

M810
Rev. Ö
Mass Flow Meter With Datamate 2100

RED SEAL MEASUREMENT

• **m** Mass Flow meter with Datamate 2100 (Ver. 5.XX)/Datamate 2000 (Ver. 3.2) Operations & Maintenance Manual

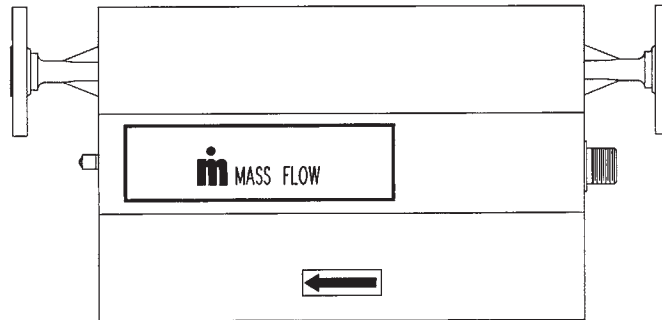
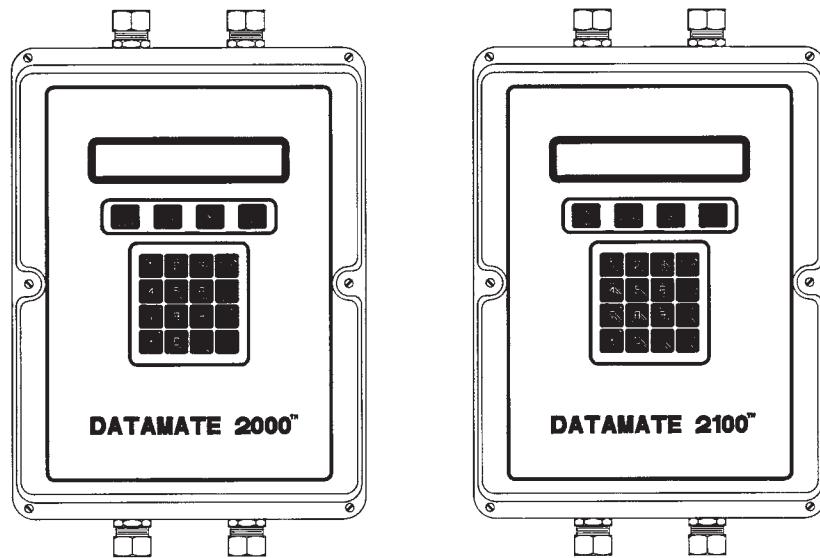


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I. INTRODUCTION

I.1. What You Need To Use This Manual

A Datamate 2100 \dot{m} [®] with V5.XX or V4.0X Firmware, or

A Datamate 2000 \dot{m} [®] with V3.XX Firmware

This manual covers only the \dot{m} [®] Mass Flow Meter with Datamate 2100™, V4.0X and V5.XX firmware or Datamate 2000™ and V3.XX firmware and the model codes described in Section VI.3. If you have any other instrument, this manual will not help you. In that case, contact Actaris for the correct manual.

To tell if your instrument is covered by this manual, look on the front of the instrument door. The name Datamate 2100™ or Datamate 2000™ will be clearly visible. To confirm that it is V5/XX, V4.0X or V3.XX, open the door and look at the gummed label on integrated circuit (U3 on the Datamate 2000 or U6 on the Datamate 2100) on the computer board which is mounted on the inside of the door. Refer to Figures 15 and 16. If it reads V5.XX, V4.0X or V3.XX and you can find the model code described in Section VI.3 then this manual covers the instrument.

Tools List

To use this manual effectively, you must have a high-impedance digital volt meter, hand tools, and (if you want to check the pulse output) a pulse counter of some sort.

I.2. Terminology Used

The \dot{m} [®] Mass Flow Meter comes in three sub-assemblies: The TRANSDUCER, which is the wetted element that fits in your piping, the ELECTRONICS, and the CONNECTING CABLE. Inside the transducer are wire coils which detect the motion of the vibrating tubes. These coils are called SENSORS.

The transducer size is defined by the nominal diameter of the hole in the center of the flange: a 1/2" meter has inlet and outlet holes that are about 1/2" in diameter. These meters often have oversized flanges, so do not confuse the transducer size with the flange size. Note that the transducer size is not the same thing as the size of the tubes in the meter. To determine the size of the tubes in your meter, check the section VI.4, Performance Specifications, at the back of this manual.

There are several displays which you will be using. The Default Display shows totalized flow on the bottom line. It is the display shown when the meter is in the in Run mode but not doing a batch. The BATCH DISPLAY shows the word BATCH on the bottom line and is the display you will see if the meter is running a batch. The MAIN MENU display is the first display you will see when you push the Main Menu key during programming.

% SOLIDS is the fraction of one substance in another (not necessarily a solid). SOLIDS FLOW is the mass of one component of a two-component system, such as the flow rate of NaOH in a caustic solution.

I.3. Principles of Operation¹

Coriolis force flow meters operate on the principle that inertial forces are generated whenever a particle in a rotating body moves relative to that body in a direction towards or away from the axis of rotation of that body. This may be illustrated by reference to Figure 1.

A particle of mass (M) moves with a mean constant velocity (v) in the tube (T) which is rotating with a constant angular velocity (w) about a fixed point (P). This particle is affected by two components of acceleration:

A radial acceleration (a_r) towards the axis of rotation (P) where:

$$a_r = w^2r.$$

A transverse acceleration (a_t) due to the Coriolis force acting perpendicularly to the radial acceleration, where:

$$a_t = 2wv.$$

To impart the transverse acceleration (a_t) to the particle, a force of magnitude $2wvM$ acting in the direction of a_t is required. This is imparted by the tube and the reaction of this force back on the tube is the Coriolis force (F_c).

$$F_c = 2wvM.$$

From Figure 1, it can be seen that when a liquid of density r flows at constant velocity (v) along a tube (T) of constant cross sectional area (A), rotating at a constant angular velocity (w), any length of tube Δx experiences a transverse Coriolis force ΔF_c , where:

$$\Delta F_c = 2wvrA\Delta x.$$

¹ API, MPMS, Chapter 5, Section 6, Pending.

Since the mass flow rate $Q_m = vA$ then:

$$\Delta F_c = 2wQ_m \Delta x.$$

This relationship holds true for any value of w .

If the vibrating tube or tubes of a Coriolis force flow meter (CFF) is viewed in a polar coordinate system, it exhibits angular velocities in the range $-w \leq 0 \leq w$ in a continuously varying sinusoidal fashion. With flow through the tubes, a Coriolis force which also varies sinusoidally is generated. Each tube is anchored at or near the points of flow entry and exit and is vibrated in such a way that the maximum amplitude of vibration is at the midpoint between the two anchored points. As a result, the Coriolis forces generated on each half of the tube are of equal magnitude but opposite direction. These opposing forces impart a bending moment on the tube which is superimposed on the vibration induced by the CFF's drive system.

The bending moment causes the vibrating tube to distort asymmetrically. The magnitude of the distortion is directly proportional to the mass flow rate of the flowing liquid. CFF manufacturers use various proprietary techniques to monitor the magnitude of the distortion and process the measured signals into appropriate analog and/or digital outputs.

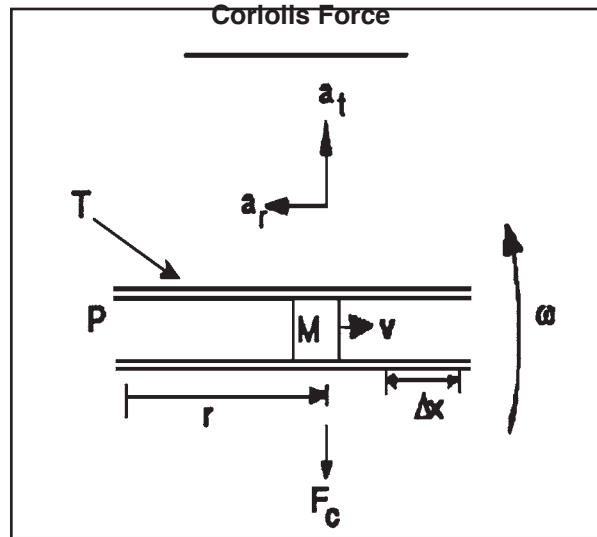


Figure 1.
Coriolis Force Illustration

II. PHYSICAL INSTALLATION

II.1. Checking the Process Conditions

This flow meter is sold for use in a particular process application. If used under different circumstances, its performance may not be as warranted and in extreme cases the meter may be damaged or destroyed. Before installing this unit, check your process conditions to be sure they fall within the limits outlined in Section VI.4, Performance Specifications, at the end of this manual. If the sheet referred to in Section VI.8 is not appended, please call and request another sheet.

II.2 Site Selection

Proper installation is critical to the operation of this meter. For the sake of accuracy and safety, several factors must be taken into account when selecting a mounting location.

Weather and Water

The electronics are housed in a NEMA 4X enclosure (CSA enclosure 3 rating) which may be mounted in a location which is exposed to rain, ice and snow. It may not be submerged, however.

Hazardous Area

Our mass flow meters are approved by the Canadian Standards Association (CSA), and the European Conformity (CE) & ATEX (ATEX). Table 1 shows the different levels of approvals:

Table 1. Hazardous Area Approvals

Agency	Components	Method	Class	Div./Zone	Group	Temp. Class	Ambient Temp.
CSA	Transducer	Intrinsic Safety	I, II, III	1,2	C,D,E,F,G	TS	Note 1
	Datamate	Non-incendive	1	2	C, D	T4A	Note 2
LCIE	Transducer	Ex ia		0,1,2	IIB	T5, T4, T2	Note 3
	Datamate	N/A	N/A	N/A	Safe Area		

Units approved for hazardous areas are limited to the ambient temperatures listed below:

Note 1 -20°C to 40°C (-4 to 104°F)

Note 2 -20°C to 65°C (-4 to 149°F)

Note 3 -20°C to 40°C (-4 to 104°F) for T5
+40°C to 60°C (104 to 140°F) for T4
+60°C to 200°C (140 to 392°F) for T2

To determine whether or not your unit is rated for these areas, compare the Model Number on your transducer and Datamate tags to those listed on the Model Number Explanation Table, Section VI.3 of this manual. If your unit is not rated for intrinsically safe do not install it in a hazardous area.

Note:

The hazardous location approvals of the m Mass Flow Meter and Datamate 2100 require that they be properly installed according to agency regulations. Refer to the appropriate drawing for specific regulations for each mass flow meter configuration:

- CSA – Intrinsically Safe
- LCIE Installations

Figure 4 (Drawing D70391-027)
Figure 5 (Drawing D600442-001)

Additionally, the National Electric Code and other national or local codes may govern the installation of electrical/electronic equipment into hazardous areas, and should be consulted.

DO NOT ATTEMPT INSTALLATION OF YOUR METER IN A HAZARDOUS LOCATION WITHOUT THE PROPER INSTALLATION DRAWING.

Vibration

Severe vibration can effect the accuracy of this meter. Although proper mounting techniques will minimize this problem, you should look for an installation location that is away from large motors, pumps, or vibrating machinery. Also, keep in mind that proper mounting does require the installation of rigid pipe mounting brackets, so select a location where solid mounting supports are available. (See Figure 2 for details.)

EMI/RFI

Do not mount the electronics or the transducer near radio frequency or electromagnetic interference sources such as variable-frequency motors, radio transmitters, large switch gear, or high voltage cables. Do not run the connecting cable next to high-voltage power cables or similar sources of EMI/RFI noise.

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Maximum Cable Length

The electronics must be mounted within 500 feet of the transducer. Practically, this distance is limited by the length of the cable available with your unit. **Splicing of this cable is NOT recommended.** If the cable with your unit is not long enough for your needs, contact your local ÜT representative for a replacement.

Transducer Installation

The transducer may be mounted in either the upright or inverted position. The upright position shown in Figure 2 is recommended whenever possible because it prevents the accumulation of air in the tubes during the zeroing process. An inverted mounting is recommended only if your process fluid contains some suspended solids which may settle during the zeroing process or if it is necessary to drain the transducer. **DO NOT MOUNT THE TRANSDUCER IN THE INVERTED POSITION UNLESS YOU HAVE BUBBLE-TIGHT BLOCK VALVES AT EACH END OF THE UNIT.**

If necessary, the transducer may be mounted in a vertical pipe, but this is not a preferred mounting position. If this position must be used, call for advice.

Piping Support Requirements

Because the \dot{m} ® employs vibrating element technology, severe vibration can have an effect on accuracy. To minimize this possibility, we recommend that each connecting pipe be tightly clamped in two places by rigid pipe supports. The support spacing for the pipe supports are outlined in Figure 2. The nearest pipe support to the flowmeter should be as close to the process flange as possible. All pipe supports should be mounted to a common base. Support of the transducer body is not necessary, nor recommended. The upstream and downstream pipe requirements do not have to be straight pipe lengths. Contact your local ÜT representative for options.

Support Spacing for Carbon and Stainless Steel, and Hastelloy C-22 Schedule 40 piping systems.

Pipe Size (in.)	1/8	1/4	3/8	1/2	3/4	1	1 ½	2	3	4	6	8
D (in)	5	10	12	13	15	16	20	22	27	31	36	41

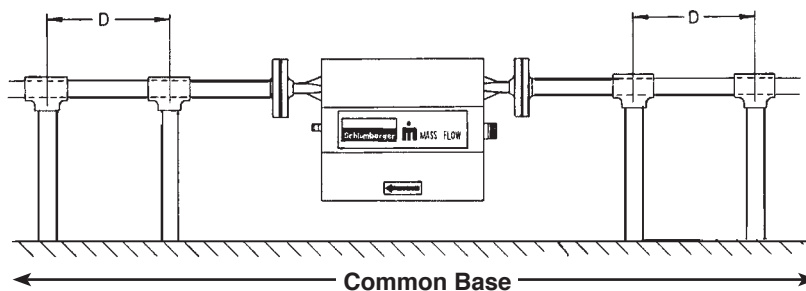


Figure 2. Transducer Mounting Requirements

Air Entrainment

Large amounts of entrained air or gas in the process fluid can cause the tubes to stop vibrating or the accuracy to be poor. Ideally, you should select a mounting location where the process fluid is free of entrained air or gas. If such a location cannot be found, the source of the gas or air should be eliminated through the placement of air eliminators, baffles, tightening of seals, or by an alteration of process. Since large amounts of entrained gas or air always lowers the accuracy of the meter, one of these solutions must be chosen if the final measurement is to be as accurate as possible.

However, if a process solution is not possible, such as in the case of Empty-To-Empty Batching, the Datamate Electronics can be programmed to minimize the error caused by air slug entrainment. For details on programming the unit for use where entrained air will be present, see Section III.4 (Slug Flow Inhibit) of this manual.

II.3. Additional Equipment Requirements

Additional equipment may be required for your application to make the meter work. They are:

Back Pressure Regulators

If the Mass Flow Sizing program indicates that your application requires back pressure on the meter to prevent cavitation, you may need to install a back-pressure regulator downstream of the transducer. If in doubt, contact your representative for advice. (This situation is particularly likely when metering liquified gases or hot solvents.)

Sufficient Pump Capacity

You must have sufficient pump capacity to compensate for the additional pressure drop of the transducer. Check the Process Data at the end of this manual to confirm the pressure drop across your transducer and that your pump has enough pumping capacity.

Block Valves

There must be a bubble-tight block valve installed downstream of the transducer so all flow can be shut off while zeroing the instrument. In many applications, a block valve should also be installed upstream so the transducer can be removed from the line for service without draining the system.

II.4. Wiring

General Comments

All cables, including signal and sensor cables, should be run inside conduit. If not feasible, the power and sensor cable may be direct-laid in cable trays or other supports provided they are not run next to any sources of electrical noise. **The National Electric Code and other national or local codes may govern the routing of signal and power cables into or through hazardous areas, and should be consulted.**

Note:

The hazardous location approvals of the \dot{m} Mass Flow Meter and Datamate 2100 require that they be properly installed according to agency regulations. Refer to the appropriate drawing for specific regulations for each mass flow meter configuration:

- CSA – Intrinsically Safe
- LCIE Installations

Figure 4 (Drawing D70391-027)

Figure 5 (Drawing D600442-001)

Additionally, the National Electric Code and other national or local codes may govern the installation of electrical/electronic equipment into hazardous areas, and should be consulted.

Caution: When installing in a hazardous area all circuits should be de-energized until all connections are tight and covers are properly closed.

Four conduit holes are provided in the electronics housing to allow electrical connections to be made without the risk of damage to the electronics which might be caused while drilling these holes. To prevent damage from humidity and corrosive aerosols, all of these openings must be sealed before the unit is placed in operation. If no wires are to be run through a particular hole, the fitting which was shipped with the unit should be replaced with an air-tight plug.

Power Supply

The Datamate 2100 power supply is in compliance with the CE low voltage directive, and bears the CE mark on the enclosure.

The CE unit is to be placed on a dedicated branch circuit. The circuit breaker to be used is a single pole, 1 amp connected in series with the AC live line between the Datamate and AC supply.

The CE replacement fuse is a 2 amp, 250v, dual-element time delay, 1.25" x 0.25"; Bussman MDQ2 or equivalent.

The Datamate will operate from 115 or 230 volts AC power. **Before powering the unit, ensure that SW1 on the power supply board (Figure 3) is in the proper position for the AC voltage supplied.** The power line wires should be connected to TB1 on the power supply board. Figure 3 shows the location of TB1 on the power supply board and Table 2 shows the power line connections for TB1. Use at least 14 AWG wire for the power supply connections.

Ensure that Switch SW1 on the power supply PCB is set to the proper voltage before applying power to the unit.

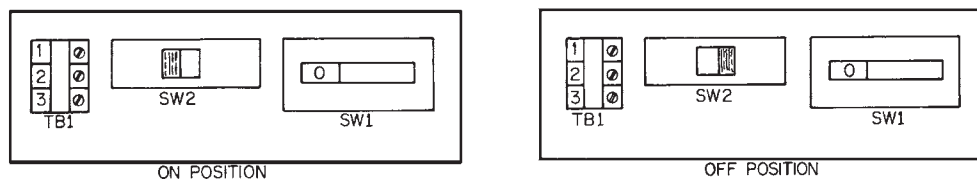


Figure 3.
Power Supply Wiring Connections

The m[®] Mass Flow Meter requires clean, regulated power for proper operation. (For detailed specifications, see Section VI.4, Performance Specifications.) If voltage transients from the AC line are a problem, you should install a line voltage conditioner (e.g., constant voltage transformer) in the power feed to the Datamate to eliminate the transients. Power line transients may be generated by lightning strikes, or switch gear, motors, or heavy machinery operating in your facility.

Note that the supply voltage must also be controlled to within the tolerances outlined in Section VI.4.

