to move on to other menus or the ">" or "<" to move to different items without changing them. Menu 1 contains application specific values which are shown below, with descriptions as necessary.

If the use of an access code has previously been selected (Section 3-9.5), the display will read:

ENTER ACCESS CODE >

There is also a hardware lockout which prevents the writing of new information to the memory of the CM800. If the proper code is used, the CM800 will check the hardware lockout. If it is in place, instructions will be displayed on screen for removing the lockout. If no code was required, or if it was properly entered, then the display will show in succession:

3-7.1 PIPE SIZE UNITS = X
1=inches 2=mm

Select the desired units for the next item.

3-7.2 INSIDE DIAMETER
X.XXX

The value displayed is the current setting for the pipe inside diameter. Appendix E contains a table of pipe schedules and sizes vs. inside diameter. The actual value should be entered. The units for this value must be the same as the previously selected units.

3-7.3 SAME or OPPOSITE SIDE SENSORS

Select Same Side or Opposite Side based on sensor configuration. The diagonal-traverse configuration has the sensors on the opposite sides of the pipe, while the bounce configuration has the sensors on the same side of the pipe. Appendix B contains configuration information.

3-7.4 LENGTH OF 1 CABLE

Allows entry for cable length in feet. The value need only be an approximation to within a foot.

3-7.5 VISCOSITY IN CENTISTOKES

The current liquid viscosity setting is shown and a new one may be entered. Appendix E contains a table on water viscosities and viscosity unit conversion formulas.

The ">" key will return the operator to the beginning of Menu 1.

3-8 MENU 2

Menu 2 and Menu 3 contain user definable parameters such as flow units, output scaling, control over the relay or totalizer function, etc. There are two menus simply to provide quicker access to any one individual item.

3-8.1 FLOW UNITS Y/N?

Pressing "No" repeatedly will cause the display to scroll through all the available flow unit choices. These choices are:
Gallons / Minute
Imperial Gallons / Minute
Cubic Feet / Minute
Cubic Feet / Second
Cubic Meters / Hour
Liters / Minute
Liters / Second
Barrels / Hour
Million Gal. / Day
Feet / Second
Meters / Second

3-8.1 20 ma FLOWRATE
XX

XX is the flowrate in the previously chosen units that will cause a 20 milliamp current at the analog output terminal.

3-8.2 AVERAGING TIME
(1-30 SECONDS)

The current setting is displayed. Any invalid input will be corrected by the CM800 when the "Oper" key is pressed.

Occasional gas bubbles or other conditions can cause fluctuations in the measured flowrate. Such fluctuations can be smoothed by employing input averaging. The CM800 includes an algorithm that averages the flowrate over a desired time period.
The CM800 performs one complete measurement and calculation cycle in one second. If an averaging time of 20 seconds is selected, the displayed flowrate and analog output will be the average value over the previous 20 seconds. It is recommended that the highest averaging time setting be used which still meets the user's response time requirements.

3-8.3 XX ma ON FAILURE Y/N?

XX is either 4 or 20, and is the output current that will be present during a failure condition. It is recommended that the selected value not correspond to a commonly measured flowrate.

3-8.4 CONTACT CLOSURE

This item allows the user to choose how the alarm relay operates. The choices are closing the relay contact when a FAILURE occurs or closing the contact when the flowrate exceeds or falls below a FLOW LIMIT value.

If a FLOW LIMIT selection is made then the following two selections will appear in the menu.

BELOW LIMIT or ABOVE LIMIT Y/N?

Select whether the contact should close when the flowrate limit is exceeded or the flowrate falls below the limit.

LIMIT VALUE XXXX
XXXX is the flowrate which when reached will cause the contact to close. This limit value need not be in the range established for the 4 to 20 ma output.

3-8.5 TOTALIZER UNITS

The available units are:
Gallons
Imperial Gallons
Cubic Feet
Cubic Meters
Liters
Barrels

The totalizer value, displayed on the data screen, is the total volume that has flowed in the positive direction since the totalizer was last reset. Reverse flows are ignored, and the totalizer is not updated during internal setups or failure conditions. The totalizer value is stored in memory and is not lost in the event of a power interruption.

3-8.6 # OF UNITS / INCR.

XXX

XXX is the current value of the totalizer units per increment, typically 1, 10, 100, etc.. This value serves as a multiplier for the totalizer display. The shown value of units/incr. must flow before the totalizer display increases by one (1). The totalizer has a maximum value of 9,999,999, at which point it will roll over back to zero. Scaling the totalizer by use of this item allows for totalizing higher volumes. 9,999,999 is also the maximum allowable value for Unit/increment.

At this point pressing the ">" key returns the operator to the beginning of Menu 2.

3-9 MENU 3

3-9.1 RESET TOTALIZER Y/N?

Only a Yes answer will reset the totalizer. Reset occurs at the moment Yes is pressed and a new totalization begins.

3-9.2 OUTPUT PULSE WIDTH

Enter the value for the pulse width for the factored pulse output in milliseconds. This ouput gives an electrical pulse each time one flow unit has been measured. The duration of the pulse should be optimized for the external equipment receiving it. The factory default value is 25 milliseconds. If the pulse width is to short, mechanical counters may miss the pulse, if it is to long, pulses may overlap and be missed.

3-9.3 4 ma FLOW RATE

Select the flowrate at which a 4 ma current will be output. The selected flowrate may be a negative number, in which case it is possible to monitor via the analog output both forward and reverse flows. For example, 4 ma = -500 GPM, 20 ma = 500 GPM, therefore, 12 ma = 0 GPM.

3-9.4 MINIMUM MEASURABLE
FLOW IN/SEC:
XX

Any forward or reverse flow which is less than this value will be ignored; i.e. set equal to zero. Zero will be used for the analog output and the totalizer will not increase. 4 inches/sec is the usual factory setting.

3-9.5 CHECK 4/20 OUTPUT Y/N?

This item allows the user to check the analog output or calibrate the output to an external device such a chart recorder or PLC. The analog output may by forced to a user selected value. Pressing Yes causes the display to change to:

1 - OUTPUT 4 ma
2 - OUTPUT 12 ma
3 - OUTPUT 20 ma

Press the appropriate number for the desired output. If the current output does not match the selection, consult with Mesa Laboratories NuSonics Service Department. If the CM800 is operational, the measured value for the analog output will be updated as soon as a new menu item is accessed.

3-9.6 REQUIRE ACCESS CODE Y/N?

This step allows the user to enter an access code. All future attempts to access the Menus will require entering this code. The code may be any number from 1 to 20 digits long. Any entry should be documented. If Yes is pressed the display will show:

CHANGE ACCESS CODE Y/N? if a code is already present, or:
SET ACCESS CODE
Enter the code digits and press the ">" key when finished. When the access code is called for it must be entered exactly as was input here, for example, 00 is NOT equivalent to 0.

The ">" key returns the display to the beginning of Menu 3.

3-10 MENU 4

Menu 4 can only be accessed if the CM800 is operational, that is, it is measuring flow.

3-10.1 SV = XXXX.X m/sec

The first item indicates the measured value for the velocity at which sound moves through the liquid being monitored. Mesa Laboratories, NuSonics Division can provide the sound velocity for an extensive number of liquids. The displayed value should be in close agreement with the lab measured value if the set-up and calibration were properly performed. If the sound velocity differs greatly from the known value, checking the set-up values and performing a calibration may be indicated.

3-10.2 USE FLOW FACTOR Y/N?

*** * * CAUTION * * ***
Pressing the yes key will cause the CM800 to stop operation. The analog output will be frozen until the following items are addressed and the "OPER" key is pressed.

A flow factor may be used to force the CM800 to agree with some other reference. Press Yes to use an existing flow factor or enter a new one. If a flow factor is currently being used, press No to disable it. The Yes key advances the display to:

FLOW RATE KNOWN Y/N?

If the operator wishes to invoke a previously set flow factor, press No. A warning message will be displayed, indicating the need to press the "OPER" key in order to enable the new flow factor and resume operation.

To enter a new flow factor press Yes, which will change the display to:

ENTER FLOW RATE:

The flowrate from the reference flowmeter should be entered, followed by the ">" key. The CM800 will perform a 4 second measurement and then calculate the new flow factor. The display will automatically revert to the Data screen, and the displayed flowrate will reflect the use of the new flow factor. It is important that the flow be steady during the 4 second measurement period.

3-10.3 ENTER COMPUTER MODE Y/N?

Computer mode operation is discussed in Appendix F. Pressing the Yes key changes the display to:

RS232 = 1 RS485 = 2
PICK A NUMBER

RS485 is an option not present on all CM800s. If this option was not incorporated, do not select RS485. Details of RS485 operation are given in an insert which is included only when the option has been selected. If RS485 computer mode is inadvertantly selected and enabled, refer to Section 3-3, CM800 Control Modes, for the recovery procedure. Selecting RS232 displays:

RS232 BAUD RATE

The choices are 300,1200,2400,4800,9600. Pressing the "Oper" key at this point enables computer mode operation.

3-10.4 USE DATA LOGGER Y/N?

See Appendix H for additional details concerning the use of a serial printer. The ">" or "No" keys return the display to the beginning of Menu 4. Pressing Yes will cause the following to be displayed:

INTERVAL HOURS or MINUTES or SECONDS followed by
ENTER CURRENT MONTH, DAY, HOUR, MINUTE and SECOND

Enter the interval between printouts. Enter the current date and time.

ENABLE LOGOUT AND
START CLOCK Y/N?

The clock will start with the input date and time at the moment Yes is pressed. Select the baud rate for the printer, and press OPERATE to begin printer mode output.

Section 4 CALIBRATION

Before the CM800 can begin operation, the questions in Menus 1, 2 and 3 must be answered, and a successful internal setup must occur. This internal setup cannot occur without a calibration having first been performed. As stated before, the calibration may have been performed at the factory. The procedure simply requires following the instructions given by the CM800. Use of the hand held terminal is necessary.

If a Calibration is desired, it may be initiated by re-entering any item in Menu 1.

The following calibration procedures will be required any time any item in Menu 1 is changed. This is <u>not</u> a recommendation. The CM800 <u>will</u> immediately initiate the calibration procedure when normal operation is attempted but a change has been registered. The CM800 also monitors the setting of several adjustable electronic components. Any change to these components may also initiate the calibration procedure.

The calibration procedure consists of two main portions: the PATHLENGTH calibration, and the NO FLOW calibration. There are several different ways to perform each procedure. The method which yields the best results is indicated. The displayed messages and instructions are very specific. If the user is unable to comply with the requests it is possible to abort the procedure at any time by pressing the "Setup" key; however, as stated before, operation cannot begin until the calibration procedures are completed.

Connect the hand held terminal to the modular telephone jack. If a calibration is needed, the display will show:

NEEDS CALIBRATION

Press the "OPER" key to begin the procedure.

4-1 PATHLENGTH CALIBRATION

The purpose of the pathlength calibration is to determine the slope of the relationship between transit time and flowrate. In order to do this the CM800 must know the distance between the two transducers. The CM800 has the ability to measure this distance very accurately if the liquid in the flowtube is water and the temperature is known. This is called a water pathlength calibration. The temperature must be measured to a minimum accuracy of one degree Fahrenheit or 0.5 degree Celsius. It is preferable but not necessary to perform the water pathlength calibration under zero (no) flow conditions.

The CM800 can also calculate the distance between transducers from the pipe size value entered in Menu 1, but this yields less accurate results.

Once a water pathlength calibration has been done, the calculated pathlength value is stored in memory. If the reason for the calibration is not due to a change in the flowtube dimensions this same value can be reused.

The display will show:

4-1.1 DO WATER PATHLENGTH
CALIBRATION Y/N?

Press No if the flowtube cannot be filled with water or if this has previously been done for the current flowtube. If No is pressed the display will show:

4-1.2 USE OLD WATER PATHLENGTH
CALIBRATION Y/N?

Press Yes to use the existing value. This can be useful if the reason for the calibration was an inadvertent change to a Menu 1 item, which has since been restored to its proper value. If No is answered the CM800 will calculate a pathlength from the pipe size and the display will advance to item 4-1.8. As stated before, this approach is less accurate due to manufacturing tolerance or field kit installation deviations.

If the water pathlength calibration was selected, the display will show:

4-1.3 FILL FLOWTUBE WITH
WATER AND MEASURE
TEMPERATURE
READY Y/N?

A No answer will cause the same message to be repeated. Press Yes when the flowtube is full of water at a known and stable temperature. The display will change to:

4-1.4 WAIT FOR INTERNAL SETUP

During this wait the CM800 is optimizing its internal settings for water and measuring the transit time of the sound wave between the two transducers. After a short wait the display will show:

4-1.5 TEMPERATURE UNITS?
CHOOSE F OR C

Press "F" for Fahrenheit or the "Clear" key for Celsius (Centigrade).

4-1.6 ENTER TEMPERATURE

Enter the measured temperature in the previously selected units. The Clear key may be used to erase a mistaken entry. Press the ">" key to enter the number and advance to the next display.

4-1.7 SIGNAL DELAY (uS)
X.XXXX

This is a diagnostic reading useful to the Mesa Service personnel when troubleshooting. Press the ">" key.

4-1.8 FILL PIPE WITH
NORMAL LIQUID
READY Y/N?
The normal liquid is the one on which flow measurements will be made. The CM800 will start an Internal Setup when Yes is pressed.

4-1.9 WAIT FOR INTERNAL SETUP

During this wait the CM800 is optimizing its internal settings for the liquid to be measured. If no faults occur, the following will be displayed in a few seconds:

4-1.10 SIGNAL DELAY (uS)
X.XXXXX

As stated before, this is a diagnostic reading. Press the ">" key.

This ends the pathlength calibration procedure. The next procedure begins immediately upon pressing the right arrow.

4-2 NO FLOW CALIBRATION

The purpose of the No Flow calibration is to determine the zero intercept (also called the zero offset) of the relationship between transit time and flowrate. The best way to determine this is to stop all flow. Alternatively, switching the transducer connections while the flow is steady can achieve results of similar accuracy, especially when the pipe size is greater than 4 inches. This secondary method requires a flathead #1 screwdriver.

The display will show:

4-2.1 CAN YOU STOP THE
FLOW Y/N?

Press No if it is not possible to stop the flow. If yes is pressed the display will show:

IS THE FLOW STOPPED Y/N?

Press Yes once the flow is stopped. A "WAIT" message will be shown, and after a 5 second wait the CM800 will begin normal operation and the display will show the Data screen. Restore normal flow; the calibration procedure is finished.

4-2.2 If it is not possible to stop the flow this alternate no flow calibration procedure will be used. It is important that the flow be steady while performing the calibration. If the deviation in flow from the beginning to the end of the calibration is 2 feet/sec, then a 1 foot/sec. offset will have been introduced. The display will show:

INTERCHANGE CABLES
AT TRANSMITTER !
ARE THEY SWITCHED
NOW Y/N?

*** * * WARNING * * ***
The following procedure requires re-wiring the transducer connections while the CM800 is powered up. Do not proceed unless the AC power terminal has a protective plastic cover installed. With the exception of the TB1 connector, do not touch any of the PCB components as damage or injury could result.

Swap the transducer cable connected at TB1-2 with the one at TB1-3. Swap TB1 with TB4. Press Yes when the cables are switched. From the time Yes is pressed until completion of the next item the flow should be very steady. The display will show a "WAIT" message for 4 seconds and then:

4-2.3 RESUME NORMAL
CONNECTIONS
BACK TO NORMAL Y/N?