Table 2. Power Supply Connections

TB1	WIRE	Signal Name
1	Black	AC Hot
2	White	AC Neutral
3	Green	Earth Ground

Grounding

Both the electronics and the transducer must be well grounded for accurate operation. In **Safe Area installations** the power circuit ground from the power supply TB1-3 should be connected to one of the unused (even numbered) positions of TB1 on the barrier board and the transducer should be connected to another unused position of TB1 on the barrier board.

Transducer Cable Connections

The transducer cable may be up to 500 ft (150 m) long. **DO NOT SPLICE THIS CABLE.** If the cable that came with your meter is not long enough, contact the factory for a replacement. You may shorten this cable if desired.

This cable is connected to a Connector Board or I.S. Barrier Board. Table 3. shows the proper connections for the transducer cable to the Connector Board. The even numbered terminals of TB1 may be used to ground the transducer and electronics.

Note: The hazardous location approvals of the m Mass Flow Meter and Datamate 2100 require that they be properly installed according to agency regulations. Refer to the appropriate drawing for specific regulations for each mass flowmeter configuration:

- CSA – Intrinsically Safe
- LCIE Installations

Figure 4 (Drawing D70391-027)

Figure 5 (Drawing D600442-001)

Additionally, the National Electric Code and other national or local codes may govern the installation of electrical/ electronic equipment into hazardous areas, and should be consulted.

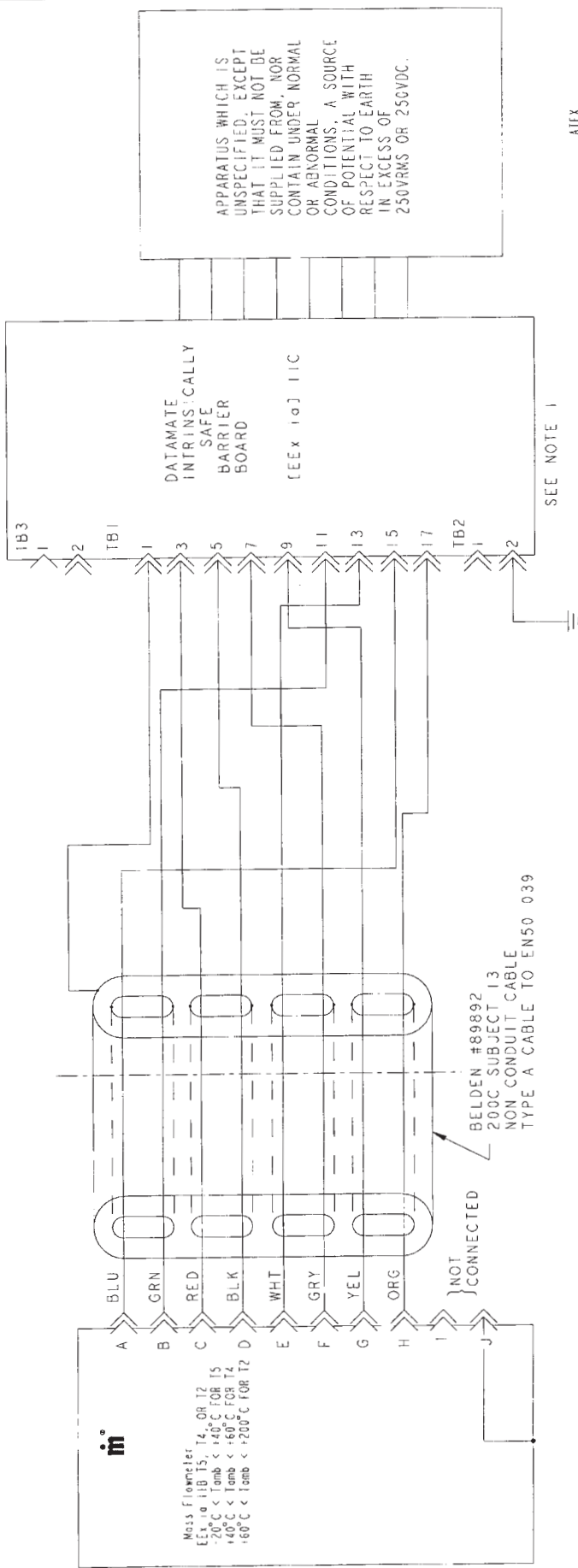
Table 3. Connector Board Cable Connection Table

Terminal Block	Pin Number	Label	Conductor Color	Transducer Connector Pin	M300 Connector Terminal	Function
TB1	1	SHLD	Bare	None	None	Ground
TB1	2		No Connect			Ground
TB1	3	RED	Red	C	J6	Tube Drive
TB1	4		No Connect.			Ground
TB1	5	BLK	Black	D	J5	Drive Return
TB1	6		No Connect.			Ground
TB1	7	GRY	Gray	F	J4	RTD Excite +
TB1	8		No Connect.			Ground
TB1	9	YEL	Yellow	G	J7	RTD Sense +
TB1	10		No Connect.			Ground
TB1	11	GRN	Green	B	J3	RTD Sense -
TB1	12		No Connect.			Ground
TB1	13	WHT	White	E	J2	RTD Excite -/ Sensor Common
TB1	14		No Connect.			Ground
TB1	15	BLU	Blue	A	J1	Sensor A
TB1	16		No Connect.			Ground
TB1	17	ORG	Orange	H	J8	Sensor B

LTR	REVISION	DATE	ECN	BY	APPD
A	INITIAL RELEASE	8/26/05	100090057	RC	R. SMITH

NON-HAZARDOUS AREA

HAZARDOUS AREA



ATX
SCHEDULE DRAWING
No modifications permitted
without reference to
LCIE


NOTES:

1. THE INSTALLATION MUST COMPLY WITH THE REQUIREMENTS OF THE COUNTRY OF USE.
2. THE APPARATUS AND CABLE IN THE HAZARDOUS AREA MUST BE CAPABLE OF WITHSTANDING A TEST VOLTAGE OF 500 VRMS WITH RESPECT TO EARTH OR FRAME FOR ONE MINUTE WITHOUT BREAKDOWN, EXCLUDING PIN "J" ON CABLE CONNECTOR.
3. THE CABLE PARAMETERS MUST NOT EXCEED THE VALUES SHOWN IN TABLE 1.

TABLE 1 CABLE PARAMETERS

GROUP	CAPACITANCE μF	INDUCTANCE mH	OR L/R RATIO $\mu H/\Omega$
II B	4.2	0.1	282
II A	11.2	12.8	531

SYSTEM LABEL

ACTARIS MASS FLOWMETER SYSTEM 

II 1/11 G SYST
EEx ia/Ia IIB T4, T4, OR T2
LCIE 05 ATEX 6052X

THE DATA, DRAWINGS, SPECIFICATIONS AND OTHER INFORMATION CONTAINED HEREIN IS CONFIDENTIAL AND PROPRIETARY TO ACTARIS AND SHALL NOT BE DUPLICATED, DISCLOSED, USED TO PRODUCE ARTICLES OR USED IN ANY OTHER MANNER WITHOUT THE WRITTEN CONSENT OF ACTARIS MEASURING SYSTEMS GREENWOOD, SOUTH CAROLINA USA Copyright 1991. All Rights Reserved.

MATERIAL

HEAT TREAT

FINISH SPECIFICATION

UNLESS OTHERWISE SPECIFIED

BREAK EDGES .0057.015

SURFACE FINISH #7

ALLOWABLE TOLERANCES

FRACTIONS DECIMALS ANGLES

$\pm 1/32$ 2 PL. 01 $\pm 1^\circ$

DO NOT SCALE DRAWING

TITLE

SH. 01/30/01

SHEET

SCALE N/A

SYSTEM DIAGRAM

ACTARIS

NO. 0600442-001

GREENWOOD, SOUTH CAROLINA

Figure 5.
LCIE System Drawing

Batch Control Board Connections

It is recommended that a manual method of disconnecting all power to the batch control circuits be included in the user's batching system.

CAUTION: THE DATAMATE POWER CIRCUIT SHOULD NOT BE USED AS THE POWER CIRCUIT FOR THE BATCH CONTROL DEVICES (E.G., MOTORS, RELAYS, SOLENOIDS, ETC.). IF THIS IS NOT POSSIBLE A POWER LINE CONDITIONER (CONSTANT VOLTAGE TRANSFORMER) SHOULD BE INSTALLED TO ISOLATE THE DATAMATE™ FROM THE VOLTAGE TRANSIENTS CREATED BY THE BATCH CONTROL DEVICES.

Relay Operation

Software below V3.XE, V4.0E and 5.XX: For signal-stage batching use the HF relay (TB1) to control the batch control device. For two-stage batching the HF relay (TB1) controls the first-stage (trickle point) control device and the LF relay (TB2) controls the second stage (batch size) device. (See Figure 13 or 14)

Software V3.XE, V4.0E and 5.XX and above: For signal-stage batching use either the HF relay (TB1), the LF relay (TB2), or both to control the batch control device(s). For two-stage batching the HF relay (TB1) controls the first-stage (trickle point) control device and the LF relay (TB2) controls the second-stage (batch size) device. (See Figure 13 or 14)

Batch Control Wiring

Electro-Mechanical Relays (Standard/Class I Division 2 Datamates)

The Datamate's batch control board provides two normally-open (SPST relay) dry-contacts for switching the power to external batch (flow) control devices. The contact rating of these relays is 10 A at 40 VDC resistive and 7 A at 240 VAC inductive. **Refer to Figures 4 (CSA I.S.), or 5 (LCIE) (Pages 7 or 8) for current and voltage limits for Datamates installed in Division 2 areas.**

R.C. "Snubber" Networking should be installed across relay contacts. This will eliminate voltage spikes that can be created when inductive loads are used.

R = 100 ohms

C = 0.1 micro farad non-polarized

Alarms

The Datamate comes with four alarms, each with a high and a low output. These may be programmed for activation by a number of variables as described in Section III.2. The alarm outputs are open-collector NPN transistors, non-isolated, rated to 50 VDC/100 mA. A typical wiring diagram is shown in Figure 6.

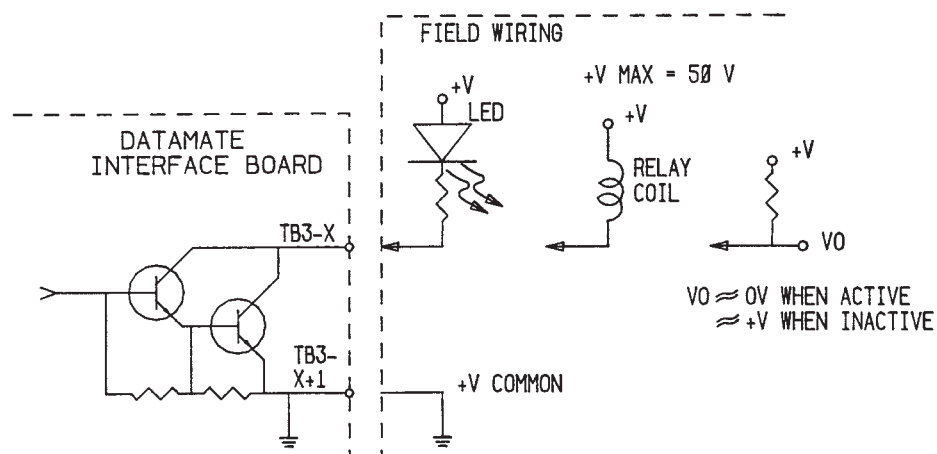


Figure 6
Typical Alarm Wiring Diagram

CAUTION: To meet the CE EMI/RFI requirement, all Alarm outputs are to be connected with Belden 8417 cable or equivalent. Inner conductor is connected to positive of alarm signal. Shield is connected to negative of alarm signal.

The alarms are wired into the instrument through 16-terminal connector TB3 on the upper left side of the Interface Board (Figure 13-Datamate 2000™, Figure 14-Datamate 2100™). Table 4 below describes the connections.

Table 4. Alarm Connector Configuration

TB3 Pin No.	Alarm Connector (TB3 Interface PCB)															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Alarm #	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
Function	Hi	Gnd	Lo	Gnd	Hi	Gnd	Lo	Gnd	Hi	Gnd	Lo	Gnd	Hi	Gnd	Lo	Gnd
Polarity	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-

Remote Start-Stop

TB2 on the Interface Board provides connections for remote start and stop push button inputs. These push buttons should be of the normally-open, momentary-contact type. The location of TB2 is shown on Figure 13 (Datamate 2000™) and Figure 14 (Datamate 2100™). Momentarily shorting Terminal 1 (the left-most one) and Terminal 3 together will initiate or re-start a batch operation. While momentarily shorting Terminal 2 and Terminal 3 will stop a batch which is in progress.

Table 5. Remote Start/Stop Connector

Terminal #	Remote Start/Stop Connector (TB2 Interface Board)		
	1	2	3
Function	Start	Stop	Gnd (Common)

Note: These Remote Start-Stop inputs can be activated by the open-collector NPN transistor, such as the Datamate's alarm outputs. This allows you to wire an alarm directly to the remote stop input, and then to interrupt a batch if, for instance, air is entrained in the liquid or process temperatures exceed allowable limits.

Output Board Configuration/Connections

The Datamate will support up to four optional output boards. These boards may be any combination of Analog (4-20 mA) and/or Scaled Pulse and/or Totalizer Pulse boards. Refer to Section VI.3., Model Number Explanation, for assistance in determining the presence of any optional output boards. Output module programming is explained in Section III.1. and III.2.

Field connections to the output boards are through the connector TB1 located in the upper-left corner of the board when viewed from the component side with the edge-connector down. Make all connections with 16 AWG or larger shield twisted-pair cable.

Never install or remove any output board without first ensuring that the Datamate is OFF. During startup the Datamate checks for installed output boards. If a slot is empty at power-up the Datamate assumes that it will remain empty. The Datamate also continuously checks data transfers to installed output boards. If a board is removed with the power on the Datamate will interpret the missing board as a bad data transfer and declare a System Error 3.

CAUTION: ALL OF THE PCB BOARDS IN THE DATAMATE CONTAIN COMPONENTS THAT ARE SENSITIVE TO ELECTROSTATIC DISCHARGE. USE PROPER ELECTROSTATIC DISCHARGE PROCEDURES WHEN HANDLING ANY BOARD.

Printer Interface Board

Refer to M-611, Datamate Printer Card Operations and Maintenance Manual.

Analog Board

An analog output card provides a driven 4-20 mA signal representing the selected variable. The board will operate correctly when the loop resistance is between 50 and 800 ohms. Connections to the card are made via TB1-1 (+) and 2 (-) with the board removed from its slot. Connect the positive current conductor to TB1-1 and the negative (return) current conductor to TB1-2. Re-install the board in its slot pressing firmly to ensure it is properly seated. (See Figure 22 for board layout details.)

Frequency Pulse Board

The frequency pulse board's output can have one of the four configurations shown in Table 6. The position of jumpers W1, 2, & 3 determine the output configuration. The output frequency can be scaled over a range of about 4,000,000:1. The setting of SW1, 2, 3, and 4 determines the card's pulse scaling factor. The duty cycle of the output pulse is approximately 50% when SW4 is not set to divide by 1. When SW4 is set to divide by 1 the pulse has an off-time of 80 microseconds. Maximum output voltage: 60 VDC. Maximum output current: 100 mA.

Frequency Pulse Board Configuration

To configure the frequency pulse boards for the desired application it is necessary to:

- (1) Set jumpers W1, W2, and W3 for the proper signal output configuration.
- (2) Determine the maximum and minimum values of the measurement parameter to be monitored.
- (3) Set SW1, SW2, and SW3, to the proper multiplication factors, and SW4 to the proper division factor.

The following section explains how to setup the Datamate with the frequency pulse option for a scaled pulse output driving a remote totalizer.

1) Output Configuration

Table 6 shows the frequency pulse board output when configured for a 12V pulse. Only the pulse amplitude will be different when one of the other output configurations shown in Figure 7 are used.

To reconfigure the output:

- a. Turn off power to the Datamate and confirm it is off by checking that the LED on the Power Supply is out.
- b. Ground yourself by touching the Power Supply support bracket and then remove the board from the unit.
- c. Set jumpers W1, W2, and W3 for the proper signal output configuration as outlined in Table 6. The location of these jumpers are shown in Figure 19.

Table 6. Frequency Pulse Board Output Configuration

OUTPUT TYPE	JUMPER POSITION			Maximum Voltage
	W1	W2	W3	
12V Pulse	A-B	A-B	A-B	12 VDC
Open-Drain	Open	A-B	A-B	24 VDC*
Isolated, Open-Collector NPN Transistor (Internal 10K Pull-up resistor)	B-C	B-C	B-C	24 VDC*
Isolated, Open-Collector NPN Transistor (External Pull-up resistor)	B-C	B-C	B-C	24 VDC*

*A 25V, 5W# zener diode (CR1) is connected between TB1-2 and TB1-3 to protect the output transistors.

2) Maximum/Minimum Parameter Values

The maximum parameter value is used to calculate the F. S. frequency of the pulse card. This value should be larger (5-10%) than the maximum expected value of the parameter being monitored. You may wish to round it to a value that makes calculations easier (e. g., 200 vs. 193.45 #/min.).

The minimum parameter value may have any value less than the maximum except in applications where a fixed number of pulse/unit of measure (e. g., batching, inventory control, etc.) are required in those application minimum must be set to zero .

3) Pulse Scaling

Rotary switches SW1, SW2, and SW3 represent a MULTIPLIER whose value can vary between 0.000 and 0.999. SW1 represents tenths, SW2 hundredths, and SW3 thousandths. SW4 represents a DIVIDER that may be one of 13 values ranging from 1 to 4096.

The full scale output frequency (F. S. FREQ.) of a pulse card is determined by the following equation:

$$F. S. FREQ. = \frac{10,000Hz \times MULTIPLIER}{DIVIDER}$$

a) F. S. FREQ.