Interchange the transducer cables and quickly answer Yes. Another 4 second "WAIT" message will appear. The CM800 will then begin normal operation and the Data screen will be displayed.

This concludes the calibration procedure and main portion of the manual.

APPENDIX A

Model CM800 Sonic Flowmeter Specifications

Dimensions:	In NEMA 4X Enclosure: 15.5" by 13.75" by 7.7"
Power Requirements:	115 VAC (+/- 10%) Optional 230 VAC (+/- 10%) 50 to 60 Hertz
Power Consumption:	Standard 10 watts With Heater 210 watts at 115 VAC 230 watts at 230 VAC
Output Signals:	
Flowrate	Internal Power Option: 4 to 20 mA (Isolated) into 1000 ohms max. External Power Option: 4 to 20 mA (Isolated), External Supply at 30 VDC maximum. Optional 0 to 10 Volt DC output into 2500 ohms, minimum.
Fault or High/Low Alarm relay	130 VAC at 1/2 amp. Contact Rating.
Status Indicator	Green Light Emitting Diode (LED), Splash resistant.
Data Link:	Hand held ASCII terminal for local control. RS232C for remote control. Optional RS485 available.
Ambient Temperature:	-10 °C (14 °F) to 50 °C (122 °F) Standard. -60 °C (-76 °F) to 50 °C with Heater.
Liquid Temperature and Pressure:	Titanium Transducers: -40 °C (-40 °F) to 250 °C (482 °F) 1000 PSIG CPVC Transducers: 0 °C (32 °F) to 27 °C (80 °F) at 250 PSIG 0 °C (32 °F) to 38 °C (100 °F) at 205 PSIG 0 °C (32 °F) to 60 °C (140 °F) at 125 PSIG
Accuracy:	Application Dependent

APPENDIX B START UP INFORMATION SHEET

Transmitter Serial Number: _____
Transducer A Serial Number _____
Transducer B Serial Number: _____
Factory Project Number: _____

Project Options:

Main Power:_____. (115/ 230 VAC or 24 VDC)

Flowtube Type:_____. (Size, Kit or Fabricated)

Liquid Type:_____

Liq. SV _____ at _____ deg ____

Transducer Size and Material:_____

Hand Held Terminal: _____ (Supplied / None / Rented / PC Software)

Analog Output:_____ (4 - 20 mA Internal or External / 0 to 10 VDC)

RS485:_____ (Yes or No)

Factory Menu Set-up:

Pipe Size Units: _____
Same or Opposite sides Sensors_____
Viscosity: _____

Inside Diameter: _____
Cable Length: _____

Flow Units: _____ _ Averaging Time:_____

4 mA Flow: _____
Contact Closure On:_____
Limit Value:_____
Minimum Measurable Flow: _____ FPS
Totalizer Units:_____

20 mA Flow: _____
Above or Below Limit:_____
Failure Output (4 or 20):_____ mA
Output Pulse Width (Typ. 25):_____ mSec.
Totalizer Units / Increment:_____

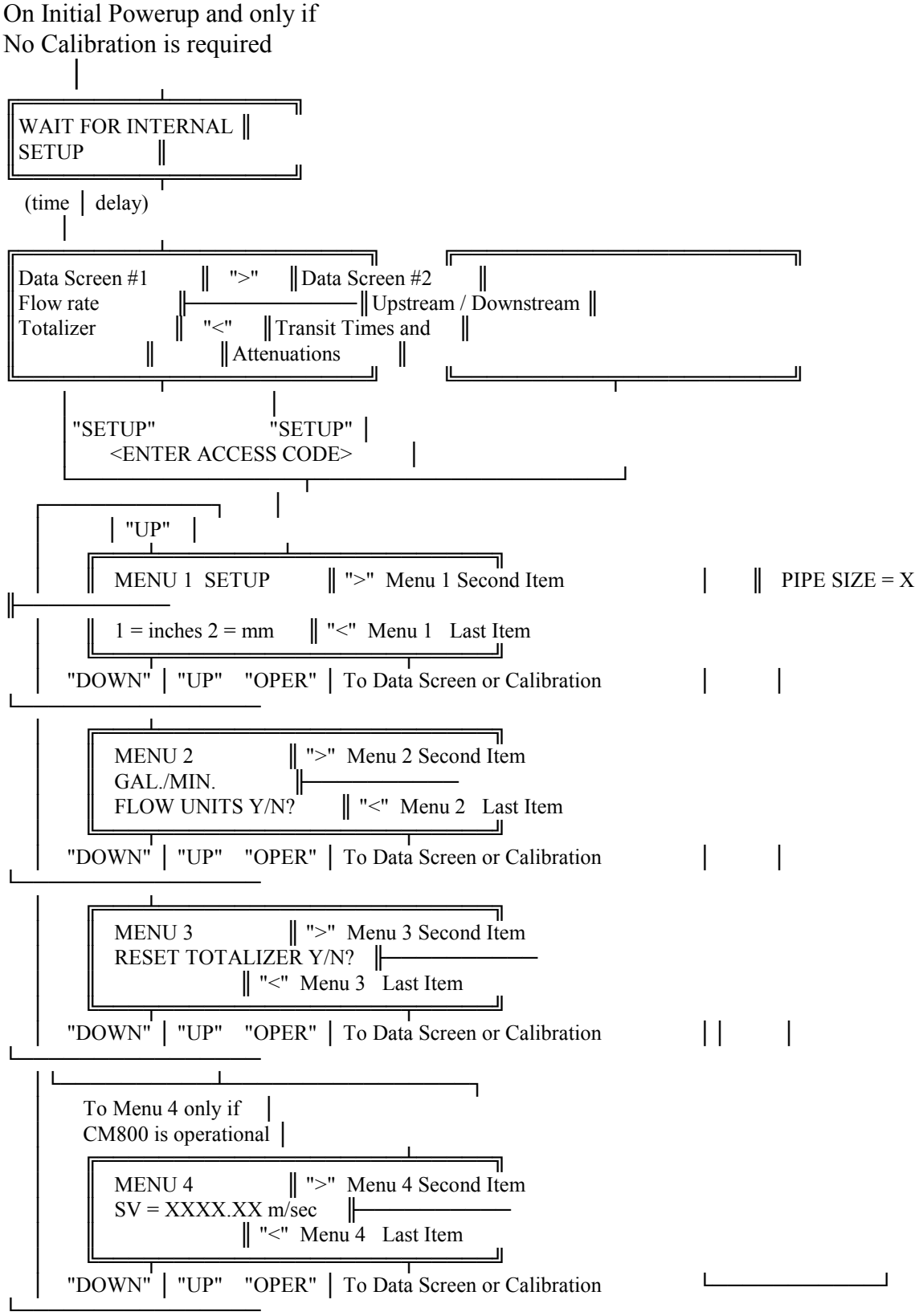
Calibration:

Pathlength Cal performed by Factory: _____
Zero Flow Cal performed by Factory: _____

Field Calibrations is: Not Needed Reccomended Necessary (circle one)