The first step in scaling a pulse card is determining the required F. S. FREQ. There are several ways to determine the F. S. FREQ. depending on how the pulse signal is to be used. We will consider the case where an output of 100 pulses/# are required. Assume that the module will be programmed for a maximum output at 185 #/min. For this application the minimum output must occur at 0 #/min. The basic equation for calculating F. S. FREQ. is:

$$F. S. FREQ. = \text{Pulse significant} \times F. S. \text{ flow rate} \times \text{time scalar}$$

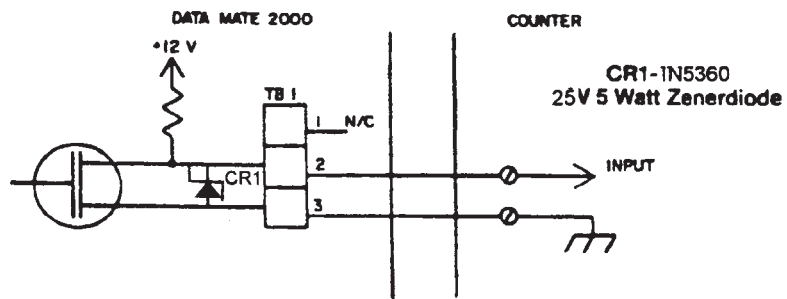
or

$$\frac{\text{Pulses}}{\text{Sec}} = \frac{\text{pulses}}{\text{measure}} \times \frac{\text{measure}}{\text{time}} \times \frac{\text{time}}{\text{sec}}$$

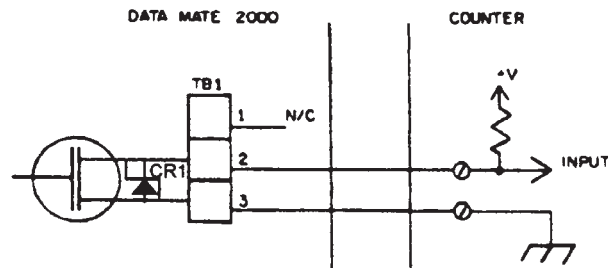
Then for our example:

$$F.S. FREQ. = \frac{\text{Pulses}}{\text{Sec}} = \frac{100. \text{ pulses}}{\#} \times \frac{185. \#}{\text{min.}} \times \frac{1 \text{ min.}}{60 \text{ sec}}$$

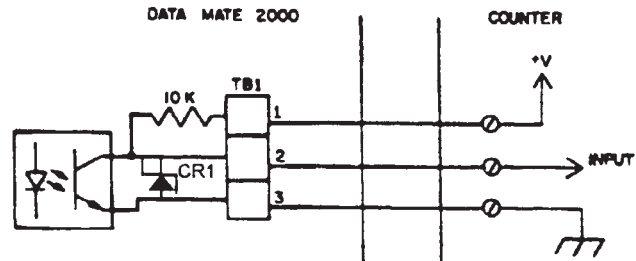
$$F. S. FREQ. = 308.33333 \text{ Pulses/Sec}$$



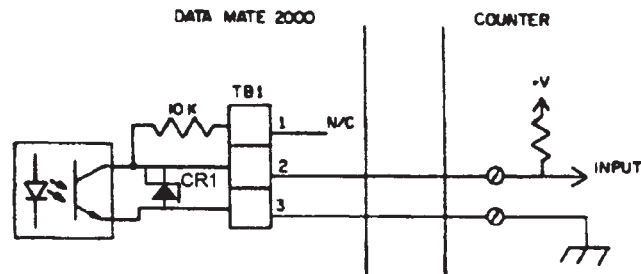
(A) 0-12 Volts DC Pulse Output



(B) Non-Isolated Open-Drain Output



(C) Isolated Open-Collector Output
Internal Pull-Up
Resistor



(D) Isolated Open-Collector Output
External Pull-Up
Resistor

Figure 7
Frequency Pulse Board Wiring Connections

If we desire a F. S. FREQ. of 300 Pul/Sec we would calculate the MULTIPLIER and DIVIDER as follows:

b) DIVIDER

Assume a multiplier of 1.

$$\begin{aligned} \text{TEMP DIVIDER} &= \frac{10,000 \text{ Pul/Sec} \times 1}{\text{F. S. FREQ. Pul/Sec}} \\ &= \frac{10,000 \text{ Pul/Sec}}{308.33333 \text{ Pul/Sec}} = 32.4324 \end{aligned}$$

The DIVIDER must be one of the Divider Values from Table 7. Choose the largest Divider Value smaller than TEMP DIVIDER calculated above. So, from Table 7 pick 32 for DIVIDER and set SW4-1, SW4-3, and SW4-8 to ON.

Table 7. SW4 Switch Positions

Divider Value	SW4 SWITCH POSITIONS							
	1	2	3	4	5	6	7	8
1	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON
2	ON	OFF	OFF	OFF	OFF	OFF	OFF	ON
4	OFF	ON	OFF	OFF	OFF	OFF	OFF	ON
8	ON	ON	OFF	OFF	OFF	OFF	OFF	ON
16	OFF	OFF	ON	OFF	OFF	OFF	OFF	ON
32	ON	OFF	ON	OFF	OFF	OFF	OFF	ON
64	OFF	ON	ON	OFF	OFF	OFF	OFF	ON
128	ON	ON	ON	OFF	OFF	OFF	OFF	ON
256	OFF	OFF	OFF	ON	OFF	OFF	OFF	OFF
512	OFF	OFF	OFF	ON	ON	OFF	OFF	OFF
1024	OFF	OFF	OFF	ON	OFF	ON	OFF	OFF
2048	OFF	OFF	OFF	ON	ON	ON	OFF	OFF
4096	OFF	OFF	OFF	ON	OFF	OFF	ON	OFF

c) MULTIPLIER

$$\begin{aligned} \text{TEMP MULTIPLIER} &= \frac{\text{F. S. FREQ.} \times \text{DIVIDER}}{10,000 \text{ Pul/Sec}} \\ &= \frac{308.33333 \text{ Pul/Sec} \times 32}{10,000 \text{ Pul/Sec}} = 0.9866666 \end{aligned}$$

Rounding TEMP MULTIPLIER to three significant digits MULTIPLIER is 0.987. (To minimize scaling error MULTIPLIER should always be greater than 0.500 and can be accomplished by increasing DIVIDER when necessary.) To make the MULTIPLIER 0.987 set SW1 to 9, SW2 to 8, and SW3 to 7.

If we plug the values for DIVIDER and MULTIPLIER into the equation for F. S. FREQ. we find:

$$\begin{aligned} \text{F. S. FREQ.} &= \frac{10,000 \text{ Pul/Sec} \times \text{MULTIPLIER}}{(\text{Pul/Sec}) \text{ DIVIDER}} \\ &= \frac{10,000 \text{ Pul/Sec} \times 0.987}{32} = 308.4375 \text{ Pul/Sec} \end{aligned}$$

Refer to section V.2 Output Board Self-Test to check the output at different percentages of the maximum pulse rate.

Refer to section V.2 "Output Board Self-Test" for instructions on checking the pulse cards output frequency.

NOTE: Mass Flow Rate was used for the previous example, but it is possible to transmit any of the displayed outputs as pulsed signals.

3. Return the Pulse Board to its original slot.
4. Repeat the above steps for all Scaled Pulse Boards
5. Re-power the unit.
6. Programming Minimum and Maximum Values of Monitored Parameter

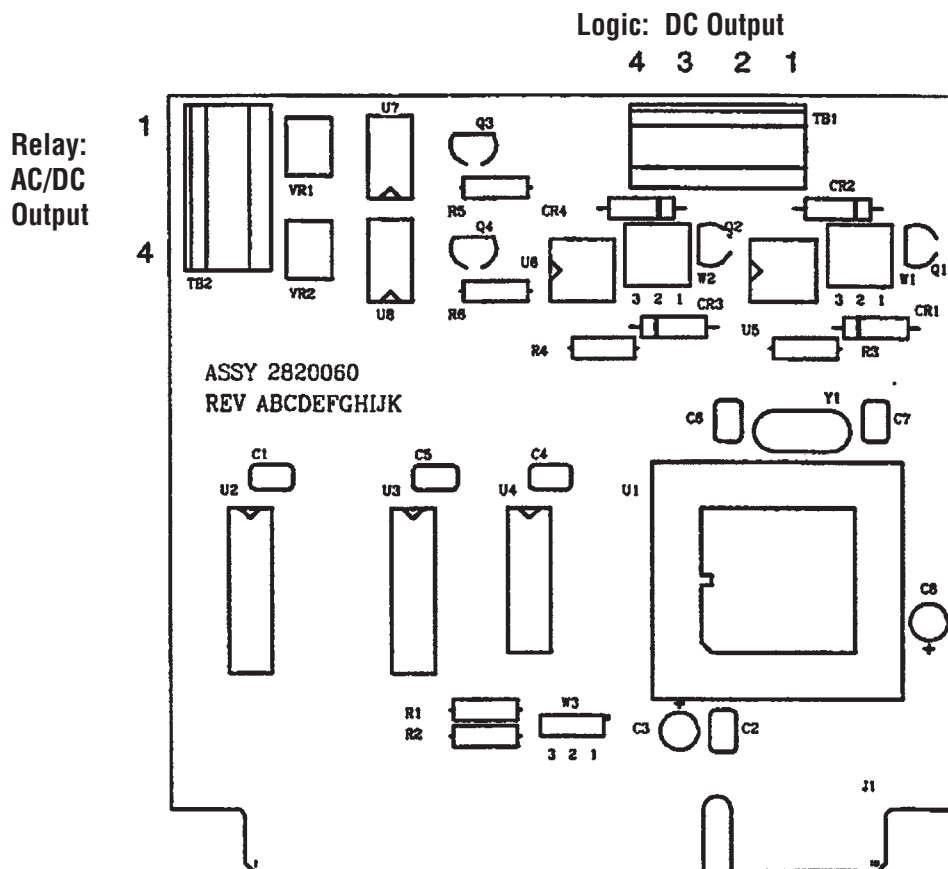
Refer to Section III.2 Output Boards for instruction on programming output modules.

Totalizer Pulse Board

The Totalizer Pulse Board (TPB) is an Output Module that provides pulsed outputs in relation to changes in the selected totalizer units. It is NOT a frequency output proportional to the flow rate (as the Scaled Pulse Board). The TPB provides two sets of pulsed output ports. Each output port provides two pulsed signals: one is a reference pulse (*In-phase or I*); the other is 90° out of phase with the reference (*Quadrature or Q*). The *In-phase* and *Quadrature* signals are used by some controllers to determine the direction of the flow based on if the *Quadrature* signal lags or leads the *In-phase* signal by 90°.

Output port 1 (TB1) is used to switch low voltage DC signals. This port can be configured as an optically isolated, open collector output or as a non-isolated open drain output. The input voltage is 0-60VDC (100mA Max, 150mW Max). Output port 2 (TB2) is used to switch high voltage AC/DC signals and is hard-wired as an optically isolated open drain output. The input voltage is 0-200VAC/DC (100 mA Max, 250mW Max) **Note: The TPB requires software version 5.0 or higher to operate.**

Below is a layout of the TPM assembly. Jumpers W1 & W2 are used to configure the Logic output. W3 sets the polarity for both outputs.



Totalizer Pulse Board Configuration

To configure the totalizer pulse board(s).

- (1) Set jumpers W1, W2 and W3 to the appropriate output configurations as per Table 7.5 or Table 7.6
- (2) Terminate output wiring as per Figure 7.5 or Figure 7.6
- (3) Program the selected output board via the Datamate (refer to Section III.2 Output Boards and the Software Reference Chart (Figure 30))

Table 7.5. TB1 Output Configuration (Logic: DC)

The pin-out for TB1's Logic output is provided in the table below.

PIN	FUNCTION
1	I+
2	I-
3	Q+
4	Q-

The table below shows the configuration for the I/Q Logic outputs based on W1/W2 and W3 jumpers.

W1/W2	W3	I/Q
1-2	1-2	0-12VDC Normally High
1-2	2-3	0-12VDC Normally Low
2-3	1-2	Opto-OC&E Normally Off
2-3	2-3	Opto-OC&E Normally On

*Opto-OC&E is an Optically isolated Open-Collector and Emitter

Table 7.6. TB2 Output Configuration (Relay: AC/DC)

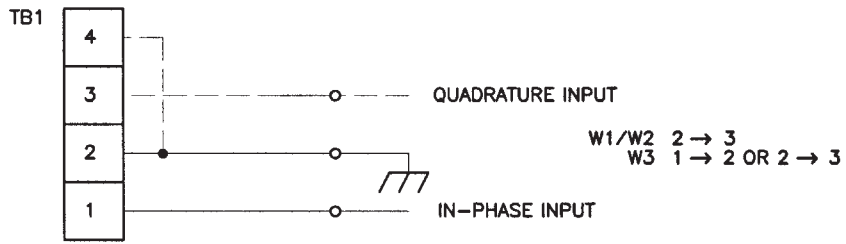
The pin-out for TB2's Relay output is provided in the table below.

PIN	FUNCTION
1	Ia
2	Ib
3	Qa
4	Qb

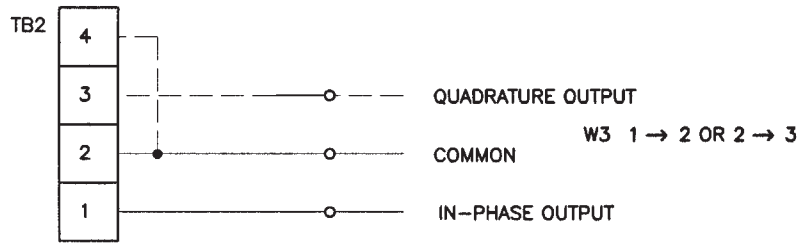
The table below shows the configuration for the Relay outputs based on jumper W3.

W3	I/Q
1-2	Opto-Relay Normally Open
2-3	Opto-Relay Normally Closed

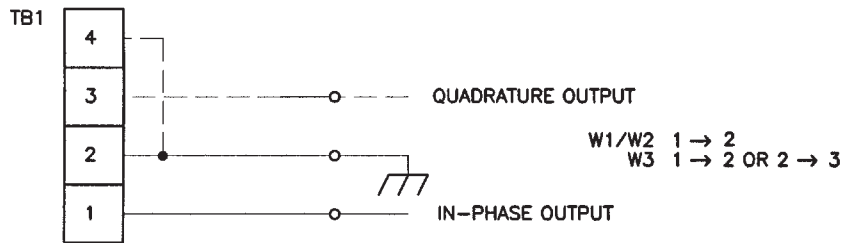
Totalizer Pulse Board Wiring Connections



A) 0-60VDC Isolated Switched Input (High Frequency < 10KHz)

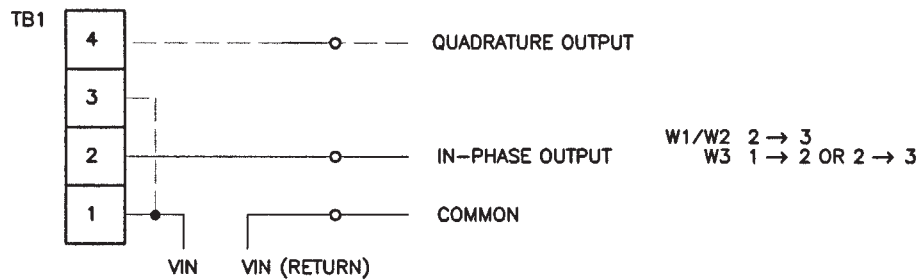


B) 0-200VAC/DC Isolated Output (Low Frequency < .1 KHz)

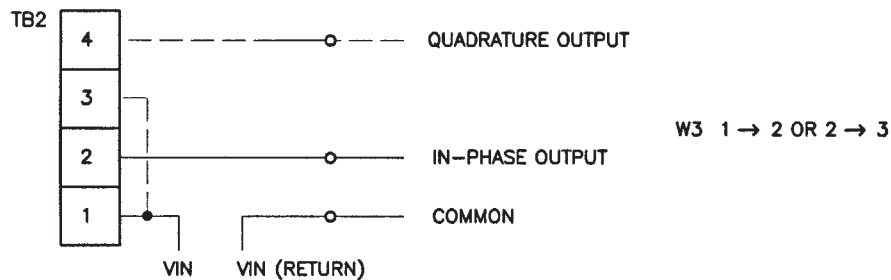


C) 0-12VDC Non-Isolated Pulse Output (High Frequency < 10KHz)

Figure 7.5.
Counters and Devices Requiring Their Inputs To Be Switched To Common



A) 0-60VDC Isolated Switched Voltage Output (High Frequency < 10KHz)



B) 0-200VAC/DC Isolated Switched Voltage Output (Low Frequency < 1 KHz)

Figure 7.6.
Counters and Devices Requiring A Switched Voltage

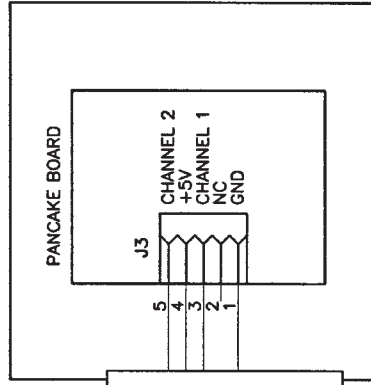
Datamate to Bestrac™ Wiring Connections

The Bestrac™ SMI 2000 is an electronic transaction monitoring system that interfaces with the pulse line of mass flow meters to automate invoicing during the delivery of liquid products. The Bestrac SMI 2000 comes equipped with solenoid lockout valve, junction box, printer, optional electronic ATC and interconnect cables, including the pulse cable between the SMI and the Datamate Flow Computer. Figure 7.7 outlines the Datamate to Bestrac wiring connection.

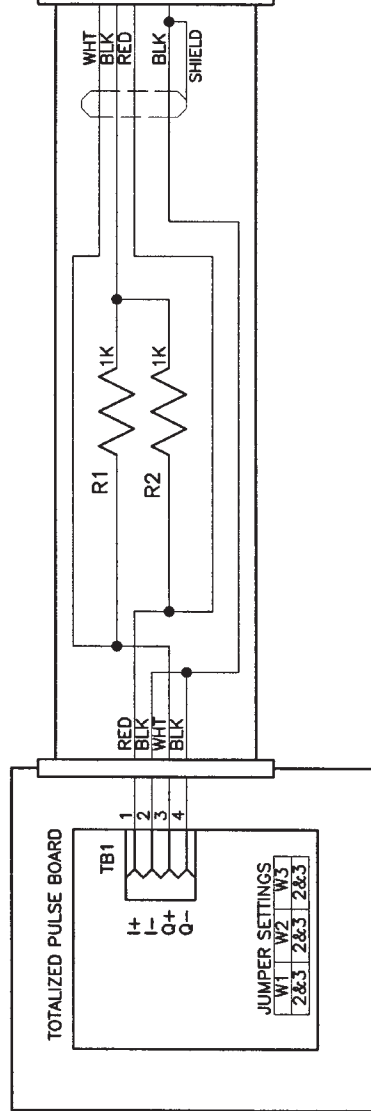
When interfacing the Datamate to the Bestrac System, the maximum pulse input frequency from the Datamate Flow Computer to the Bestrac SMI 2000 shall not exceed 200 Hz. This is based on the full scale frequency equation: $((\text{Max. Flow Rate per minute} / 60) \times \text{Pulses/unit})$. Typical pulse per unit values for each meter size are as follows: 1/4" (m025) – 100 (max. 150); 1/2" (m050) – 10 (max. 40); 1" (m100) – 10; 2" (m200) – 1 (max. 3).

LTR	REVISION	DATE	AUTH	BY	APPD
A	RELEASE	8/21/98	N23514	TK	SHERPA

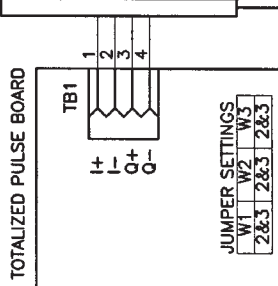
BESTRAC SMI-2000



DATAMATE 2100



NOTE: TB1-2 AND TB1-4 NEED TO BE CONNECTED TOGETHER WITH A JUMPER WIRE.



JUMPER SETTINGS		
W1	W2	W3
2&3	2&3	2&3

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	<p>HEAT TREAT</p>		<p>BREAK EDGES .005/015</p>		<p>7/23/98</p>		<p>SCHEMATIC</p>		
<p>FINISH SPECIFICATION</p>		<p>FRACTIONS N/A</p>		<p>SURFACE FINISH .125</p>		<p>SHEET 1 OF 1</p>		<p>DATAMATE/BESTRAC INTERFACE</p>	
		<p>DECIMALS 2 PL .01 3 PL .005</p>		<p>ANGLES N/A</p>		<p>SCALE</p>		<p>NO. D000846</p>	
		<p>DO NOT SCALE DRAWING</p>				<p>FILE: D000846A.SCH</p>		<p>REV. A</p>	
						<p>ACTARIS</p>		<p>GREENWOOD, SOUTH CAROLINA</p>	

Figure 7.7. Datamate to Bestrac Wiring Connections

III. SET-UP AND START-UP

III.1. Hardware Set-Up

Basic Checks

1. Turn off the Datamate using switch SW2 on the power board. When the unit is off, LED CR13 on the power supply will be off.
2. Check all connections, both electrical and piping.
3. Be sure the voltage selector switch on the power supply is set to the correct voltage. Switch SW1 selects the power supply input voltage. For 110-120 volt AC operation, place SW1 in the 115V position. For 220-240 volt AC operation, place SW1 in the 230V position.
4. Check pins on W1, of the computer board (Figure 15–Datamate 2000™ and Figure 16–Datamate 2100™) mounted on the back of the enclosure door, to be sure they are not jumpered together. If they are connected, remove the jumper. **Failure to remove jumper will result in loss of calibration data from memory when power is re-initiated.** Note: On version V4.0 there is a feature, at power-up, that prompts the user to select if the Non-Volatile RAM should be erased or not. If the jumper is in place and there has not been any checksum errors, the display will ask if the user wants to press F1 and continue (without erasing the RAM) or to press F2 to erase the RAM. (**WARNING! erasing the RAM means that all the calibration parameters will be lost and will have to be re-entered.**)
5. Turn on the meter using SW2 on the power supply and verify that the unit has power by checking that LED CR13 on the power supply is lit.
6. Allow the unit to warm up for at least 15 minutes.
7. Flush the transducer with enough of the process fluid to remove all the air from the transducer and to bring the transducer temperature into equilibrium with the process fluid temperature.
8. Perform the tube drive adjustment procedure outlined in Section V.4 Interface Board.

Display Viewing Angle

The display may be adjusted for different viewing angles. To make this adjustment, open the electronics housing and look for adjustable resistor RV1 in the upper right corner of the computer board (Figure 15 Datamate 2000™, or Figure 16 Datamate 2100™). Using an instrument screwdriver, adjust this pot to obtain maximum display contrast.

III.2. Programming

Read This First

The Datamate Mass Flow Computer was designed to operate in one of three modes: PROGRAM, RUN, or BATCH mode. RUN mode is used for normal flow measurement and programmed batching (Batching is done in the BATCH mode, a sub-set of the RUN mode. It is not possible to go from BATCH to PROGRAM mode. You must first return to RUN.). RUN mode does not allow the user to change critical calibration data like the scaler, the zero, etc. PROGRAM mode (as the word implies) is mainly used for programming the Datamate's measurement parameters; however, all the measurement functions -except batching- are available.

To enter into PROGRAM mode on the Datamate 2000™ with firmware versions V3.2 and lower, ensure that the Datamate is not in the batch mode then turn the key switch on the front panel to PROGRAM.

To enter into PROGRAM mode on the Datamate 2100™, we use a four digit password. The password is entered the following way:

1. Press MAIN MENU, <MORE>, <PROG>.
2. The display will prompt you to enter the password. The first time that you program the Datamate you should enter the default password: 0000. While you enter the password the display will show "*"s to prevent on-lookers from learning the password. If you entered the correct password the Datamate will enter into PROGRAM mode.
3. While in PROGRAM mode the user can change the password to any four digit number by pressing: MAIN MENU, <MORE>, <CHNG.PASS>, and entering the new password. To enter RUN mode just press MAIN MENU, <MORE>, <RUN>.

To enter into PROGRAM mode on the Datamate 2100™ with Weights and Measures software Version 5.1X, a jumper must be placed on pin "J5" located on the computer board. Once this jumper is in place the Datamate 2100™ will automatically enter into PROGRAM mode.

Please keep the following points in mind while working with the Datamate software:

1. The four function keys (F1, F2, F3, F4) have functions that change depending on what information is being used. The display above the function key will show a label which describes the present purpose of the key. Throughout this manual, a name in caps (such as EXIT) is the name printed on the key, while a name in brackets (such as <METER>) is that shown on the LCD display above one of the four function keys.
2. A number which is too large to express in three significant digits will be entered and displayed in scientific notation, using both a number and a power of ten. For example, 3,840,000 will be expressed as 3.84 E6 meaning the number is actually $3.84 \times 1,000,000$. When entering data in scientific notation, the power of ten term is entered after entering the three significant digits and the decimal point.
3. If the Datamate has been operating in the BATCH mode (BATCH mode is a sub-set of the RUN mode), the user has to terminate the BATCH mode before entering the PROGRAM mode. To be sure your unit is out of batch mode, press STOP, RESET TOTAL, and STOP again. Now you can set the Datamate to PROGRAM mode.
4. All of the following instructions start from and end with the Default Display so you can complete any of them as a single operation.

Engineering Units

The Datamate displays all values in direct engineering units. Since several types of units are possible, you must select the units you want to use before you perform any other operations.

WARNING: Once you have selected the units to be used, DO NOT CHANGE YOUR SELECTION unless you are going to repeat all the following programming steps. This is because the electronics do not re-calculate values when the engineering units are changed. If you set up an alarm point at 200 lb., for instance, then change the mass units to Kg without resetting the rest of the software, your alarm point will shift to 200 Kg, a major change.

To select the engineering units press the following key sequence: MAIN MENU, <METER>, <CONST>, <UNITS>. The meter will now ask you to select units for volume, mass, density, and temperature. Press F2 to scroll to the desired units and press ENTER to make your selections. After all choices have been made, press EXIT to return to the Default Display.

Default Display

You may select the variable that is normally displayed by the Datamate. In the RUN mode the Datamate will return this variable to the display after 15 seconds after another variable has been selected from the <DISP> menu. To gain access to the display selection menus, type MAIN MENU, <DISP>. Now press F2 to select the value you want displayed on the top line of your display. You may select from measured mass flow rate, measured line temperature, calculated volume flow rate, measured line density, calculated percent solids, calculated solids flow rate, or flow counts. (Note that selecting calculated volume flow rate will cause the meter to batch and display volumetric totals, while selection of the percent solids or solids flow rate will cause the meter to batch and display solids fraction mass totals. IF YOU CHANGE THE TYPE OF UNIT DISPLAYED AND HAVE SET UP YOUR INSTRUMENT TO RUN BATCHES, YOU MUST REPROGRAM THE BATCH FUNCTIONS AS OUTLINED BELOW.) When you have called up your selection, press F1 to select it, then EXIT to return to the Default Display.

Notes: If you choose to display calculated volumetric flow rate, the volume totalizer will automatically be displayed. If you select flow counts the unprocessed flow signal will be displayed. There will also be a number in the upper right corner. A 20 signifies a stable signal and a 4 signifies an unstable signal.

Totalizers

The Datamate has three totalizers that run continuously. They are:

Mass Total (Mtot) - indicates the total mass since resetting,

Volume Total (Vtot) - indicates the total volume since resetting, and

Solids Total (Stot) - indicates the total solids fraction mass since resetting.

The totalizer displayed is determined when the default display is programmed. See Section IV.4 for information on resetting the totalizer. In the RUN mode pressing RESET TOTAL will hold the displayed totalizer. It will continue to be updated internally, and upon your releasing the RESET TOTAL key the Datamate will update the displayed value.

Output Boards

NONE OF THE OUTPUT BOARDS WILL WORK UNTIL THEY ARE PROGRAMMED. YOU MUST COMPLETE THIS STEP IF YOUR METER HAS ANY OUTPUT CARDS.

Your meter may have up to four of these cards. To program these outputs, press MAIN MENU, <PROG>, <MOD>, <PROG>, and select the appropriate card. (If the selection <mod> does not appear on the display, your unit does not have output cards. Skip the rest of this paragraph.) The display will show "*****" for every empty output card socket and MOD "X" for every socket with a card. (The "X" is a number from 1 to 4 which corresponds to the location, from left to right, of the card being programmed.) Select an output card by pressing the function key below its label. Use the F2 key to select the desired output variable. Your options are None (the card is turned off), Mass Flow, Temperature, Volume Flow, Density, % Solids, Solids Flow, Mass Total, Volume Total and Solids Total. When the desired variable is displayed, press F1. The meter will then ask you for the amount of flow, temperature, etc. that you want to generate a full-scale (i.e. 20 mA from the 4-20 mA card) output. Type in this amount and press F1. Next enter the amount needed to produce a zero output (i.e. 4 mA for the 4-20 mA board) and press F1. You have now programmed one output card.

Select the next output card and repeat the process. Continue until all output cards are programmed. When finished, press EXIT twice to return to the Default Display. NOTE: If you do not program an output card, it will not provide any output. To work, each card must be programmed using the above sequence.

Refer to M-611, Datamate Printer Card Operations and Maintenance Manual for directions for programming the Printer Interface Board.

Batching Functions

Your unit has all the hardware and software needed to run a two-stage batching operation. IF YOU WANT YOUR OPERATOR TO RUN A BATCH, YOU MUST COMPLETE THIS PROGRAMMING SEQUENCE.

Also, note that this instrument will batch in mass, volume, or solids fraction depending on the type of units selected for display. If the instrument is set up for the wrong type of batch (mass rather than volume, for instance), you must change the type of units displayed as outlined in the section on Display Content above.

To gain access to the batch programming menu, press MAIN MENU, <PROG>, <BATCH>. You will now be asked for the following values:

BATCH CUTOFF POINT: This is the amount of the total mass, volume, or solids that you want in your batch after it is finished. For accurate and repeatable batching batch sizes should be large enough to allow the meter to run 30 seconds for each batch. The batch size must be greater than the Trickle Offset below. Press F1 when finished.

BATCH TRICKLE OFFSET: This is the amount of mass, volume, or solids that you want to flow through the meter between the closure of the "trickle" relay and the final batch cutoff. This value should be set large enough to prevent water hammer, pipe damage, or erratic final batch sizes but still short enough to allow a fast batch run. You will probably have to try several values before you pick the best one, but a good starting value would be whatever your system flows over 5 seconds at full capacity. To enter this value, type in the value, then press F1.

Note: If the Trickle Offset is zero, both batching relays (HF and LF) energize simultaneously when the batch starts and are de-energized simultaneously when the batch stops. (See Relay Operation page 9.)

SYSTEM RESPONSE TIME: This value tells the meter to send the signal to the cutoff valve early to compensate for the time it will take the valve to close. If you do not want to use this option, press F1. If you do, make an estimate of the amount of time (in seconds) it will take your valve to close. Type that value (9.99 seconds maximum), then press F1. The relay for the batch cutoff point will activate when:

$$\text{Batch Total} = \text{Batch Cutoff Point} - (0.5 * \text{Flow rate} * \text{System Response Time}).$$

When two-stage batching is desired, the Trickle Offset should be large enough to allow the HF relay to de-energize prior to de-energizing the LF relay. If you do not, the system response time feature will open both batching relay contacts at once.

AUTO-RESTART DELAY: If you wish to run repeated batches of the same size at fixed intervals, enter the time interval (delay) in minutes and seconds (e. g., m:ss). The maximum interval is 9 minutes and 59 seconds. You must enter a value for the minutes digits (e. g., 0). Use the "." key to enter the colon. If you do not want an automatic restart, simply press F1 or enter 0.00, as required.

RUN MODE EDIT: If you want your operator to be able to change the size of the batch, press F2 until this value is ON. If you do not want your operator to be concerned with the batch size, press F2 until this value is OFF. When the correct value has been selected, press F1 and then EXIT to return to the Default Display.

BATCH JOG MODE: In the event of a sensor error due to fluid conditions in the transducer before or during a batch, this feature will allow the operator to clear the sensor error by pressing and holding the start key. Pressing the start key energizes (closes) the batching relays for as long as the start key is depressed. The Datamate will de-energize the batching relays when the sensor error has cleared. After the sensor error is cleared, normal batching functions will return to normal. If you wish the operator to be able to clear sensor errors if they occur during a batch, press F2 until this value is ON. If you do not want your operator to be able to clear sensor errors during a batch, press F2 until this value is OFF.

Alarms

Your meter is equipped with four independent alarms, each with a High and a Low set point. The alarm outputs can be configured for two modes of operation: FAILSAFE <FSAFE> mode and INDICATOR <INDI> mode. In the FAILSAFE mode the output of the programmed alarm output is active (sinking current) during the non-alarmed condition and it is de-activated when the alarm condition occurs. This alarm mode is desirable for situations in which the loss of power has to be monitored by the alarm system. In the INDICATOR mode the alarm output is de-activated during non-alarm conditions and it goes active when the alarm condition occurs. To avoid confusion the term “set” will be used to define an alarm condition and “re-set” to define a non-alarm condition.

Each alarm is programmed using the same key sequence. To program one of the alarms, press MAIN MENU, <PROG>, <ALARM>. Select either <FSAFE> or <INDI> (see above). Select one of the four alarms and activate it by pushing the appropriate function key. Press F2 to scroll through the alarm functions and select one using the F1 key. Your options are None to turn the alarm off, Mass Flow, Temperature, Volume Flow, Density, % Solids, Solids Flow, Batch Total, or System Fault. Enter the High and Low set points when called for by the Datamate. Proceed to the next alarm by pressing the <NEXT> key and repeat this process until all alarms are set. Press the EXIT key to return to the Main Menu, and press it again to return to the Default Display.

PROCESS VARIABLE ALARMS: The alarm points for the flow, density, and solids variables are absolute minimum and maximum values. There is no hysteresis, the setting and re-setting occur at the same point, the point you enter when programming the alarm. These alarms may be programmed at overlapping values if desired. (For example, a Mass Flow High alarm programmed for 20 lb./min. and a Low programmed for 30 lb./min. can be combined. In this case, a flow rate of 35 lb./min. would set only the High alarm, while a 25 lb./min. would set both of them.

BATCH ALARMS: The Batch Total alarm allow you to program a tolerance in mass, volume, and % solids units for over-or under-sized batches. They are relative values that are referenced to the size of the batch, so they will move up or down with the batch when its size is changed. The Low alarm will be “set” whenever flow stops and the batch totalizer is less than the final batch less the Low alarm offset. It will “re-set” as soon as flow re-commences. The High alarm will be “set” as soon as the batch counter exceeds the sum of the batch cutoff value and the High alarm set-point. It remains active until the batch counter is reset for the next batch.

SYSTEM DIAGNOSTIC ALARMS: The High System Fault alarm is “set” if the transducer tubes stop vibrating or the cable is cut. The Low alarm will be “set” if the microprocessor fails any of its self-checks.

Percent Solids

Your meter may be programmed to calculate Percent Solids and Solids Flow using the measured Temperature, Density, and Mass Flow variables. The Percent Solids is the percent, by mass, of one component in the process stream. The Solids Flow is the flow rate, in mass units, of that single component. **Note that the term “solids fraction” is used here to denote the component of interest in a two-component process stream.** That component may actually be solid, as in a clay slurry; the dissolved solute of a solution, as in a brine solution; or it could be a liquid, as in an alcohol/water mixture. The software will work equally well in all cases. **The term “liquid fraction” denotes the second (other) component of a two-component process stream.**

Because the output of this function is calculated, the software uses several assumptions in its calculations. They are:

1. Both the density and temperature calibration functions are correctly calibrated. (If you are unsure of these calibrations, confirm them with the procedures outlined in Section III.3 and III.4 of this manual.)
2. The process stream must act as a two-component system. A slurry of brine, and sand cannot be handled by this software because it acts as a three component system. (e.g., The amount of sand in the slurry will cause errors in the calculation of the salt concentration in the brine.) On the other hand measuring the amount of sand lifted from the ocean floor is possible because the salt in ocean water is relatively constant.
3. There is no phase changes taking place in the process stream. This can be a particular problem when the process temperature changes because such changes can often induce precipitates or cause additional solid to dissolve. (A salt-brine slurry, for instance, would allow salt to go into solution when it was heated, thus giving a false Percent Solids reading.) In general, this software will not work when soluble precipitates are present and the process temperature is not stable.
4. Except for changes due to temperature, the density of the solid and the liquid fractions may not change from that used to set up the software.
5. All thermal expansion coefficients are valid over a narrow temperature range. Insure that you select expansion coefficients for the temperature range where you will be operating. (The default value for water is good for temperatures near 25 Degrees C.)

To program your meter for % Solids calculations, you must first obtain a table (up to 20 points) relating the concentration of the solids fraction to the process liquid density at a Reference Temperature (TREF). The Reference Temperature at which the table was generated should be as close to the process operating temperature (TOP) as possible. If you have an application involving insoluble solid/ liquid fractions, such as TiO₂ slurry in water, this table may consist of only two points. The first point would provide the lowest expected concentration and density, and the second the highest expected. (This is also the case for immiscible liquid/liquid applications, such as oil/water emulsions.) For solid/solvent applications, such as rubber crumb/Alcohol, you must enter the density of the liquid fraction (the solvent) as the 0% concentration density.

Miscible liquid/liquid mixtures, such as liquid sugars in water, are much more difficult. You should gather as many points as possible, up to 20. Enter the liquid fraction density for 0% concentration and the solid fraction density for the 100% density points.

No matter what your process components are, you must also have the thermal expansion constants for the solid and liquid fractions of the process stream if you anticipate significant process temperature changes. Since the thermal expansion constants change with temperature, please be sure they are correct for your process temperature. (The values for water are already programmed in as defaults.)

Begin programming this data into your meter by pressing MAIN MENU, <METER>, <CONST>, <% SOL>. The meter will ask you for the density of your process fluid at a known concentration. Type in the density at the 0% concentration (density of the liquid fraction at reference temperature) and then ENTER. Then enter the corresponding solids fraction concentration for the first point (0%) and then ENTER. Repeat this process using the next lowest concentration point until all the data has been entered. (Note that you must enter the data sorted by increasing concentration with the lowest concentration value first.) The last data point pair must be the process density at 100% concentration (density of the solid fraction at reference temperature). Finally, enter a pair of data points with the density and concentration of zero so the Datamate will know to ignore any data points that may be stored after the ones you have entered. Press EXIT when you are finished.

You will now be asked for the Reference Temperature. This is the temperature at which the table relating the concentration of the solid fraction to density is correct.

*** NOTE * For maximum accuracy the Reference Temperature should be as close as possible to the temperature at which the process is operating.**

Type in this value and then press ENTER or just press the ENTER key to accept the default value of 68 Degrees F. Note: Selection of the default value may result in significant inaccuracies in the % solids calculations if TREF is significantly different than TOP.