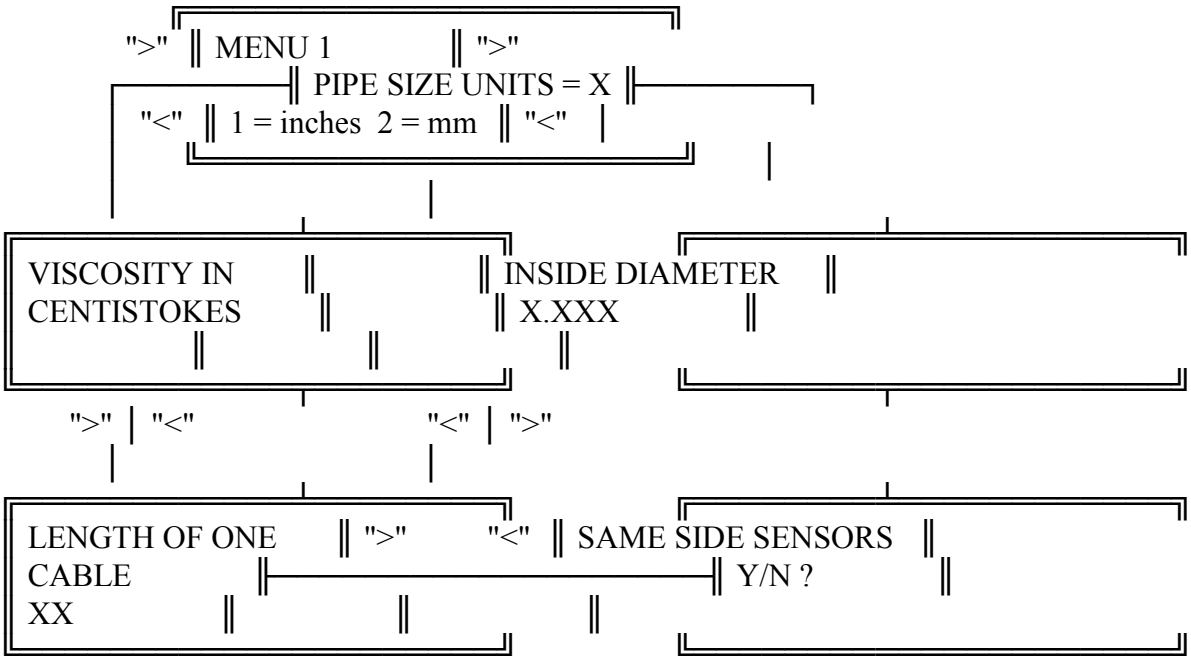
Comments: _____
_____
_____
_____

APPENDIX C: CM800 Hand-held Terminal Menu Loop Flowchart
<Items in brackets optionally present>



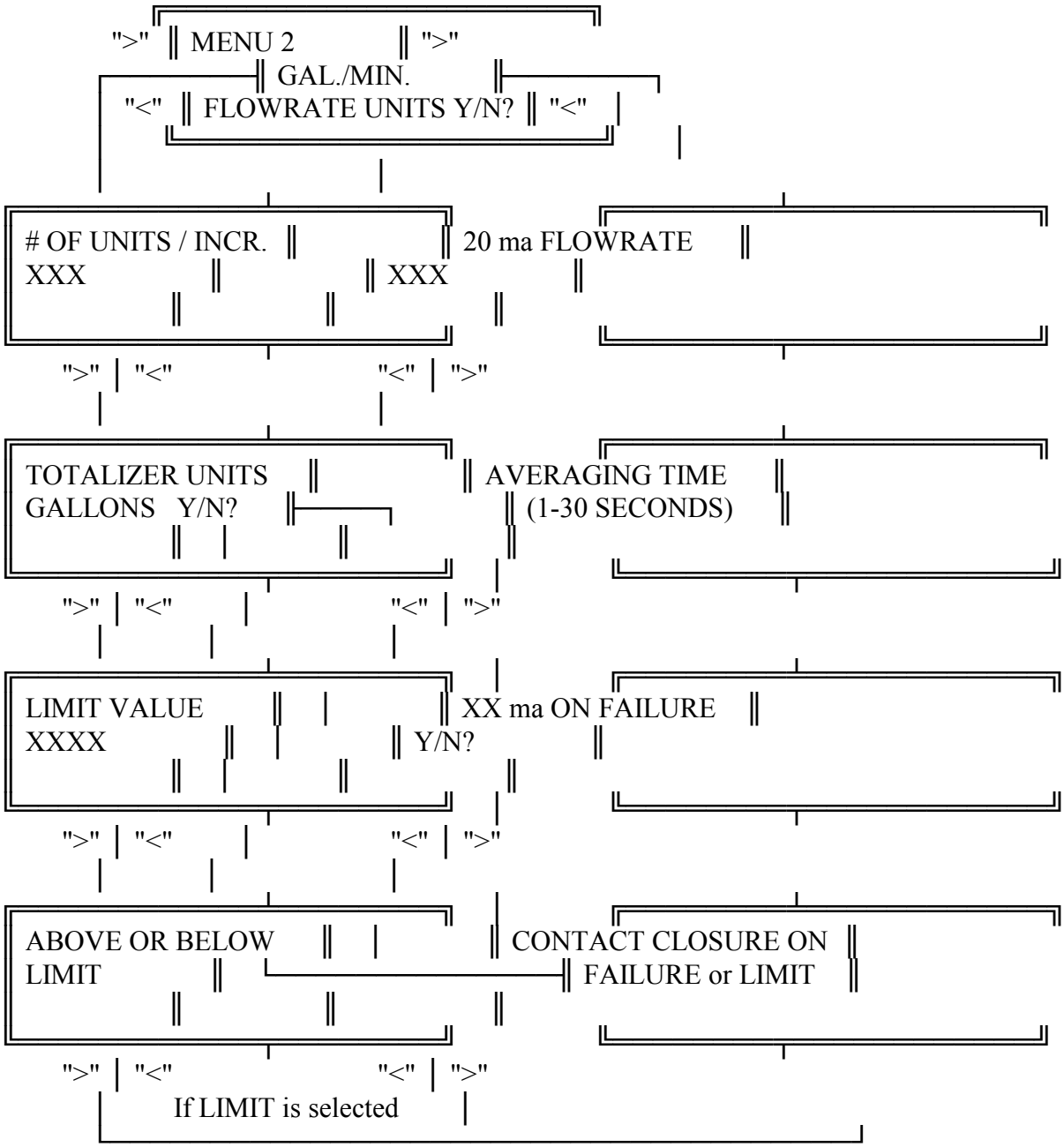
Menu 1 Flowchart:

">" key moves clockwise around loop. Any change to Menu 1 causes the "OPER" key to start a Calibration.



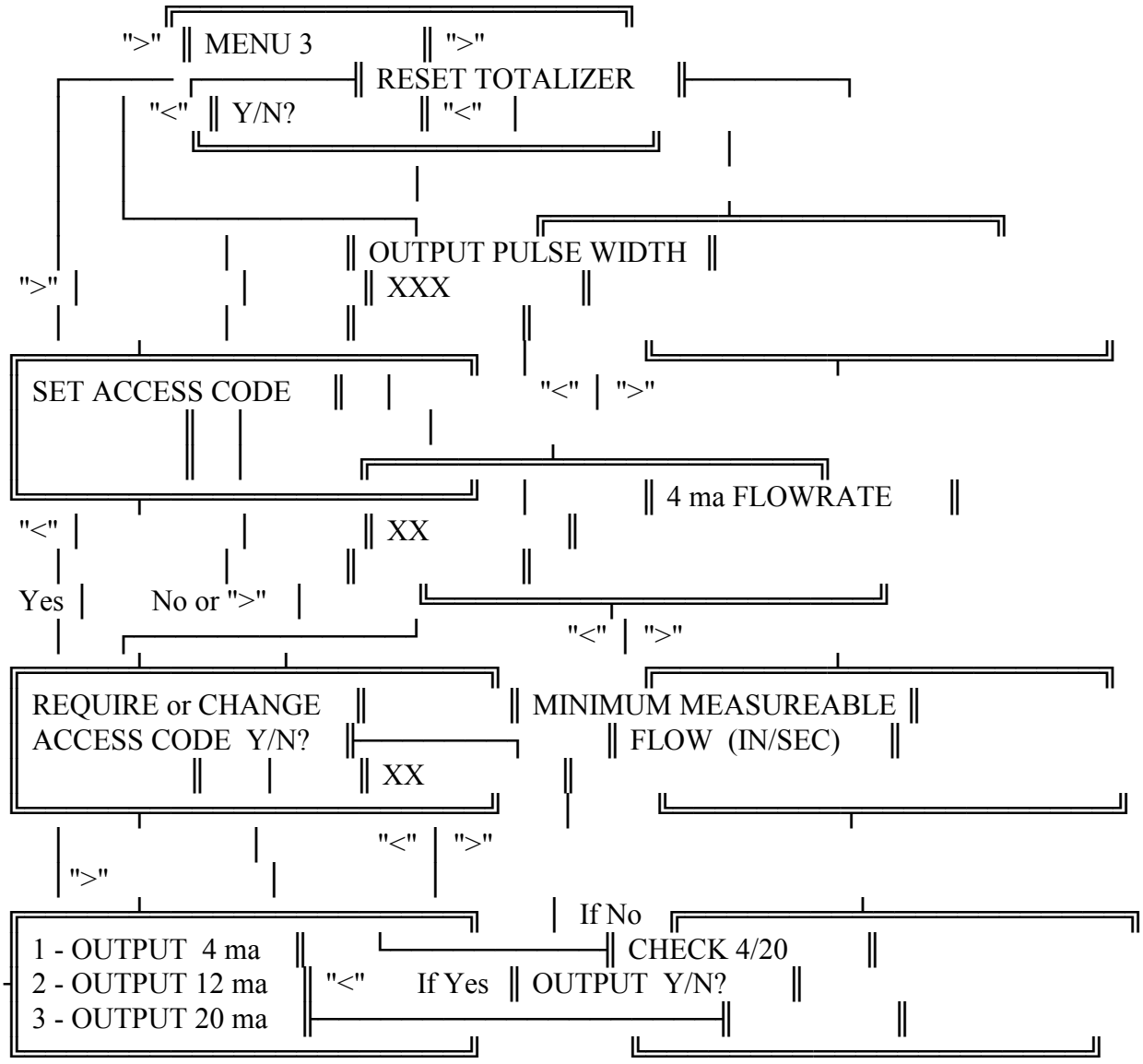
Menu 2 Flowchart:

">" key moves clockwise around the loop.

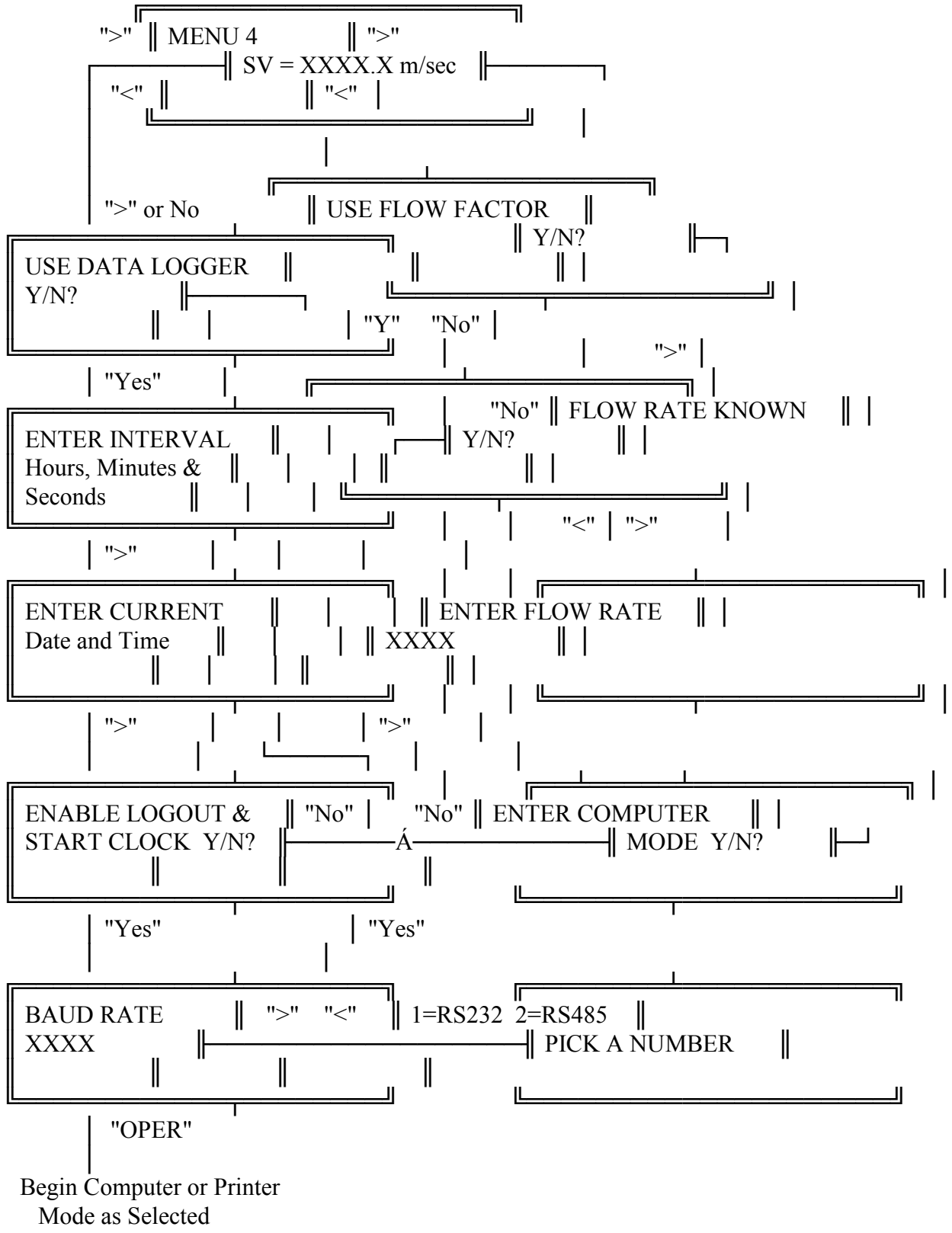


Menu 3 Flowchart:

">" key moves clockwise around the loop.

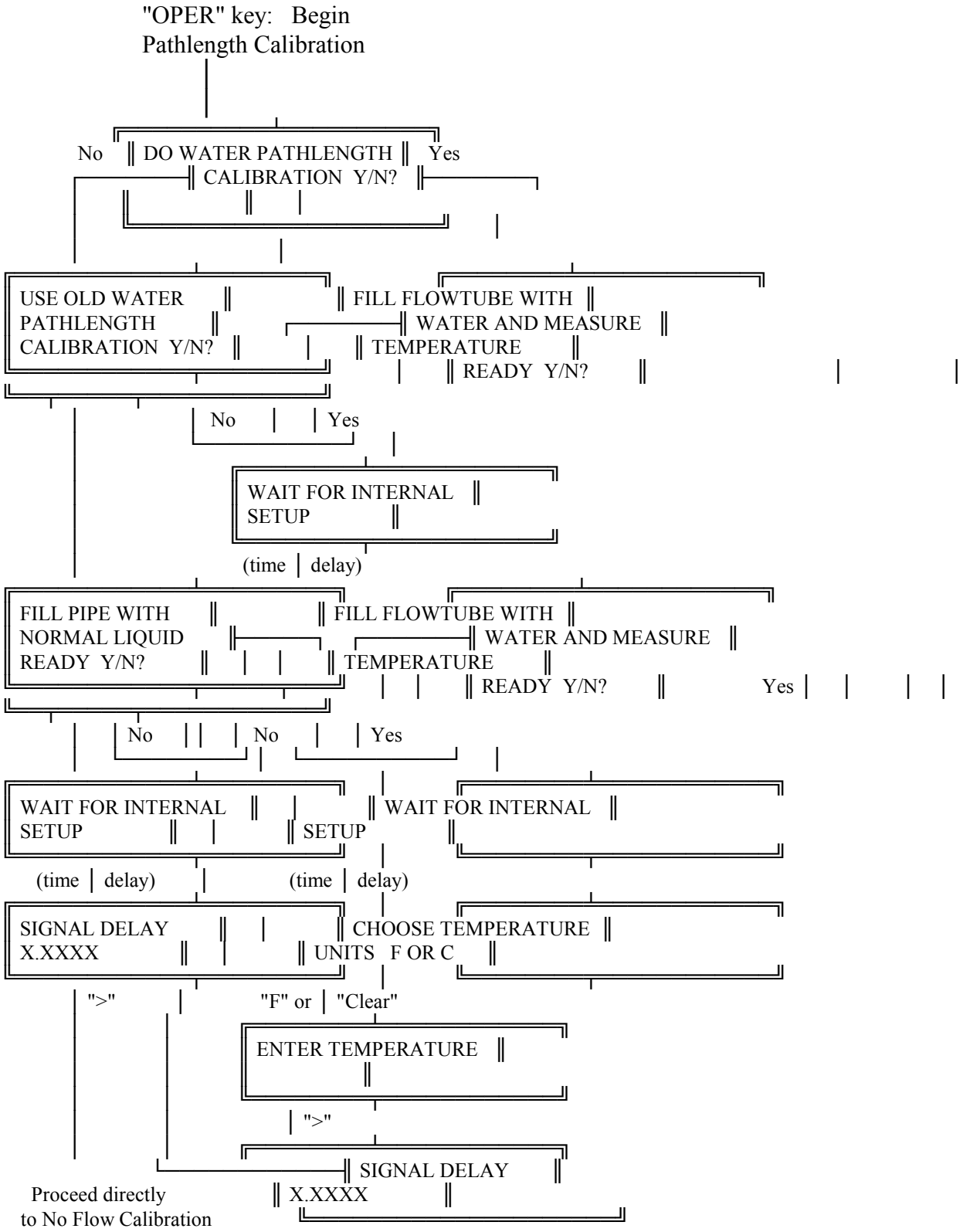


Menu 4 Flowchart:
Accessible only if the CM800 has been made operational.

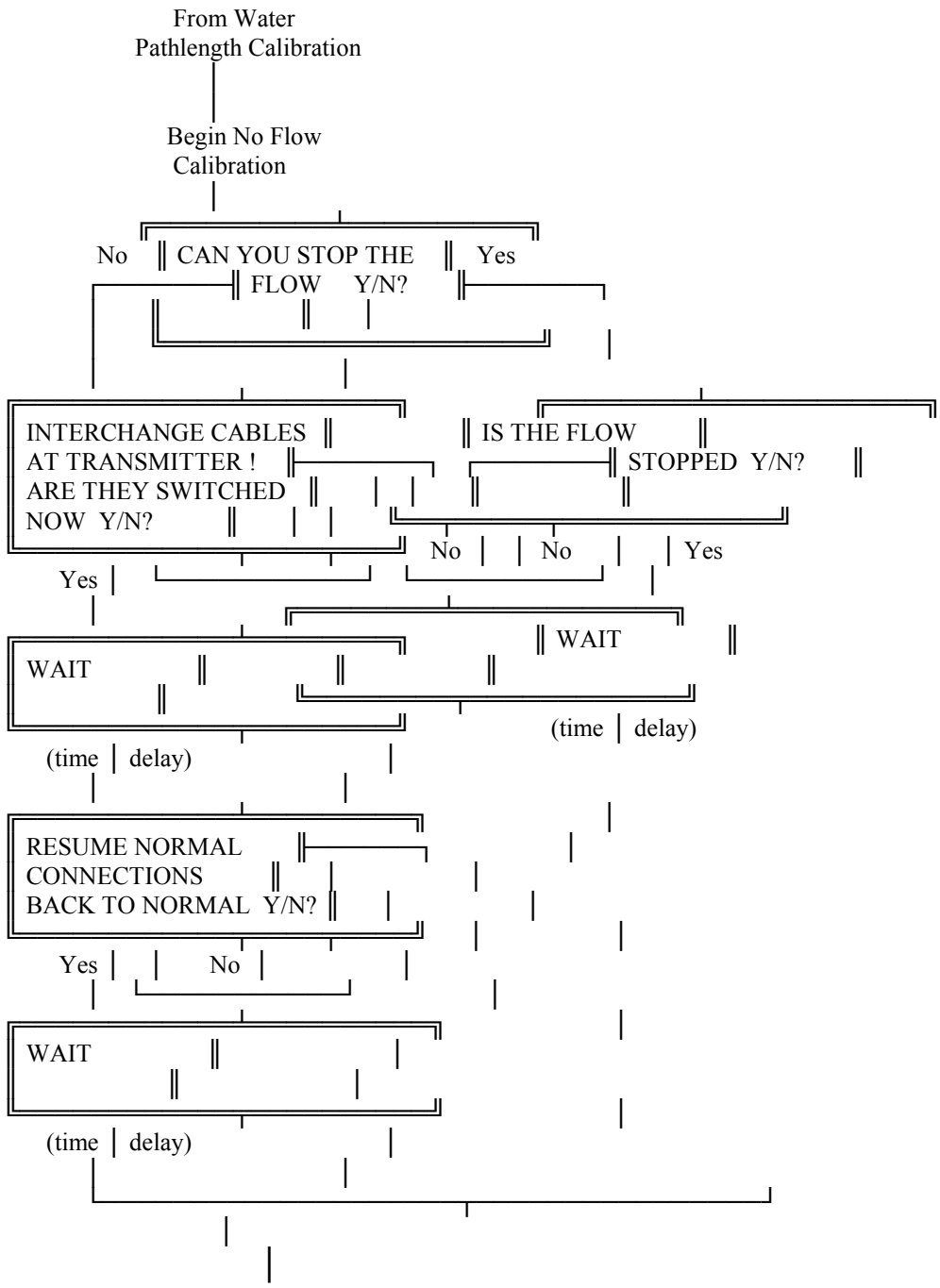


Calibration Procedure Flowchart:

"Setup" key returns to Menu 1 at any time. Items marked "time delay" require no action to proceed. See Section 4 for the description of conditions which initiate this procedure.



Calibration Procedure Flowchart (Cont.)



CM800 begins operation
at Data Screen

APPENDIX D CM800 ERROR CODES

D-1 Quality Factor

The quality factor (QF) is a measure of the receive signal quality. QF is continuously displayed at Data screen 2. QF is also readable in computer mode. There is a separate QF for each of the two transducers, i.e. an upstream QF and a downstream QF. The receive signal quality is affected by the acoustic signal quality and the electrical noise present in the CM800's environment.

Acoustical signal quality is affected by such variables as bubbles or solids in the process liquid or the acoustical energy absorption characteristics of the liquid. Detrimental electrical noise can be increased by such things as nearby electrical motors, welding operations, RF (radio frequency) transmitters and is compounded by improper equipment grounding.

The CM800 calculates the flowrate from the measurement of transit time, the time it takes for the acoustical signal to leave the transmitting transducer and arrive at the receiving transducer. Prior to each second when the display and/or outputs are updated, the CM800 makes many measurements of transit time. Of these many measurements, some may be bad due to the aforementioned variables, such as bubbles passing between the transducers. The CM800 can distinguish between good and bad measurements. QF is the ratio of the good measurements to the total number of measurements.

If the QF is greater than 0.555 operation is normal, and the CM800 proceeds with all its measurements and output calculations. A QF smaller than 0.555 causes the transit time measurement to be invalidated. The last valid transit time will be used instead and the Status LED will flash.

When a fault occurs the 4 to 20 ma circuit will not immediately change. The CM800 will first attempt a new Internal Setup and will freeze the output at the last known value. If the Internal Setup is unsuccessful, the analog output will then drive to its selected failure condition (4mA or 20 mA)..

D-2 Error Codes and Messages

Associated with a low QF value are error codes. When QF is less than 1, a code and a "?" is displayed on the terminal screen preceding the flowrate value. The code is a number 0 -9 or letter A - F. The code represents a likely cause for the error. The codes and their meaning are:

0 No error.

1, 9 A minor uncertainty, not likely to affect accuracy. A typical cause would be a short term, small increase in electrical noise.