The meter will now display the density of the liquid fraction to allow you to check its calculation. If the displayed value is unacceptable, return to the beginning of this operation by typing EXIT, <METER>, <CONST>, <% SOL> and correct the points entered. If the value is correct, type ENTER to continue.

The display will now show the liquid thermal expansion coefficient for water at the current measured temperature. The Datamate will calculate and display this coefficient automatically. If your liquid fraction is not water you can enter the new coefficient (per degrees Celsius) by typing in four digits and then the exponent. Type ENTER when finished.

You will be asked to check the density of the solid fraction. Again, if acceptable, press ENTER. If unacceptable, press EXIT, <METER>, <CONST>, <% SOL> to correct the table values.

The display will show a default value for the solid fraction thermal expansion coefficient (1.490 * E-5 per degree C.). Enter the correct solid fraction thermal expansion coefficient. Type ENTER when finished. This completes programming of the Datamate's % Solid function. Press EXIT to return to the Default Display.

Note: If the density measured is below the Density/Concentration table that the user entered, the Datamate will assume a solid fraction concentration of 0%. If the density measured is above the Density/Concentration table that the user entered, then the Datamate will assume a solid fraction concentration of 100%. Also the module outputs and alarms configured for % solids and solids flow will signal 0% or 100% solids and solids flow.

Standard/Actual Volume

If you intend to use calculated volume for any function, you have the option of having the meter calculate it using a Standard Density rather than the one the meter actually measures. This can be particularly useful if the measured density is unreliable due to entrained air, or a large amount of thermal expansion will take place in the measured liquid after it has passed through the meter. NOTE THAT THIS STEP MAY BE SKIPPED IF YOU WISH TO USE THE MEASURED DENSITY TO CALCULATE ACTUAL VOLUME OR IF YOU WILL NOT BE USING A VOLUME VALUE IN YOUR METER.

To set the Standard Density, press MAIN MENU, <CONST>, <VOL>. The meter will ask you for the Standard Density. Enter zero if you do not wish to use the Standard Density feature. Otherwise, enter the value, in gm/cc or specific gravity, that you want to use for the Standard Density. When complete, press ENTER.

RS-422 Computer Interface

Your electronics package is equipped with an RS-422 asynchronous serial interface. This feature allows a computer to communicate directly with up to 32 Datamate mass flow computers and send commands necessary to configure: batching, alarms, output cards, etc. and to read all measured variables. A detailed description of all the commands will be found in Appendix A.

To program the Datamate to communicate through the RS-422 interface, press MAIN MENU, <PROG>, <COMM>. Use the F2 key to select the baud rate, then press F1. Set the parity using the F2 key, then press F1, then EXIT.

III.3. Calibrate Temperature

The Datamate's temperature measurement is factory calibrated. Its calibration can be confirmed by following the procedure below. The temperature calibration menu allows you to calibrate the temperature measurement <CALB>, and edit the temperature gain coefficient <EDIT>.

Calibrate Temperature

To calibrate the temperature measurement, press the following key sequence: MAIN MENU, <METER>, <CALB>, <TEMP>, <CALB>. The display will show the measured process temperature. If this is correct, press <YES>. If not, press <NO> and enter the correct temperature. In either case, finish the sequence by pressing EXIT to return to the Default Display. If the temperature was calibrated, the temperature gain coefficient will have changed. To view this value press MAIN MENU, <METER>, <CALB>, <TEMP>, <EDIT>. Record this value on the Data sheet provided at the end of this manual. Press EXIT twice to return to the default display.

Reentering the Temperature Gain Coefficient

The original temperature gain coefficient of your mass flow meter was recorded on the Calibration Data Sheet. This coefficient was determined when your meter was factory calibrated. To view or reenter this value press MAIN MENU, <METER>, <CALB>, <TEMP>, <EDIT>. Use the numeric keypad to modify the coefficient as required. Press EXIT twice to return to the default display.

Hint: To improve the accuracy of a temperature calibration,

- 1) place the test thermometer as close to the transducer inlet or outlet as possible. Greater errors will be observed as the distance between the two sensors is increased.
- 2) increase the flowrate through the transducer to the maximum possible. Lower flowrates will allow more time for the liquid temperature to change as it moves between the transducer and the test thermometer. (1 and 2 will work together to make the situation better or worse.)
- 3) Do not attempt the calibration until the temperatures indicated by both the Datamate and the test thermometer stop changing.

III.4. Calibrate Density

The Datamate's density measurement is factory calibrated. Its calibration can be confirmed by following the procedure below. The density calibration routine allows you to calibrate the density measurement <CALB>, program the slug flow inhibit option <SLUG>, and edit density calibration constants <EDIT>.

Note: The density measurement is dependent on accurate temperature measurement. Prior to re-calibrating the density, the temperature measurement calibration should be verified. See Section III.3 for the temperature calibration procedure.

Calibrate Density Measurement

To calibrate the density measurement, press the following key sequence: MAIN MENU, <METER>, <CALB>, <DENS>, <CALB>. The display will show the measured density of the fluid in the meter. If this is correct, press <YES>. If not, press <NO> and the meter will ask you for the tube frequency in air. The air frequency can be found on the name-plate of the transducer or the meter's Calibration Date Sheet. Enter it by typing the value and then pressing F1 key. The meter will then ask you for the "tube temperature in air". This value can also be found on the name plate on the transducer or the meter's Calibration Data Sheet. (Please note, this NOT a temperature that can be measured, but a constant measured at the factory.) Enter it by typing the value and then pressing F1. The meter will now display the process fluid temperature. If this value is wrong, Press F1, followed by the EXIT key, and then follow the instructions in Section III.3 before continuing. If the displayed temperature is correct, press F1. Next, you will be asked for the density of the process fluid at the displayed temperature. Enter the density and press F1. When finished, press EXIT to return to the Default Display.

If the density is re-calibrated, the density calibration constants (C1 and C2) will change. Record the new values on the Calibration Data Sheet provided at the end of this manual for future reference. To view the coefficients, press MAIN MENU, <METER>, <CALB>, <DENS>, <EDIT>. The value of C1 will be displayed first. Press ENTER to display the C2. These coefficients are specific to the transducer whose serial number is listed on the Calibration Data Sheet.

Reentering the Density Coefficients

The original density coefficients, C1 and C2, for your mass flow meter were recorded on the Calibration Data Sheet. These coefficients were determined when your meter was factory calibrated. To view or reenter these values press MAIN MENU, <METER>, <CALB>, <DENS>, <EDIT>. Use the numeric keypad to modify the C1 coefficient as required and press ENTER. Modify C2 as above and press ENTER to return to the default display.

Note: The meter must be accurately calibrated for density and temperature if you wish to measure density, percent solids, solids flow, or actual volume.

Slug Flow Inhibit

As described in Section II.2 of this manual, we recommend that you set up your process piping so that large slugs of air are never mixed with your process liquid. However, if this is unavoidable, the effects of air slugs can sometimes be minimized using the Slug Inhibit software feature.

This feature works by looking for the drop in measured density that will occur when air or gas becomes mixed with the process fluid. When the concentrations of gas become significant, slugs will develop and cause the indicated mass flow rate to fluctuate erratically. When the process density drops for any reason, this feature causes the Datamate to ignore the erratic mass flow signal and to substitute it with a preselected value. The preselected value is based on the user-selected option to either lock into the last measured rate prior to the drop in density or 0 flow rate. The limitation of this system is that an active measurement of the flow in the tubes is no longer in effect. **Therefore, some inaccuracy will always occur whenever this feature is engaged.**

To program the Slug Flow Inhibit, press MAIN MENU, <METER>, <CALB>, <DENS>, <SLUG>. You will be asked for a Low Density Cutoff. Enter a density that is slightly lower than the lowest density you expect to see for your process liquid (e.g., 0.9 g/cc for water). Do this by typing the low density value and then pressing F1. **(IF YOU DO NOT WANT TO USE THIS FEATURE, ENTER A VALUE OF 0.00 FOR THE LOW DENSITY CUTOFF POINT AND THE FUNCTION WILL BE DISABLED.)**

You will now be asked to choose the Slug Flow Default value. Use the F2 key to select either <LAST> or <ZERO>.

By selecting <LAST>, the meter will hold its mass flow rate reading and flow related outputs at the last measured value if slug-flow or a Sensor Error is detected. This selection is recommended if you are using the meter in a continuous or control application and the duration of the slug is short.

Select <ZERO> if you are performing Empty-To-Empty Batching. This selection will cause the flow measurement and flow related outputs to go to zero if slug-flow or Sensor Error is detected.

Next a prompt for Sensor Error Delay will appear. This feature delays forcing the indicated flow rate to zero and the display of the sensor error message for a period of 0-25 seconds as programmed. The delay allows the transducer a predetermined time to recover from any condition that is dampening its tube vibrations. Tube vibrations can be dampened by entrained gases or density stratification in the liquid in the transducer. During the delay period the indicated flow rate will be determined by the programming of the Slug Flow Default parameter above.

Finally, return to the Default Display by pressing EXIT.

III.5. Zero Flow Calibration

CORRECTLY ZEROING THE MASS FLOW METER IS CRITICAL FOR ACCURATE MASS FLOW MEASUREMENT, SO PLEASE FOLLOW THESE INSTRUCTIONS CAREFULLY.

There are two ways you can zero this meter: automatically and manually. The former is used whenever possible, while the latter may be needed if the presence of solids, foams, mechanical vibration, or EMI/RFI noise prevent the meter from zeroing automatically.

Automatic Zero Procedure

1. Flow fluid through meter until you are assured no vapors are present in tubes. Stop all flow through the transducer with at least one block valve installed at the outlet of the meter (and preferably another block valve installed at the inlet of the meter). Do this in such a manner that the transducer remains full of liquid.
2. Set the unit to PROGRAM mode. Press the following key sequence: MAIN MENU, <METER>, <ZERO>.
3. Wait about 2 minutes while the meter zeros itself. If the process takes more than two minutes, an automatic zero is not possible. You will have to abort the automatic zero using the EXIT key. The meter display will show "Invalid zero" while flashing "Fill Tubes Try Again". If after a second attempt the meter does not complete the automatic zero within two minutes refer to the Manual Zero Procedure, below.

4. To view the zero count, press the following key sequence: MAIN MENU, <METER>, <MASS>, <CALB>, <EDIT>, F1. Copy the Zero Count number into the Data Sheet on the back of this manual for future reference. Press ENTER to return to MAIN MENU.

Checking Zero

To check if the Automatic Zero, outlined below, is accurate perform the following procedure.

1. Set the unit to PROGRAM mode.
2. Press the following key sequences: MAIN MENU, <DISP>. Press F2 several times until "Flow Counts" appears. Press F1 to select it, then EXIT to display it.
3. Flush the meter with clean bubble free liquid for at least 30 seconds. Assure that all air/gas has been purged from the transducer, and that it has stabilized to the process temperature. Stop flow through the meter using two block valves.
4. Watch the variation of the Flow Count for a period of two minutes. IF this count is fluctuating about zero the meter is properly zeroed.

If the flow counts are not fluctuating about zero perform the manual zero procedure as described below.

Note: The meter will produce an inaccurate zero flow measurement, if the tubes in the transducer are not completely full of liquid. An indication of this condition is a low or unstable density measurement. To observe the density display press MAIN MENU, <DISP>. Now press F2 repeatedly to scroll through the display options. When "Display: Density" appears press F1 to select it, then EXIT to display it. Repeat step 3 above. A stable density display is an indication that the meter is completely full of liquid.

Manual Zero Procedure

If your process is very noisy, or if your process fluid has a high inherent gas or solids content, the Automatic Zero as described may not work. In this case, you will need to complete the following procedure to zero your meter. Because this procedure is more difficult than the Automatic Zero, we recommend you contact your local representative for assistance while performing this procedure.

If the above check indicates the meter has an inadequate value for the zero count, a manual zero should be performed. Follow the steps listed below.

1. Press the following key sequence: MAIN MENU, <METER>, <CALB>, <MASS>, <EDIT>. The flow scaler will appear. Press F1 and the display will prompt for you to "Enter Zero Count". Enter zero (0), then press EXIT four times.
2. Open the block valves and flush the meter with clean bubble-free liquid for at least 30 seconds.
3. Close the block valves and observed the flow counts. Repeat step 1 but instead of entering zero enter the average flow count that was observed. Record this number for future reference on the Data Sheet at the end of the manual. Press EXIT four times to return to MAIN MENU.

III.6. Mass Flow Calibration

Your mass meter was factory calibrated and no further calibration should be needed, however, you may confirm your meter's calibration by using one of two techniques: Wet Calibration (with flowing liquid), and Dry Calibration (adjusting the calibration constant directly). Wet calibration is the preferred method, but may not always be possible. The following procedure outlines both methods. (Note that you need to perform only one of these.)

Note: Both, the Slug Flow Inhibit and the Sensor Error Delay features are disabled during the Calibration Process. The flow rate reported is the flow rate measured by the meter (The Slug Flow Default parameter is ignored.) Also, a sensor error will be declared as soon as it is sensed and will cause the **CALIBRATION TO ABORT**, regardless of the Sensor Error Delay programmed.

Mass Flow Calibration

Wet, Dump

The Dump calibration method is used when something other than the Datamate will control liquid flow (e. g., operator at hand valve, PLC, etc.).

1. Weigh an empty drum or tank to obtain the Tare. Be sure to select a tank or drum that can be accurately weighed when it is full and is large enough to hold the equivalent of one minute's flow at your maximum process flow rate.
2. Set up the empty drum so that it can be easily filled from the meter and then weighed. (Note that for an accurate calibration, the accuracy of the weigh scale must be better than 1/1000 of the capacity of the weigh tank.)
3. Press the following key sequence: MAIN MENU, <METER>, <CALB>, <MASS>, <DUMP>.
4. The meter will ask you to begin flow to start the calibration. (Note: If flow starts prior to the Datamate's prompt to start flow, the Dump Calibration Process will not start. The Datamate will display a message indicating that the flow must be zero before starting the calibration process.) Begin flow at as high a rate as possible through the meter into the drum. When the drum is full, stop the flow and weigh the liquid in it. Wait until the liquid sloshing stops in order to obtain an accurate weight. Subtract the weight of the empty drum to get the net liquid weight.
5. Press F1 and compare the value displayed with what you just weighed. If they are the same, press <YES>. If not, press <NO> and enter the amount from your scale. Repeat the calibration as many times as you wish.
6. Select <NO> for linear correction, and then press F1 to finish the calibration sequence.
7. Press MAIN MENU, <METER>, <MASS>, <CALB>, <EDIT>. Copy the displayed scaler on to the Data Sheet in the back of this manual for future reference. Press F1 twice followed by EXIT.

Wet, Batch

The Batch calibration method is used when the Datamate controls liquid flow (e. g., when the Datamate's batching relays are used to operate a solenoid valves). When Batch calibration is selected, the Datamate will prompt the operator for a Batch Cutoff Point and Batch Trickle Offset in addition and prior to the steps above. Liquid flow is controlled in the same matter as a normal batch.

(Note: If the fluid starts flowing before the operator presses the START key to start the batch, the Batch Calibration Process will not start. The Datamate will display a message indicating that the flow must be zero before starting the calibration process.)

Dry Calibration

1. Press MAIN MENU, <METER>, <CALB>, <MASS>, <EDIT>.
2. Copy down the Scaler shown and multiply it by the ratio of the Correct Flow/Measured Flow.
3. Enter the new value into the meter by typing in the new Scaler, then press F1 twice followed by EXIT.
4. Copy the new Scaler value in the back of this manual for future reference. Estimated scalers for your size meter are shown in the table below.

Table 8. Approximate Mass Flow Calibration Scaler

Transducer size (ins.)	Scaler
m012 (1/8)	1.8
m025 (1/4)	11
m050 (1/2)	26
m100 (1)	67
m200 (2)	190
m300 (3)	609
m400 (4)	860 ¹ /570 ²

Note:

1. V4.XX software installed.
2. V5.XX software installed.

Check U6 on the computer board to determine your software revision.

III.7. Start-Up

Datamate 2000™ (Firmware version 3.2 and lower)

Make sure all door screws are tight. Turn the key-switch to RUN and remove the key from the unit. Store the key and this manual in a safe place for future use. The unit is now operating and, if set up to do so, may be used to run batches.

Datamate 2100™ (Firmware version 4.XX, 5.0X or higher)

Make sure all door screws are tight. Press MAIN MENU, <MORE>, <RUN>. The unit is now operating and, if set up to do so, may be used to run batches.

Datamate 2100™ (Firmware version 5.1X or higher)

Make sure J5 jumper is removed from the bottom of the computer board. Make sure all door screws are tight. The unit is now operating and, if set up to do so, may be used to run batches.

IV. OPERATION

IV.1. Read This First

This section is written to stand alone as a set of instructions to tell you, the Operator, how to run this meter. All instructions assume that the Datamate is set to RUN mode. If it is in the PROGRAM mode, set it to the RUN mode before going any further with these instructions.

NOTE: For software version 5.1X W&M Software: Remove the jumper from J5 on the computer board, and the Datamate will automatically go to RUN mode.

To use these instructions, you need to understand how the instrument keys work. Many of them actually have two functions. First, they all have a name printed on the key, such as MAIN MENU. When these instructions refer to such key, the name will be written in capital letters, such as RESET TOTAL.

Four of the keys (F1, F2, F3, and F4) are function keys and have a second function, one which is described by the name that appears above the key in the display. These instructions will use the format <XXXX> to describe that name.

To give an example, if you press the MAIN MENU key you will see a display which has the word <DISP> written above the F1 key. Whenever the word <DISP> appears over this key, pressing the F1 key will call up a menu which allows you to change the display.

Finally, you should be aware that you will be using several different types of displays. A Menu Display is one which has four words on the bottom line, one above each of the four function keys. The Default Display is the one with a totalized flow number on the bottom line. The Batch Display has the word Batch on the bottom line.

IV.2. Batch Operations

The Datamate is a full featured two-stage batch controller. For accurate and repeatable batching, batch size should be large enough to allow the meter to run 30 seconds for each batch. Assuming proper programming and installation of the meter and associated equipment, the following procedures will allow you to control batching with the Datamate:

Running A Batch

The lower line of the display indicates how much has been delivered. On the far-right of the upper line of the display a letter will be displayed: B, T, C, or S. This letter indicates the status of the current batch (B) indicated that the batch is in progress but has not reached the trickle point, (T) indicates that the batch is in progress and has reached the trickle point, (C) indicates that the batch is complete, and (S) indicates that the batch was stopped manually or automatically before completion.

You may see the display SLUG-FLOW, - HOLD - appear. This message indicates that the measured density of the process liquid has dropped below the Low Density Cutoff that you programmed from the SLUG menu. When this message is displayed the meter may no longer correctly measure flow and is either assuming the last valid flow rate, or a flow rate of zero. This display will return to normal when the liquid density rises above the Low Density Cutoff or when the you lower the Low Density Cutoff.