2, 3, A, B A changing receive signal quality. Reliable operation may still be possible. May occur during periods of very rapidly changing flow.

4, C The measured transit time is too small. If attenuation is also high the CM800 will immediately attempt a new internal setup. Could occur if acoustical noise exceeds signal levels, e.g. excessive pipe vibrations at the transducers.

5, 6, D, E The receive signal is definitely invalid.

7, F No receive signal at all or transit time too long. If attenuation is also high the CM800 will immediately attempt a new internal setup. A short in the transducer cables or the absence of liquid in the pipe might cause this error.

8 Bad hardware calibration. Measurement accuracy is definitely impaired but will continue. Status LED will be extinguished.

All codes 8 through F may be generated in the event of electronic component failure or damage.

Data screen 2 shows transit times regardless of their validity, and the error codes are always displayed.

Some of the error codes require an immediate new internal setup. If an unbroken string of any error code occurs for more than 10 seconds, the CM800 will also attempt a new internal setup and the status LED will be extinguished. Prior to the setup the display will make an error report, showing the last measured transit time (as opposed to the last valid transit time), attenuation and the error code. If observed, this should be recorded.

Six Error Messages can be displayed during internal setup. They are:

BAD STEP 0 Is accompanied by "Delta F = XX.XX"; indicates the hardware is in need of calibration.

BAD STEP 1 Generated if an error code of 4 or 7 or an attenuation of 100% occurred during setup.

BAD STEP 2 Generated if continuous error is found during the internal setup.

BAD STEP 3 Generated when QF is too small after all attempts at internal optimization.

NEEDS CALIBRATION Generated if component damage/change is detected, or if internal calibration constants are lost.

NEEDS SETUP Generated if necessary Menu settings or values are lost.

As stated before, the CM800 can function accurately when QF is between 0.555 and 1; however, in order for the CM800 to be able to distinguish between good and bad measurements a good quality signal is required during the first internal setup.

D-3 Attenuation

Attenuation is usually considered to be the amount of acoustical energy received as a percent of acoustical energy transmitted. In actuality, attenuation is the direct measure of electrical amplification required to make the received signal useful. When the received signal strength is low, more amplification is required, which also amplifies the noise levels. Satisfactory operation of the CM800 is less likely when the attenuation level is high. Since attenuation is continuously displayed on the terminal at Data screen 2, it is the first consideration when diagnosing any problem. Determining the correlation between periods of high attenuation and some external event may yield the solution to problematic operation. If the attenuation levels are very different for the two transducers a wiring or cable problem may be causing a problem.

D-4 Troubleshooting

If the flowrate is predictable but inaccurate, and other functions appear normal, calibration may be needed, and can be initiated by changing and then restoring any Menu 1 item.

If no display appears on the LCD screen, the CM800 may be in Computer or Printer modes. Re-establish Terminal mode by disconnecting the terminal, turn AC power off and back on, wait 5 seconds, then connect the hand-held terminal.

All wiring connections should be double checked. If external devices are connected to the CM800, they should be disconnected and the continuation of the problem verified.

Any displayed error codes or messages, along with attenuation, sound velocity, measured flowrate and the expected actual value of flow should be recorded. This information can be extremely helpful in diagnosing a problem and determining the proper course of action.

Please contact Mesa Laboratories, Inc. NuSonics Service Dept. when error codes or messages indicate the need for hardware calibration. The Service Dept. should be contacted for an RGA (Return Goods Authorization) number before the return of any equipment. In many cases the return of unit to the factory is not necessary.

APPENDIX E PIPE SCHEDULES and MISCELLANEOUS

PIPE INSIDE DIAMETER FOR VARIOUS SCHEDULES 11/30/94

Pipe Size	Sch. 5	Sch. 10	Std. Wall	Sch. 40	Sch. 80	Sch. 160
2	2.245	2.157	2.067	2.067	1.939	1.687
2½	2.709	2.635	2.469	2.469	2.323	2.125
3	3.334	3.260	3.068	3.068	2.900	2.624
4	4.334	4.260	4.026	4.026	3.826	3.438
5	5.345	5.295	5.047	5.047	4.813	4.313
6	6.407	6.357	6.065	6.065	5.761	5.187
8	8.407	8.329	7.981	7.981	7.625	6.813
10	10.482	10.420	10.020	10.020	9.562	8.500
12	12.420	12.390	12.000	11.938	11.374	10.126
14	- -	13.500	13.250	13.124	12.500	11.188
16	- -	15.500	15.250	15.000	14.312	12.812
18	- -	17.500	17.250	16.876	16.124	14.438
20	- -	19.500	19.250	18.812	17.938	16.062
24	- -	23.500	23.250	22.624	21.562	19.312

Temperature Units Conversion Formulas:

°C = (5/9)*(°F-32)

°F = (9/5)*(°C) + 32

The Viscosity of Water:

Temperature °C	Temperature °F	Viscosity in CentiStokes
10	50	1.3073
20	68	1.0037
30	86	0.8009
70	158	0.4133

Viscosity Units Conversion Formula:

CentiStokes is equivalent to Kinematic viscosity. Centipoise is equivalent to Absolute viscosity.

CentiStokes = Centipoise / Density (in gram/cc)

The velocity of sound through clean water as a function of temperature:

Temperature °C	Velocity in Meters/Second
10	1447.2
20	1482.3
30	1509.0
40	1528.5
50	1541.6
70	1549.7

APPENDIX F RS232C Communications Syntax

Requirements:

An adapter to connect the J1 modular type connector to a standard RS232 9 pin connector is available from Mesa Laboratories, Inc.. Connector pinout is detailed at the end of this section.

The cable between the CM800 and the computer should not exceed 50 feet.

Communications should be set up for 8 data bits, No Parity, One stop bit.

The RS232 signal ground is isolated from earth, but not other circuits on the CM800. If there is significant spacing between the computer, the CM800 and any other peripheral devices, they should be isolated from one another.

Syntax:

There are 4 commands available to the user:

Rcc [ffffcrlf]	Read number at address cc
Wccffff [crlf]	Write number to address cc
O [crlf]	Same as "OPER" key
T	Resume Terminal mode

cc A two digit hex address (two ASCII characters)
crlf carriage return and line feed (0D 0A hex, 13 10 ASCII)
ffff A multi-digit number, floating point or integer
[ ] Shows the response of the CM800, excluding command character echos.

The CM800 will echo each characters received before responding. All letters must be upper case. Invalid characters will be echoed and no further response will come.

HEX ADDRESS	VARIABLE
00	Attenuation / Downstream to Upstream
01	Attenuation / Upstream to Downstream
03	Flow Factor
04	Averaged Flowrate in inches/second
05	Averaged Flowrate in user selected units
07	Downstream QF
08	Upstream QF
09	Liquid sound velocity
0D	Totalizer Count
10	Averaging time
12	Cable length in feet (*)
13	Difference of U/D transit times is uSecs.
14	4 ma flowrate
15	20 ma flowrate
16	Minimum measurable flow
19	Flowrate Limit for relay activation
1C	Pipe inner diameter in inches (*)
1D	Lowest value of satisfactory QF (typ. 0.555)
22	Totalizer units/increment
26	Pathlength from water calibration
27	Pathlength calculated from pipe size
2A	Viscosity in centistokes (*)
2D	Reynolds number

(*) Writing to these or an unlisted address may cause the CM800 to require calibration.

The totalizer may be reset by writing a value of 0 to address 0D, the Totalizer count.

If The CM800 is operational and in Terminal Mode, it may be placed in Computer mode by transmitting the ASCII string "WPPPRRUY" one character at a time, with a delay between each character but no carriage return or line feed. After each character is sent, the receive buffer should be cleared.

For the Extended Communications Code set, please contact Mesa Laboratories. The extended set contains the codes required to establish total control of the CM800 via the RS232 function.

Examples of communications software are available from Mesa Laboratories, Inc..

Programming Hints:

The default Baud rate is 9600.

Care should be taken regarding the inappropriate transmission of the carriage return or line feed codes.

Comparing the transmitted command to the echo is a good debugging or verification tool.

Monitoring the status of the RS232 receive buffer (e.g. BASIC LOC function) and importing data one character at a time usually results in trouble-free program execution and command string echo verification.

Very fast computers may require timing loops or delays inserted in the code.

Pin connections / J1 Connector:

The modular telephone type connector, J1 on the board or mounted on the exterior of the NEMA 4X enclosure, has six pins. When the connector is viewed such that the connector catch is at the bottom, the function of the pins from right to left is:

1 Signal Ground
2 Data Receive
3 Data Transmit
4 Interrupt
5 Not Used
6 + 5 VDC

The Interrupt must be held high (+5 VDC) while communicating with the CM800. The CM800 will not send data while the interrupt is low. Jumper JP5 (see Appendix I) may be used to control the interrupt level. If the interrupt is low during power up, the CM800 will revert to terminal mode.

Communications may be conducted in a null modem wiring format. This requires connecting CTS to RTS, and DSR to RLS to DTR at the PC. For a 9 pin connector, this is connecting pin 7 & 8 together; pins 1, 4 & 6 together; signal ground is pin 5, PC transmit (to receive of CM800) is pin 3, and PC Receive (to transmit of CM800) is pin 2.
Jumper JP5 must be in position A.

APPENDIX G: PC INTERFACE SOFTWARE

A software package which emulates all the functions of the hand-held terminal on a DOS based computer is available from Mesa Laboratories, Inc. The package includes a diskette, a special adapter (Modular RJ12 to DB9), and 6 feet of cable. Longer cable lengths are available. Please specify desired disk size.

The Terminal Emulator program is named "CM800.EXE". If desired, it may be copied and run from the system hard-drive.

Decide to which of the PC's RS232 Communications Ports the CM800 will be connected. If there is a communications port not being used, use that port. The port selected must be COM1 or COM2. If the PC has only one port, and it is in use by a mouse, either disable the mouse driver (typ. involves editing the autoexec.bat file - ref. the PC owners manual) or connect the CM800 to the PC only while CM800.EXE is already running. A CM800 in Terminal Mode is continuously outputting data. If it is connected to a port designated as a mouse input, this continuous data will cause errors in the PC's screen cursor position.

Connect the adapter to the PC port, the cable to the adapter and to the CM800. At the CM800 the cable may be connected to either jack J1 on the PCB (See Fig. 1) or to the jack provided on the exterior of the enclosure.

Run CM800.EXE. The program will identify which port the CM800 is connected to. The system will then be checked for the availability of graphics and color. A picture of the standard hand-held terminal will be displayed.

The function of the software is generally identical to that of the hand-held terminal. The user should familiarize himself with Sections 3 and 4 and Appendix C before proceeding. Only the differences are outlined below.

Use the first letter of a desired Selection. For example, Pressing the "O" key is equivalent to "OPER" and "S" is the same as "Setup". Entries are not case sensitive.

The cursor arrows may be used. The cursor arrow functions are the same as "UP", "DOWN", "<" and ">". The Enter key is also equivalent to ">".

The function keys may be used to access special program functions such as help screens, computer mode or printer mode. Instructions are given on the computer monitor. Printer mode can be used to log data at regular intervals to a user named computer file.

APPENDIX H SERIAL PRINTER FUNCTION

In the Printer mode, the CM800 uses its communications port to print out data to a serial printer at regular user-defined intervals. The CM800 prints date, time, flowrate, totalizer value and error codes (if applicable).

An adapter for connecting a standard DB9 RS232 type connector to the modular (RJ12) telephone type jack on the CM800 (or its enclosure) is available from Mesa Laboratories, Inc. Appendix F contains additional details regarding the hardware connections for the RS232 functions.

The communications format is 8 data bits, no parity and one (1) stop bit. This is equivalent to 7 data bits, space parity and one stop bit. Null modem format is not recommended. Many serial printer have limited input buffers which may cause data to be missed during carriage returns or line feeds.

Printer mode is enabled in Menu 4 (see Section 3-10). The CM800 should be initialized with the hand-held terminal. The printer is then connected in place of the terminal and printout begins.

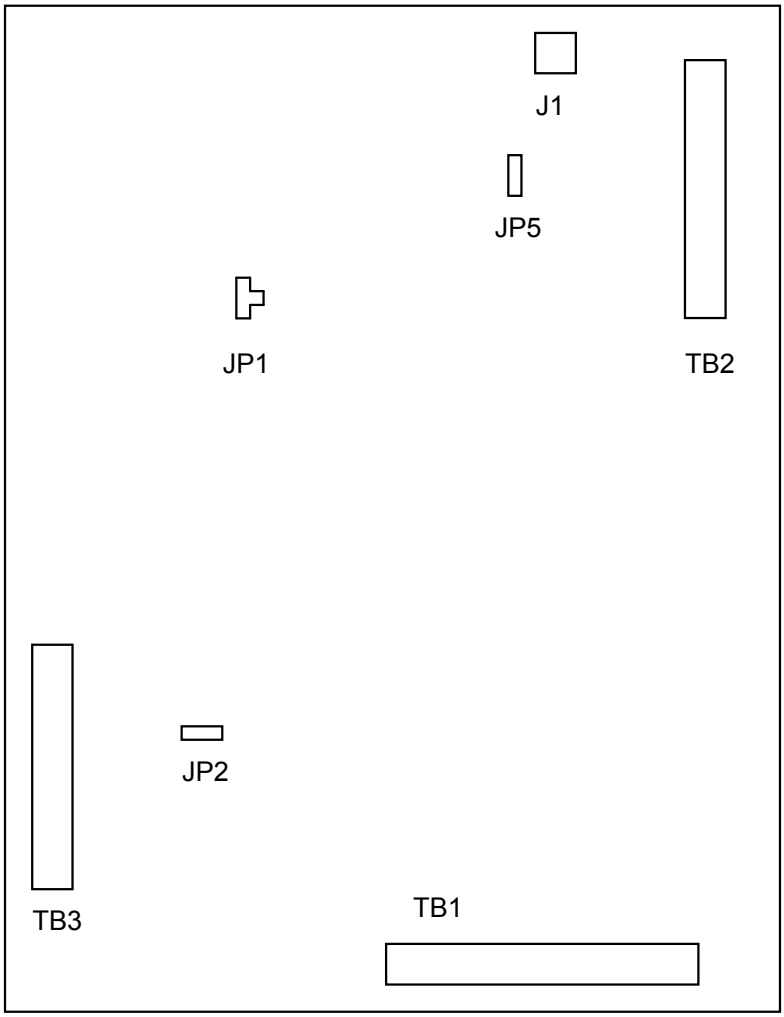
Printout will continue as long as power to the CM800 is not interrupted. A temporary fault condition or internal setup requirement will disable the printout, but function will resume with the correct date and time.

The CM800 clock does not compensate the date during a leap year, i.e., February always has 28 days.

A sample printout:

06/29 14:30:05
5.12
FEET/SEC
2045 x 100

APPENDIX I: PC Board Jumper Functions



PC board jumper locations with respect to Terminal Barriers

Jumper	Function	Position	
JP1	Memory Write:	A = Enabled	B = Protected
JP2	4 - 20 mA Power Source	A = Internal	B = External
JP5	Serial Communications Interrupt	A = No Interrupt	B = External Interrupt.

JP5 - A is normally reserved for RS485 Communications. It can also be used if an RS232 Null-Modem format is desired. JP5-A also prevents loss of computer mode in the event of a power failure. In order to restore Terminal Mode by powering down the unit, JP5 must be in position B.