Begin A Batch

You have programmed the Datamate to either allow you to change the batch sizes before each batch (Run-mode Edit On) or run repeated batches of the same size (Run-mode Edit Off). If you programmed it to allow different size batches, press the START key. The display will show you the Batch Cutoff Point. This is the batch size. If you want to change the batch size, enter in the new batch size. When you have entered the correct batch size, press START again and the batch will begin (B displayed until trickle point reached).

If you programmed the Datamate to run repeated batches of the same size, just press START to begin the batch (B displayed until trickle point reached).

Interrupting A Batch

You may have to interrupt a batch, either to take a test sample, because it is not running correctly, or to start it over. To stop a batch, just press STOP (S displayed).

Restarting a Batch

To continue a batch after interrupting it, just press START (B or T displayed).

Terminating a Batch

To terminate a batch after interrupting it, press RESET TOTAL (S displayed).

Starting A New Batch

When the batch has finished (C displayed), the Datamate will show the amount of liquid delivered. If the Datamate is not programmed correctly, or some other piece of your equipment failed, this value may be quite a bit different than the requested batch size. It is, however, the quantity delivered.

With Run-mode Edit Off, you can run another batch by pressing START. If Run-mode Edit is On you may run a batch that was the same size as the last one by pressing START twice. To run a different size batch, press START and enter the new batch size and press START again.

Exiting the Batch Mode

To exit the batch mode, press STOP, then RESET TOTAL and then STOP again (no letter is displayed).

IV.3. Viewing Other Process Variables

While you did program the Datamate's display to default to one process variable, it is possible to view other process variables while in the RUN mode. To do this, press MAIN MENU, <DISP>. You will be given a menu allowing you to select one of the following process variables: temperature (<TEMP>), flow volume (<VOL>), process density (<DEN>), or more choices (<MORE>), then solids flow (<SOLF>), percent solids (<MORE>), previous display (<PREV>), or (<EXIT>). Press the appropriate key(s) and the selected variable will be displayed on the upper line of the display along with the associated totalizer for 15 seconds. Press EXIT to return to the Default Display or Batch Display.

IV.4. Totalizer Reset

The Datamate's totalizers cannot be reset while in RUN mode. To reset the Datamate's totalizers, insure that the Datamate is in the PROGRAM mode (See Section III.2). Then, from the Default Display, press RESET TOTAL. All three totalizers will reset when the RESET TOTAL key is released. When finished, return the Datamate to the RUN mode.

V. SERVICE AND TROUBLE-SHOOTING

V.1. Maintenance Activities

The m[®]/Datamate has no wearing parts, so maintenance requirements are virtually non-existent. We recommend that when performing high-accuracy measurements such as custody transfer, inventory control, or high-yield batching, you should monitor the zero once a day as described in Section III.5, Checking a Zero.

V.2. Fault Analysis

There are several possible causes of instrument failure. Many of the causes are outlined under Section VI.1, Error Message Summary. There are also several tests which you can perform to check performance of several sub-systems of the meter.

Output Board Self-Test

The Output Boards can be checked using a DVM (set for milli-Amps dc for the 4-20 mA board) and a frequency counter (for the scaled pulse card). To activate this function, be sure you read Section III.2 first. Then set the Datamate to PROGRAM and, from the Default Display, type MAIN MENU, <PROG>, <MOD>, <TEST>. Select the card you wish to test by pushing the function key under that card name. The meter will ask you to specify a test output in percent of maximum output. If you type in 50% and press ENTER, a 4-20 mA board will produce an output of 12 mA. If the output is from a scaled pulse board, the output will be determined by the board pulse scaling. If the output is not within 0.2% of the requested value, replace that output board to get the instrument back into service and contact the factory for instructions concerning the defective board.

When finished at one test point, you may repeat the test at another point by pressing the <REP> key or selecting another board to test by pressing <NEXT>. When finished with all testing, press <EXIT> twice to return to the Default Display.

Cable Check

The cable and connector can easily be checked using a DVM. The resistance of any conductor in this cable should be less than 1 ohm. Cables for CSA approved meters will have a jumper between pins J - D, and there may be jumpers between pins E - B and G - F for some cable configurations. In addition, the resistance between the Shield (the uninsulated) conductor and any other conductor or the connector shell must be greater than 100 Megohms.

Transducer Resistance Test

The electrical continuity between the various pins of the cable connector on the transducer can be checked with a high-impedance DVM (refer to Table 9 if you have a Datamate 2000™ or if you're checking a Datamate 2100™ transducer through the transducer cable.) and Table 10 (If you have a Datamate 2100™), and Figure 18 to locate the appropriate pins.

Table 9. Allowable Resistances in Ohms
(Datamate 2000™ Transducer Configuration or Datamate 2100™
Transducer Configuration with Transducer Cable.)

Cable Color	Pin Pairs	Transducer Size (ins.)					
		1/8	1/4	1/2	1	2	4
RED-BLK	C - D	72-88	80 - 96	74 - 90	46 - 55	46 - 55	33 - 39
WHT-BLU	E - A	28 - 144	80 - 96	10 - 12	10 - 12	10 - 12	80 - 96
WHT-ORG	E - H	128 - 144	80 - 96	10 - 12	10 - 12	10 - 12	80 - 96
GRY-YEL	F - G	Less than 0.1 ohms for all transducers sizes					
WHT-GRN	E - B	Less than 0.1 ohms for all transducers sizes					
WHT-GRY	E - F	RTD - 108 ohms @ 75°F for all transducer sizes					
	J - Case	Less than 1.0 ohm all sizes					
	Any other - Case	Over 100 Mohms for all transducer sizes					

Table 10. Allowable Resistances in Ohms
(Datamate 2100™ Transducer Configuration with or without transducer cable)

Pin Pairs	Transducer Size (ins.)						
	1/8	1/4	1/2	1	2	3	4
C - D	72 - 88	80 - 96	74 - 90	46 - 55	46 - 55	33 - 39	33 - 39
E - A	128 - 144	80 - 96	10 - 12	10 - 12	10 - 12	78 - 94	80 - 96
E - H	128 - 144	80 - 96	10 - 12	10 - 12	10 - 12	78 - 94	80 - 96
B - G	RTD - 108 ohms @ 75°F for all transducer sizes						
J - case	Less than 1.0 ohm all sizes						
Any other - Case	Over 100 Mohms for all transducer sizes						

V.3. Software EPROM Replacement

BEFORE YOU BEGIN, READ THIS PARAGRAPH: The EPROM chips that this software is stored in are easily damaged by static electricity. To prevent this, **DO NOT TOUCH THE BARE METAL PINS OF THE CHIPS** and be sure to discharge the static electricity in your body by means of an ESD (Electrostatic Discharge) grounding strap. If an ESD strap is not available, discharge your self by touching the metal power supply support or a suitable earth ground immediately prior to handling the EPROM.

The steps below require that you have 26 pin IC remover (a small instrument screwdriver will work also), the replacement chip, and the O & M Manual for the Datamate. To replace the chip, proceed as follows:

1. RECORD THE CALIBRATION PARAMETERS.

When upgrading and EPROM chip with a new software version, there is a possibility that the differences between the previous and the new software versions may cause operational problems. In order to prevent any complications **we strongly recommend that the Data Memory be erased immediately after installing the new software version.** Therefore, it is necessary to have a record of all the calibration parameters and user programming prior to executing the change. To replace the EPROM chip, please follow the steps below.

Set the Datamate to **PROGRAM** mode. Press the **<MAIN MENU>** key.

To read the Calibration Parameters, press the following sequence of key strokes:

- a) **SCALER & ZERO.** Press: **<METER>**, **<CALB>**, **<EDIT>**. Record the Scaler in the display. Next, press F1 and record the Meter Zero. Then exit the sequence by pressing **<EXIT>**.
- b) **TEMPERATURE GAIN.** Press: **<METER>**, **<CALB>**, **<TEMP>**, **EDIT>**. Record the Temperature Gain in the display, then exit the sequence by pressing **<EXIT>**.
- c) **DENSITY CONSTANTS.** Press: **<METER>**, **<CALB>**, **<DENS>**, **<EDIT>**. Record the Density Constant "C1" in the display, then press F1. Record the Density Constant "C2". Next exit the sequence by pressing **<EXIT>**.

If you programmed any parameters to the Output Modules, Batch, Alarm, % Solids, and/or the RS-422 Communication settings, follow the programming instruction in the O & M manual to read and record the programmed values.

2. TURN OFF POWER TO THE UNIT. The LED on the power supply will go off.

3. GROUND YOURSELF as described above.

4. REMOVE THE OLD EPROM.

The old EPROM is located on the board on the computer board (the board on the Datamate's door). The EPROM socket is labeled U3 on the Datamate 2000 and U6 on the Datamate 2100. To remove it, use an IC remover or slip a small instrument screwdriver between the socket and one end of the chip. Gently pry that end up about a tenth of an inch. Move the screwdriver blade to the other end of the chip and pry it up by the same amount. Continue prying out alternate ends until the chip is removed. Be careful to keep the chip parallel with the socket while you do this so that no pins are bent. Also, do not damage the small capacitor located next to the chip's socket.

5. STRAIGHTEN THE PINS ON THE NEW CHIP.

Remove the new chip from its protective foam. You might have to straighten the pins of the chip inward in order to make it fit in the socket. If so, slightly bend the pins using a flat surface. Check the pins against the empty socket to see if they line up with the socket holes. If not, repeat the bending operation until they do line up. **DO NOT OVERBEND THE PINS.**

6. INSERT THE NEW CHIP.

Align the chip over the socket so that the **notch on the top of the chip points towards the capacitor and the bottom of the door.** Slip the ends of the pins into the socket holes and check that they are all aligned. Gently press the chip half way in with your thumb, then stop and check that all pins are going in smoothly. If any of them are misaligned, remove the chip, straighten the pins, and begin the insertion process again. If they all seem to be positioned correctly, gently push the chip in the rest of the way.

7. INSERT JUMPER ON W1 PINS.

Included in the package is a header-pin shorting jumper. Place this jumper over the header-pins labeled **W1** in the computer board to short the pins out.

8. REACTIVATE THE UNIT.

Datamate 2000 (with V3.XX or V2.X). Turning on the system with the **W1** jumper in place will ensure the erasure of the data memory.

Datamate 2100 (with V4.XX and V5.XX) With the **W1** jumper in place, press and hold the **F2** key while turning the power on to ensure the erasure of the data memory. The Datamate will indicate that the memory is erased.

9. **REMOVE THE W1 JUMPER.** Leaving the jumper in place in the Datamate 2000 (V3.XX) will cause the Data Memory to be **erased** every time the power is turned on. On the Datamate 2100 (V4.XX and V5.XX), you will get a message asking if you want to erase the Data Memory at power-up; however, we strongly recommend that you remove the jumper to avoid confusion.

Re-program the unit using the instructions in your O & M manual the calibrating parameters you copied from the unit in step 1 above.

After verifying that the unit operates normally, **discard** the old **EPROM**.

V.4. Board Replacement

All the boards in this instrument may be replaced if necessary. When performing any of the following replacement procedures, be sure the power to the unit is off. Make sure to discharge static electricity from yourself before you touch any electronics. This is preferably done by using an anti-static wrist-strap connected to earth ground. If the wrist-strap is not available and the meter is plugged into a properly grounded receptacle, you can ground yourself by touching the Power Supply Support Bracket. Board replacement procedures are as follows:

Note: Replacing the Datamate or any PCBs may change the operation and/or calibration of this meter. After any maintenance, kY recommend verifying programming, calibration, and operation prior to returning the meter to normal service.

Computer Board

1. If you have not already done so, record all the program parameters such as: Scaler, Zero Count, Density Coefficients C1 and C2, Temperature Coefficient, % Solids Table, output modules, Batching, Alarms, and Standard Volume from the existing memory by following the instructions in Section III.3 through III.6
2. Turn off the power to the Datamate.
3. Ground yourself by connecting an approved anti-static wrist-strap between yourself and earth-ground.
4. Disconnect the five connectors from the board on the inside of the Datamate door.
5. Using an I.C. remover, carefully remove the EPROM chip from the socket U3 on the old Computer Board. If no I.C. remover is available, a small screwdriver could be used by prying up alternate ends of the chip. You can re-insert it into the new board. (Be very careful not to bend any pins.)
6. Remove the four small nuts that hold the board in place and remove the board.
7. Use the four small nuts to mount the new board in place of the old one.
8. Reconnect the five connectors to the board.
9. Set the position of the Datamate's address switches SW2, Datamate 2100 (SW1, Datamate 2100), on the new board to duplicate those on the old board.
10. Short out pins W1 on the Computer board while returning power to the unit.
11. Remove the short jumper from pins W1.
12. Re-enter the scaler by pressing MAIN MENU, <METER>, <MASS>, <CALB>, <EDIT>, then enter the value recorded in Step 1 above. Press ENTER when finished.
13. Re-enter the zero count by pressing CLEAR, then enter the value copied in Step 1 above. Press ENTER three times then EXIT when finished.
14. Re-program the rest of the programmed parameters as outlined in Section III.2, III.3, and III.4.

Output Boards

1. Turn off the power to the unit.
2. Unplug the board and remove the wires from the connector block.
3. Insert the replacement board and install the wires into the connector block according to Section II.4.
4. Adjust the boards by following the procedures outlined in Section III.1.
5. Power up the unit.

Power Supply Board

This board can only be replaced by changing the entire power supply. To do this, disconnect all wires and remove the bracket supporting screws. Return the entire assembly to the factory for repair. **There are no operator replaceable parts. All servicing must be performed by qualified service personnel.**

Barrier Board

1. Turn off power to the unit.
2. Disconnect all board connectors.
3. Unscrew the board supporting bracket and remove the board.
4. Install the new board and plug all connectors back in.
5. Power up the unit.

Interface Board

1. Turn off power to the unit.
2. Remove any Output Boards and/or Batching Board from the Interface Board.
3. Disconnect all cables from the board.
4. Remove the board and install the replacement.
5. Re-insert any Output Boards and all board connectors.
6. Check the chip in socket U3 on the Computer board to be sure you have the right software for your board. If you have any questions contact your local representative for assistance.
7. Adjust the Transducer/Electronics Interface
Set the Temperature Amplifier Offset Voltage.
 1. Turn off the unit and move the jumper from pins 1 and 2 to pins 2 and 3 on W11 and W12 on the Interface board.
 2. Connect a DC DVM between TP59 (+) and TP1 (-).
 3. Power up the unit and adjust RV2 to get 0.0 ± 0.1 mVDC on the voltmeter.
 4. Return the jumpers to pins 1 and 2 on W11 and W12.Set the Vibration Amplitude/Sensor Voltage.
 1. Connect an AC DVM to pins TP56 and TP1.
 2. Adjust RV1 until the voltage across these pins is 200 ± 5 mV RMS. This voltage should be $140 \pm$ mV RMS for the m300 and m400 transducers.
8. Recalibrate the Datamate as outlined in Section III.3 to III.6 of this manual.

V.5. Datamate Replacement

The entire Datamate can be replaced as a unit without removing the transducer from your line.

To remove the existing unit

1. Record any application specific programming.
2. Record the connection of all the external wiring to the Datamate then disconnect.
3. Remove the unit from the wall.
4. Reverse the above steps.
5. Follow steps 7 and 8 of the Interface Board section of Section V.4. Board Replacement, above.
6. Reprogram as required for your application.

VI. REFERENCE

VI.1. Error Message Summary

The following Error Messages may occur when operating your unit:

POWER WAS RECYCLED Press F1 to Continue: Power to the unit was interrupted. The meter is now measuring flow correctly, but the batch and totalizing counters will show a low count if fluid flowed through the meter while the power was off.

***** SENSOR ERROR *** /TUBES NOT VIBRATING:** This message is caused by low sensor voltage from the transducer. When this message is displayed, the meter is unable to monitor any measurements and forces all outputs to zero. Any of the following conditions could cause this condition:

1. Transducer tubes not full
Gases and liquids present in the tubes simultaneously. The gas allows the liquid to slush around and dampens the tube motion.
2. Vaporization of process liquid
Liquids with high vapor pressures can flash to vapor under the proper conditions
3. Density stratification of liquid in transducer
Non-homogeneous liquid in the transducer. Same as 1 above but not a severe (sensor voltages 30-70 mVRMS vs. 0-10 mVRMS).
4. Pipe vibration
Vibration of the piping system can cause the PLL to drop lock. This causes the drive frequency to shift away from the transducer resonance frequency.
5. Wiring
Improper wiring of the transducer barrier board plug. Confirm wiring per Table 3 page 6 of the O&M manual.
6. Low Drive Voltage
Check and adjust the tube drive circuit as described in "Set the Vibration Amplitude/Sensor Voltage" procedure page 34. This adjustment should be checked at the start-up of each meter.
7. Bad Transducer/Cable
 - a. Listen for a hum from the transducer when it is on.
 - b. Compare transducer resistances with the chart on page 31.
 - c. Ring out the transducer cable per Table 3 page 6.

Sensors OK, Press F1: This message is displayed when sensor voltages return to normal after a Sensor Error (See *** SENSOR ERROR *** /TUBES NOT VIBRATING above). The meter starts measuring as soon as this message is displayed. The batch and totalizer counters will show a low count if any liquid flowed through the meter while the tubes were not vibrating.

SLUG-FLOW, -HOLD- (V3.XX); SLUG-FLOW/Low Dens. (V4.0X or V5.XX): The Slug-Flow Inhibit feature has been engaged because the density of the liquid dropped below the inhibit trip point. While this display is shown, the meter will not measure the liquid flowing through it, but will provide an artificial output of either zero flow or the last flow rate before the Slug-Flow Inhibit was engaged. For details, see Section III.2.

SLUG-FLOW, -HOLD- / Key to PROGRAM (V3.XX); SLUG-FLOW/Low Dens. (V4.0X or V5.XX): In the RUN mode this message alerts the operator that the Slug-Flow Inhibit feature is engaged. To change the programming values, the operator must go to PROGRAM mode and follow the steps outlined in Section III.2.

**** SYSTEM ERROR 1 ** / OPERATION TERMINATED:** The Watchdog Timer has timed-out. In normal operation the program will reset the watchdog circuit periodically to prevent its timing-out. If in its normal execution the Datamate fails to reset the watchdog timer times out twice in a 30 second period this error is declared. The Datamate may return to normal operation after recycling the power. If recycling the power doesn't clear the problem, erase the non-volatile RAM. To erase the non-volatile RAM, see the SYSTEM ERROR 2 description. Some reason for this problem and possible solutions are given below:

1. Noise entering the meter through the transducer cable of Trigger Interface Board Datamate. Eliminate noise by re-routing cables
2. Improperly substituting the transducer cable. Cross-talk in the cable can cause the drive system to go into high frequency oscillation. Install proper cable.
3. Improper error handling by software in all versions lower than V3.2C and version of V4.0X lower than V4.0C. Replace software with V3.XG or V5.XX.

WARNING! Re-setting the non-volatile RAM will erase all of the Datamate programmed parameters (calibration, alarms, etc.). You will have to reprogram the unit as outlined in Section III.

**** SYSTEM ERROR 2 ** / OPERATION TERMINATED:** The meter failed an internal RAM checksum, meaning the data memory (non-volatile RAM, where calibration parameters and other constants are stored) has been corrupted. This error calls for the non-volatile RAM to be erased and re-programmed. Repeated System Error 2s maybe caused by the following:

1. Voltage spikes and/or noise on the power line, or by voltage fluctuations. Reread all cautions for wiring the Datamate's to the AC line and connecting the Datamate's batching relays. Make any corrections required and then install a line voltage conditioner (constant voltage transformers) on Datamate's power circuit as required. (Power line noise will be the source of this problem in almost every case.)
2. Bad computer board, replace as required.

NOTE ON ERASING DATA MEMORY: To erase the memory, short out the pins on W1 on the Computer Board while the power is cycled. When the Datamate 2100™ is powered with the W1 jumper in place and there has not been a SYSTEM 2 ERROR, the display shows the message: W1 jumped, ERASE RAM? If you press F1 the system will continue on without erasing the Data Memory. If you press F2 the non-volatile RAM gets re-set (erased) and any error related to data corruption is cleared. If the Datamate 2100™ detects a SYSTEM ERROR 1 or 2 at power-up and the W1 jumper is in place, it will automatically reset the Data Memory without prompting the operator to press F2 to erase it. The Datamate 2000™ with firmware version 3.2 or lower will always reset the Data Memory when powered-up with the W1 jumper in place. To re-program the Datamate follow the programming instructions in Section III.

**** SYSTEM ERROR 3 ** / OPERATION TERMINATED:** Improper data transfer between computer and interface board. When digital data is received by the interface board parity is generated by the receiver. The parity information is sent back to the computer board where it is compared to the parity information generated when the data was transmitted. If the returned parity information is not correct a System Error 3 is declared. The error may be caused by a defective Computer Board, a defective Interface Board, a faulty connecting cable, or a bad or missing output board. As a first step in correcting the error, turn off power to the unit and check all cable connections before re-powering the unit. If the error persists, replace either of the two boards until it is corrected.

**** SYSTEM ERROR 4 **/OPERATION TERMINATE (V3.XX):** Sensor Error after a System Error has been declared or a System Error occurs during a Sensor Error. Clear the Sensor Error first and then determine which System Error has occurred and correct it.

VI.2. Physical Dimensions

Dimensions																	
Model Size	Connection	A1		A2		B		C		D		E		F			
		cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in		
m012-1/8"	3/8" VCO	33.60	13.23	33.60	13.23	17.78	7.00	13.46	5.30	3.81	1.50	12.95	5.10	18.80	7.40		
	1/2" 150#	30.28	11.92	N/A	N/A												
m025-1/4"	3/8" VCO	42.27	16.64	42.27	16.64	20.07	7.90	15.75	6.20	9.14	3.60	13.21	5.20	26.92	10.60		
	1/2" 150#	38.94	15.33														
	1/2" 300#	40.26	15.85														
	1/2" 600#	41.53	16.35														
	DN15 - PN40	37.72	14.85														
m050-1/2"	1" VCO	61.80	24.33	61.80	24.33	64.87	25.54	22.35	8.80	17.78	7.00	10.16	4.00	14.99	5.90	39.62	15.60
	1/2" 150#	55.88	22.00														
	1/2" 300#	57.20	22.52														
	1/2" 600#	58.47	23.02														
	3/4" 150#	55.88	22.00														
	3/4" 300#	57.84	22.77														
	3/4" 600#	59.11	23.27														
	1" 150#	56.26	22.15														
	1" 300#	58.14	22.89														
	1" 600#	59.41	23.39														
	DN15 - PN 40	56.13	22.10														
	DN25 - PN 40																
	M100-1"	1" 150#	68.76	27.07	78.16												
1" 300#		70.64	27.81														
1" 600#		71.91	28.31														
1 1/2" 150#		69.72	27.45														
1 1/2" 300#		71.30	28.07														
1 1/2" 600#		72.87	28.69														
2" 150#		70.33	27.69														
2" 300#		71.91	28.31														
2" 600#		73.84	29.07														
DN25 - PN 40		68.94	27.14														
DN50 - PN 40																	
DN50 - PN100																	
M200-2"		2" 150#	86.61	34.10		97.94	38.56	55.88	22.00	44.20	17.40	26.67	10.50	37.59	14.80	62.99	24.80
	2" 300#	88.19	34.72														
	2" 600#	90.04	35.45														
	3" 150#	87.58	34.48														
	3" 300#	90.12	35.48														
	3" 600#	91.92	36.19														
	4" 150#	88.19	34.72														
	4" 300#	91.08	35.86														
	4" 600#	93.50	36.81														
	DN50 - PN 40	86.11	33.90														
	DN80 - PN 40																
	DN100 - PN 40																

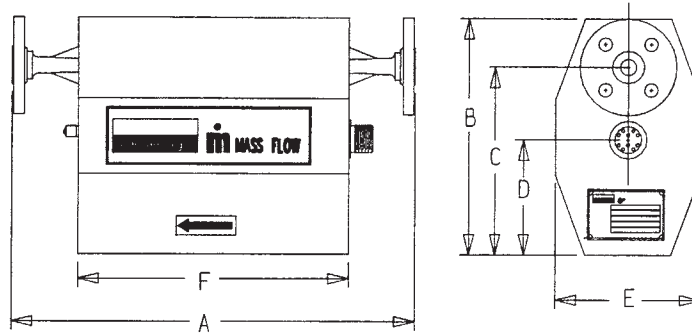


Figure 8
Dimensional Diagram Standard (except m400)

Notes: A1. 316L SS Wetted Parts
A2. Hastelloy C-22
Wetted parts -
Lap-Joint Flanges.

Dimensions																	
Type	Model-Size	Connection Size	Eccentric Reducer Size	A ¹		A		B		C		D		E		F	
				cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in
Sanitary	m012-1/8"	1 1/2"	1 1/2"x1/2"	23.5	9.2	41.2	16.2	17.8	7.0	13.5	5.3	3.8	1.5	12.7	5.0	5.0	2.0
	m025-1/4"	1 1/2"	1 1/2"x1/2"	31.8	12.5	49.6	19.5	20.1	7.9	15.7	6.2	9.1	3.6	13.2	5.2	5.0	2.0
	m050-1/2"	2"	2"x1"	45.5	17.9	70.9	27.9	22.4	8.8	17.8	7.0	10.2	4.0	15.0	5.9	6.4	2.5
	m100-1"	2.5"	2 1/2"x1 1/2"	53.6	21.1	79.0	31.1	33.8	13.3	27.4	10.8	17.8	7.0	22.4	8.8	7.7	3.1
Industrial	m200-2"	4"	4"x3"	69.2	27.3	95.3	37.5	55.6	21.9	44.5	17.5	26.7	10.5	37.6	14.8	11.8	4.7
	m025-1/4"	1 1/2"	1 1/2"x1/2"	38.2	15.0	56.0	22.0	20.1	7.9	15.7	6.2	9.1	3.6	13.2	5.2	5.0	2.0
	m050-1/2"	2"	2"x1"	55.1	21.7	72.9	28.7	22.4	8.8	17.8	7.0	10.2	4.0	15.0	5.9	5.0	2.0
	m100-1"	2.5"	2 1/2"x1 1/2"	68.3	26.9	93.7	36.9	33.8	13.3	27.4	10.8	17.8	7.0	22.4	8.8	6.4	2.5
	m200-2"	4"	4"x3"	85.0	33.5	111.1	43.7	55.6	21.9	44.5	17.5	26.7	10.5	37.6	14.8	11.9	4.7

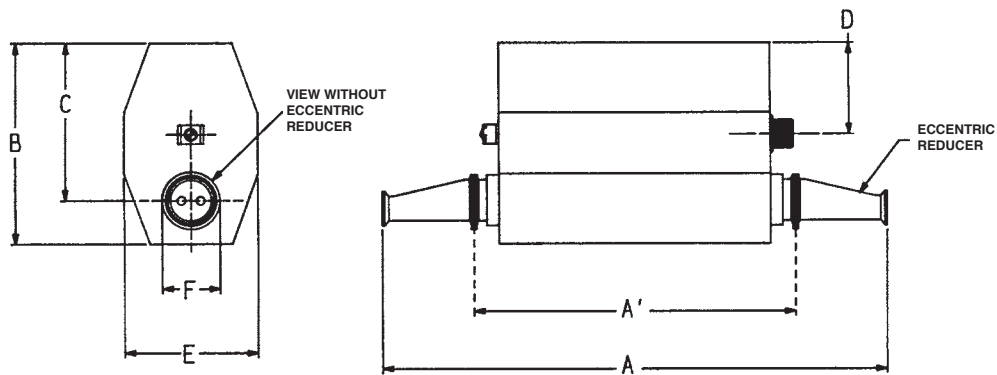


Figure 9
Dimensional Diagram Tri Clamp®

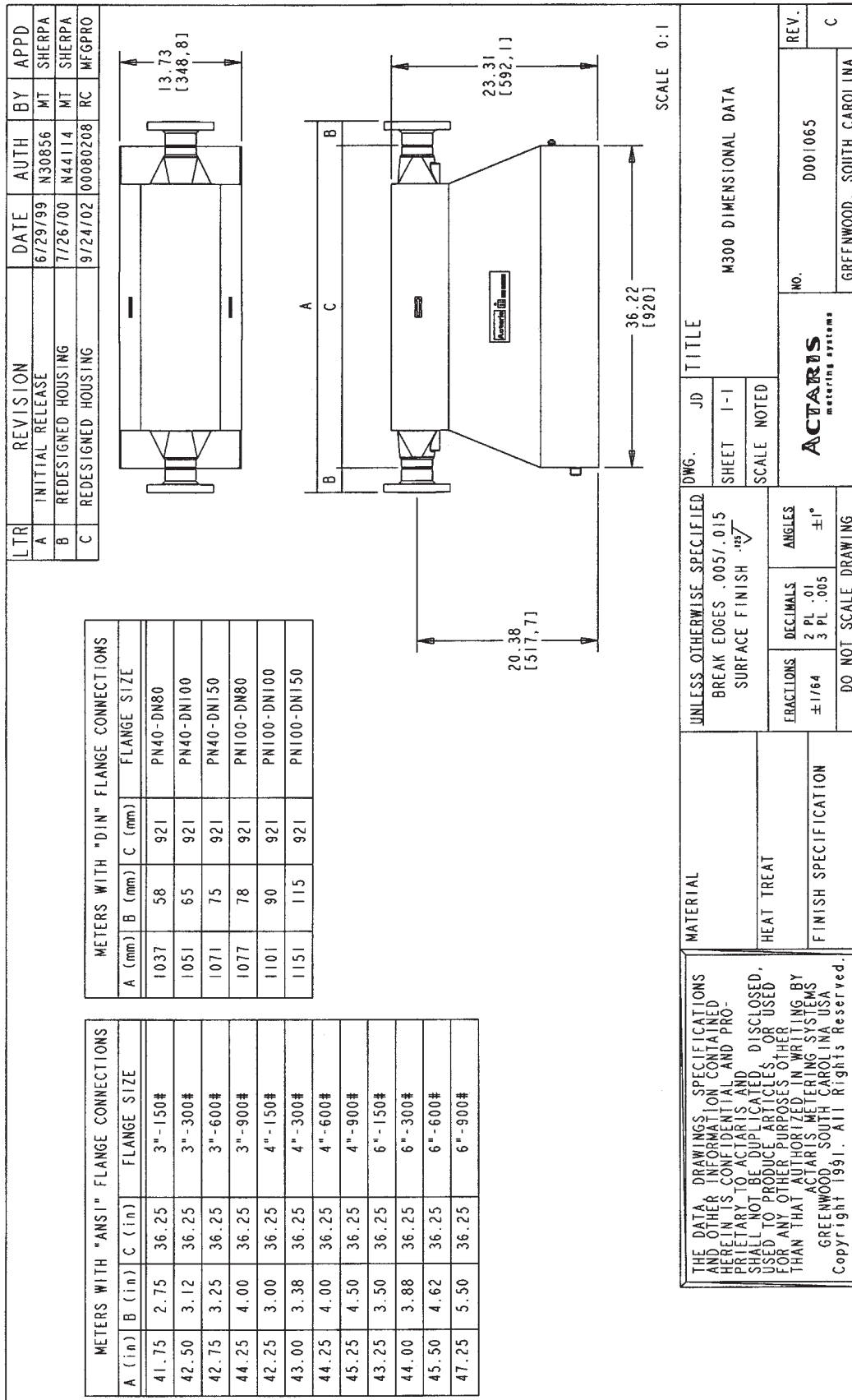


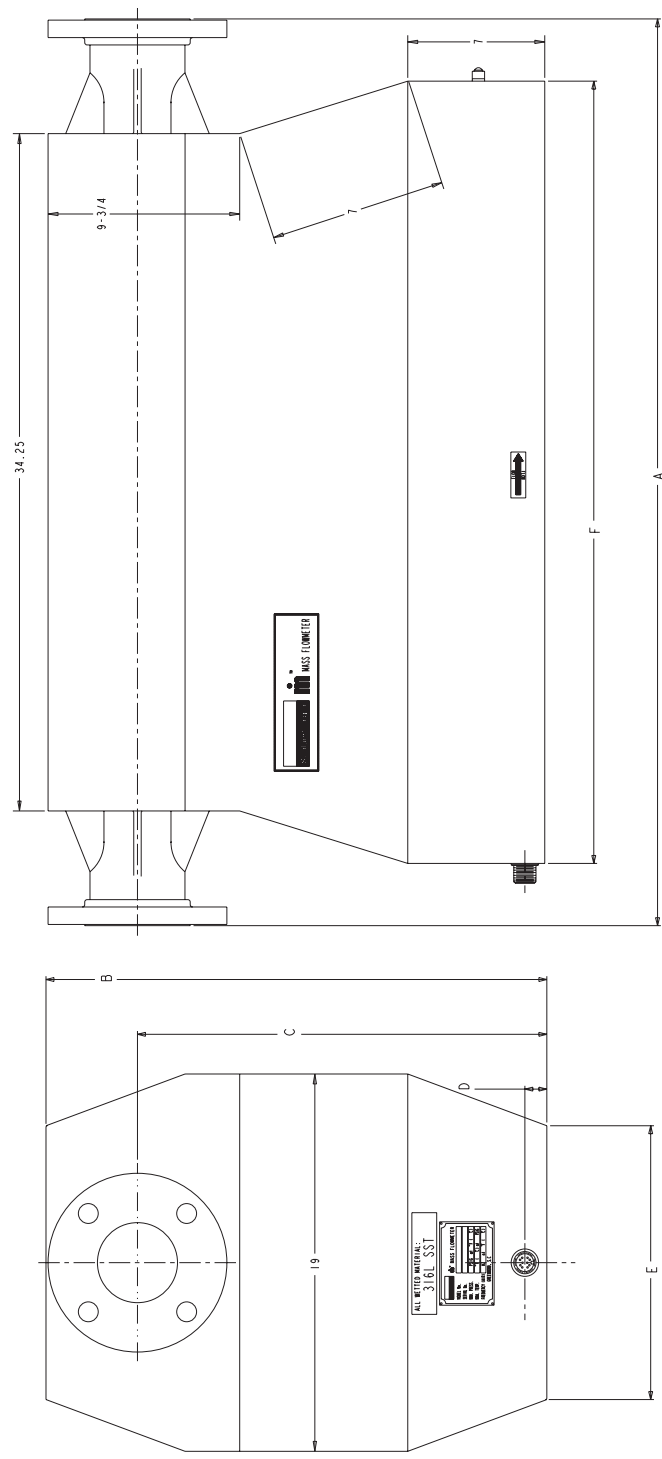
Figure 10
Dimensional Diagram Standard (m300)

ITEM #	PART NUMBER	ITEM DESCRIPTION	QTY.

LTR	REVISION	DATE	AUTH	BY	APPD
A	INITIAL ISSUE	3-25-00	N42688	SH	SHERPA

	PN40-DN100, 150, 200	PN100-DN100, 150, 200
	CM	CM
	IN	IN
A	117.81	46.38
B	63.50	25.00
C	52.07	20.50
D	3.81	1.50
E	34.49	13.58
F	100.40	39.53

	4"-150#	4"-300#	4"-600#	4"-900#	6"-150#	6"-300#	6"-600#	6"-900#	8"-150#	8"-300#	8"-600#	8"-900#
A	46.38	46.38	49.50	49.50	46.38	46.38	49.50	49.50	46.38	46.38	49.50	50.00
B	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
C	20.50	20.50	20.50	20.50	20.50	20.50	20.50	20.50	20.50	20.50	20.50	20.50
D	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
E	13.58	13.58	13.58	13.58	13.58	13.58	13.58	13.58	13.58	13.58	13.58	13.58
F	39.53	39.53	39.53	39.53	39.53	39.53	39.53	39.53	39.53	39.53	39.53	39.53



UNLESS OTHERWISE SPECIFIED	TITLE
BRAM ERRES: 0.05/0.15	OUTLINE DIMENSIONAL
SURFACE FINISH: #7	4" MASS FLOW
SCALE: .375	
EXCLUSIONS: #1/4	
REVISIONS: 5 PR. 284	
FINISH SPECIFICATION: DO NOT SCALE DRAWING	

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NO.	REV.
070384-040	A

Figure 11
Dimensional Diagram Standard (m400)

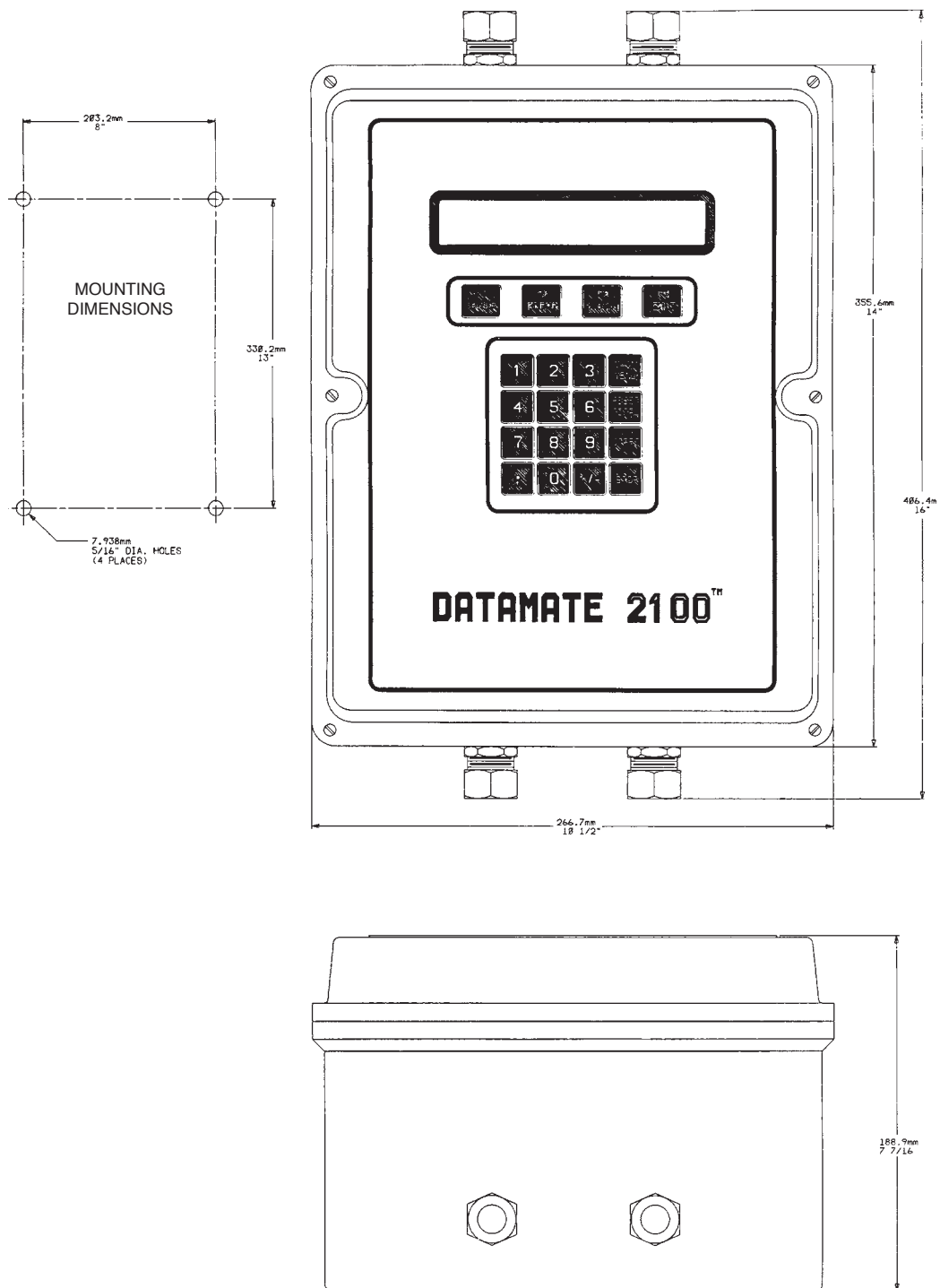


Figure 12
Dimensional Diagram Datamate 2000/2100™

VI.3. Model Number Explanation

Table 11 is an explanation of Model Number of an \dot{m} ® Mass Meter with Datamate 2000™. Please note that an \dot{m} ®transducer with Datamate 2000™ has only one Model Number.

**Table 11 \dot{m} ® Mass Meter with
Datamate 2000™ Model Numbers**

MODEL NUMBER			DESCRIPTION
M	-	-	
0 1 2			1/8" flowmeter w/3/8" female VCO fittings ① ② (1 1/2" Nominal)
0 2 0			1/4" flowmeter w/3/8" female VCO fittings
0 2 5			1/4" flowmeter w/1/2" connections ① ② (1 1/2" Nominal)
0 5 0			1/2" flowmeter w/1/2" connections
0 7 5			1/2" flowmeter w/3/4" connections
0 9 5			1/2" flowmeter w/1" connections ① ② (1 1/2" Nominal)
1 0 0			1" flowmeter w/1" connections
1 5 0			1" flowmeter w/1 1/2" connections ①
1 9 5			1" flowmeter w/2" connections ① ② (2" Nominal)
2 0 0			2" flowmeter w/2" connections
2 5 0			2" flowmeter w/3" connections ①
2 9 5			2" flowmeter w/4" connections ② (4" Nominal)
	0 8		VCO fittings (m012 and m020 only)
	1 8		ANSI 150# RF flanges
	2 8		Industrial grade sanitary clamp connection – See Note--②
	3 8		ANSI 300# RF flanges
	4 8		3-A authorized sanitary clamp w/2 tube access – See Note ①
	6 8		ANSI 600# RF flanges
	2		DATAMATE 2000™ electronics, no I.S. option
	4		DATAMATE 2000™ electronics, FM I.S. option
	5		DATAMATE 2000™ electronics, CSA I.S. option
	1		115 volts AC power required, 50/60 Hz
	2		230 volts AC power required, 50/60 Hz
	0		Connector only (I.S. approved only when ordered factory assembled with P/N 300064-002 below)
	1		10 ft. (3 m) Belden cable supplied
	2		30 ft. (9 m) Belden cable supplied
	3		50 ft. (15 m) Belden cable supplied (for lengths above 50 ft. – see below)
	0		No 4-20 output*
	1		One 4-20 output*
	2		Two 4-20 outputs*
	3		Three 4-20 outputs*
	4		Four 4-20 outputs*
	0		No pulse outputs*
	1		One pulse output*
	2		Two pulse outputs*
	3		Three pulse outputs*
	4		Four pulse outputs
Part No. 300064-002			Connector cable for lengths greater than 50 ft. (must be ordered with flowmeter).

① When ordering the 3-A authorized version, only those connection sizes with a ① can be selected.

② When ordering the industrial grade Tri-Clamp. connection, only those connections with a ② can be selected.

Note: The nominal Tri-Clamp connector sizes (in parenthesis) differs from standard.

--* Maximum total of four (4) outputs in the DATAMATE 2000.

N/C = No Charge

Table 12 is an explanation of Model Number of an ~~XXXXXXXXXX~~® Mass Meter with Datamate 2100™. Please note that in this configuration the ~~m~~® transducer and the Datamate 2100™ have separate model numbers.

**Table 12. ~~m~~® Mass Meter with Datamate 2100™ Model Numbers
1/8" ~~m~~® Mass Flow Meter***

M012		X	X	X	X	X	Description
Config Options - Must Select One Option Per Category							
TYPE							
2							TRANSDUCER 1/8" HASTELLOY (R) C-22 *
8							TRANSDUCER 1/8" SST *
S							TRANSDUCER 1/8" SST SANITARY TRI CLAMP *
FLANGE							
000							1 1/2" 3A SST SANITARY TRI CLAMP
212							1/2" 150 LB ANSI RF HASTELLOY C-22
213							1/2" 300 LB ANSI RF HASTELLOY C-22
801							3/8" CAJON VCO **
812							1/2" 150 LB ANSI RF SST
813							1/2" 300 LB ANSI RF SST
XXX							SPECIAL - CONTACT FACTORY
APPROVALS							
0							GENERAL PURPOSE
2							CSA APPROVED
3							LCIE APPROVED
CABLE							
000							NO CABLE
101							ASM CBL KIT 10 FT. ***
102							ASM CBL KIT 20 FT. ***
103							ASM CBL KIT 30 FT. ***
105							ASM CBL KIT 50 FT. ***
110							ASM CBL KIT 100 FT. ***
ELECTRONICS							
0							NO ELECTRONICS
D							FOR USE WITH DATAMATE
N							FOR USE WITH NEXGEN

* Note: Wetted materials and connection materials must be the same.
 ** Note: Only available as 3/8" female CAJON VCO connections. Requires male CAJON VCO -8- VCO by SWAGELOCK®.
 *** Note: For a complete list of available cables, contact ~~xxx~~ 1.

1/4" ~~m~~® Mass Flow Meter*

M025		X	X	X	X	X	Description
Config Options - Must Select One Option Per Category							
TYPE							
2							TRANSDUCER 1/4" HASTELLOY (R) C-22 *
8							TRANSDUCER 1/4" SST *
S							TRANSDUCER 1/4" SST SANITARY TRI CLAMP *
FLANGE							
000							1 1/2" 3A SST SANITARY TRI CLAMP****
212							1/2" 150 LB ANSI RF HASTELLOY (R) C-22
213							1/2" 300 LB ANSI RF HASTELLOY (R) C-22
801							3/8" CAJON VCO **
812							1/2" 150 LB ANSI RF SST
813							1/2" 300 LB ANSI RF SST
814							1/2" 600 LB ANSI RF SST
846							1 1/2" SST INDUSTRIAL TRI CLAMP ****
8BE							DN15 PN40 SST
XXX							SPECIAL - CONTACT FACTORY
APPROVALS							
0							GENERAL PURPOSE
2							CSA APPROVED
3							LCIE APPROVED
W & M							
0							NONE
W							CUSTODY TRANSFER (WEIGHTS & MEASURES)
CABLE							
000							NO CABLE
101							ASM CBL KIT 10 FT. ***
102							ASM CBL KIT 20 FT. ***
103							ASM CBL KIT 30 FT. ***
105							ASM CBL KIT 50 FT. ***
110							ASM CBL KIT 100 FT. ***
ELECTRONICS							
0							NO ELECTRONICS
D							FOR USE WITH DATAMATE
N							FOR USE WITH NEXGEN

* Note: Wetted materials and connection materials must be the same.
 ** Note: Only available as 3/8" female CAJON VCO connections. Requires male CAJON VCO -8- VCO by SWAGELOCK®.
 *** Note: For a complete list of available cables, contact ~~xxx~~ 1.
 **** Note: The 1 1/2" Industrial and 3A Sanitary Tri-Clamp Connections are available with 316L SS wetted materials only.

**Table 12. \dot{m} ® Mass Meter with Datamate 2100™ Model Numbers (cont.)
1/2" \dot{m} ® Mass Flow Meter***

Config Options - Must Select One Option Per Category		
M050	X	Description
		TYPE
	2	TRANSDUCER 1/2" HASTELLOY (R) C-22 *
	8	TRANSDUCER 1/2" SST *
	S	TRANSDUCER 1/2" SST SANITARY TRI CLAMP *
		FLANGE
	000	2" 3A SST SANITARY TRI CLAMP****
	232	1" 150 LB ANSI RF HASTELLOY (R) C-22
	233	1" 300 LB ANSI RF HASTELLOY (R) C-22
	811	NUT VCO CAJON SST **
	812	1/2" 150 LB ANSI RF SST
	813	1/2" 300 LB ANSI RF SST
	822	1/2" 150 LB ANSI
	823	3/4" 300 LB ANSI RI SST
	832	1" 150 LB ANSI RF SST
	833	1" 300 LB ANSI RF SST
	846	1 1/2" SST INDUSTRIAL TRI CLAMP ****
	8BE	DN15 PN40 SST
	XXX	SPECIAL - CONTACT FACTORY *****
		APPROVALS
	0	GENERAL PURPOSE
	2	CSA APPROVED
	3	LCIE APPROVED
		W & M
	0	NONE
	W	CUSTODY TRANSFER (WEIGHTS & MEASURES)
		CABLE
	000	NO CABLE
	101	ASM CBL KIT 10 FT. ***
	102	ASM CBL KIT 20 FT. ***
	103	ASM CBL KIT 30 FT. ***
	105	ASM CBL KIT 50 FT. ***
	110	ASM CBL KIT 100 FT. ***
		ELECTRONICS
	0	NO ELECTRONICS
	D	FOR USE WITH DATAMATE
	N	FOR USE WITH NEXGEN

- * Note: Wetted materials and connection materials must be the same.
- ** Note: Only available as 1" female CAJON VCO connections. Requires male CAJON VCO -16- VCO by SWAGELOCK®.
- *** Note: For a complete list of available cables, contact ~~ask~~ 1".
- **** Note: The 1 1/2" Industrial and 2" 3 A tri-clamp connections are available with 316L SS wetted materials only.
- ***** Note: The special 2" mating flanges to the MT truck accessories are no charge (N/C).

1" \dot{m} ® Mass Flow Meter

Config Options - Must Select One Option Per Category		
M100	X	Description
		TYPE
	2	TRANSDUCER 1" HASTELLOY (R) C-22 *
	8	TRANSDUCER 1" SST *
	S	TRANSDUCER 1" SST SANITARY TRI CLAMP *
		FLANGE
	000	2 1/2" 3A SST SANITARY TRI CLAMP****
	252	2" 150 LB ANSI RF HASTELLOY (R) C-22
	253	2" 300 LB ANSI RF HASTELLOY (R) C-22
	832	1" 150 LB ANSI RF SST
	833	1" 300 LB ANSI RF SST
	842	1 1/2" 150 LB ANSI RF SST
	852	2" 150 LB ANSI RF SST
	853	2" 300 LB ANSI RF SST
	856	2" SST INDUSTRIAL TRI CLAMP ****
	8DE	DN25 PN40 SST
	8FE	DN50 PN40 SST
	XXX	SPECIAL - CONTACT FACTORY **
		APPROVALS
	0	GENERAL PURPOSE
	2	CSA APPROVED
	3	LCIE APPROVED
		W & M
	0	NONE
	W	CUSTODY TRANSFER (WEIGHTS & MEASURES)
		CABLE
	000	NO CABLE
	101	ASM CBL KIT 10 FT. ***
	102	ASM CBL KIT 20 FT. ***
	103	ASM CBL KIT 30 FT. ***
	105	ASM CBL KIT 50 FT. ***
	110	ASM CBL KIT 100 FT. ***
		ELECTRONICS
	0	NO ELECTRONICS
	D	FOR USE WITH DATAMATE
	N	FOR USE WITH NEXGEN

- * Note: Wetted materials and connection materials must be the same.
- ** Note: The special 2" mating flanges to the MT truck accessories are no charge (N/C).
- *** Note: For a complete list of available cables, contact ~~ask~~ 1".
- **** Note: The 2" industrial and 2 1/2" 3a tri-clamp connections are available with 316L SS wetted materials only.

**Table 12. m[®] Mass Meter with Datamate 2100™ Model Numbers (cont.)
2" m[®] Mass Flow Meter***

Config Options - Must Select One Option Per Category		
M200	X	Description
		TYPE
2		TRANSDUCER 2" HASTELLOY (R) C-22 *
8		TRANSDUCER 2" SST *
S		TRANSDUCER 2" SST SANITARY TRI CLAMP *
		FLANGE
000		4" 3A SST SANITARY TRI CLAMP ****
252		2" 150 LB ANSI RF HASTELLOY (R) C-22
272		4" 150 LB ANSI RF HASTELLOY (R) C-22
273		4" 300 LB ANSI RF HASTELLOY (R) C-22
852		2" 150 LB ANSI RF SST
853		2" 300 LB ANSI RF SST
862		3" 150 LB ANSI RF SST
863		3" 300 LB ANSI RF SST
866		3" SST INDUSTRIAL TRI CLAMP ****
872		4" 150 LB ANSI RF SST
873		4" 300 LB ANSI RF SST
8FE		DN50 PN 40 SST
8GE		DN80 PN 40 SST
XXX		SPECIAL - CONTACT FACTORY **
		APPROVALS
0		GENERAL PURPOSE
2		CSA APPROVED
3		LCIE APPROVED
		W & M
0		NONE
W		CUSTODY TRANSFER (WEIGHTS & MEASURES)
		CABLE
000		NO CABLE
101		ASM CBL KIT 10 FT. ***
102		ASM CBL KIT 20 FT. ***
103		ASM CBL KIT 30 FT. ***
105		ASM CBL KIT 50 FT. ***
110		ASM CBL KIT 100 FT. ***
		ELECTRONICS
0		NO ELECTRONICS
D		FOR USE WITH DATAMATE
N		FOR USE WITH NEXGEN

* Note: Wetted materials and connection materials must be the same.
 ** Note: The special 2" mating flanges to the MT truck accessories are no charge (N/C).
 *** Note: For a complete list of available cables, contact ~~884~~ 1.
 **** Note: The 3" or 4" industrial and 4" 3A tri-clamp connections are available in 316L SS wetted materials only.

3" m[®] Mass Flow Meter*

Config Options - Must Select One Option Per Category		
M300	X	Description
		TYPE
8		TRANSDUCER 3" SST
		FLANGE
862		3" 150 LB ANSI RF
863		3" 300 LB ANSI RF
872		4" 150 LB ANSI RF
873		4" 300 LB ANSI RF
882		6" 150 LB ANSI RF
887		6" 900 LB ANSI RF
8GE		DN80 PN40 SST
8HE		DN100 PN40 SST
XXX		SPECIAL - CONTACT FACTORY *****
		APPROVALS
0		GENERAL PURPOSE
2		CSA APPROVED
3		LCIE APPROVED
		W & M
0		NONE
W		CUSTODY TRANSFER (WEIGHTS & MEASURES)
		CABLE
000		NO CABLE
101		ASM CBL KIT 10 FT. ***
102		ASM CBL KIT 20 FT. ***
103		ASM CBL KIT 30 FT. ***
105		ASM CBL KIT 50 FT. ***
110		ASM CBL KIT 100 FT. ***
		ELECTRONICS
0		NO ELECTRONICS
D		FOR USE WITH DATAMATE
N		FOR USE WITH NEXGEN

*** Note: For a complete list of available cables, contact ~~884~~ 1.

Table 12. \dot{m} ® Mass Meter with Datamate 2100™ Model Numbers (cont.)

4" \dot{m} ® Mass Flow Meter*

Config Options - Must Select One Option Per Category						
M400	X	X	X	X	X	Description
TYPE						
8						TRANSDUCER 4" SST 150/300 LB *
9						TRANSDUCER 4" SST 600/900 LB *
FLANGE						
872						4" 150 LB ANSI RF
882						6" 150 LB ANSI RF
892						8" 150 LB ANSI RF
893						8" 300 LB ANSI RF
897						8" 900 LB ANSI RF
8HE						DN100 PN40 SST
8IE						DN150 PN40 SST
XXX						SPECIAL - CONTACT FACTORY *****
APPROVALS						
0						GENERAL PURPOSE
2						CSA APPROVED
3						LCIE APPROVED
W & M						
0						NONE
W						CUSTODY TRANSFER (WEIGHTS & MEASURES)
CABLE						
000						NO CABLE
101						ASM CBL KIT 10 FT. ***
102						ASM CBL KIT 20 FT. ***
103						ASM CBL KIT 30 FT. ***
105						ASM CBL KIT 50 FT. ***
110						ASM CBL KIT 100 FT. ***
ELECTRONICS						
0						NO ELECTRONICS
D						FOR USE WITH DATAMATE - SEE PAGE 13
N						FOR USE WITH NEXGEN - SEE PAGE 11

*** Note: For a complete list of available cables, contact factory.

Table 12. \dot{m} ® Mass Meter with Datamate 2100™ Model Numbers (cont.)

DM2100		X	X	X	X	X	Config Options - Must Select One Option Per Category	Description
SOFTWARE								
2							HASTELLOY (R) C-22 (M012 - M200)	
4							W & M HASTELLOY (R) C-22 (M012 - M200)	
8							316 L STAINLESS STEEL (M012 - M200)	
9							316 L STAINLESS STEEL (M300 - M400)	
A							W & M 316L STAINLESS STEEL (M012 - M200)	
B							W & M 316L STAINLESS STEEL (M300 - M400)	
APPROVALS								
0							GENERAL PURPOSE	
2							CSA APPROVED, INTRINSICALLY SAFE	
3							LCIE APPROVED, INTRINSICALLY SAFE	
ANALOG-BRD								
0							NO ANALOG OUTPUTS	
1							ONE OUTPUT *	
2							TWO OUTPUTS *	
3							THREE OUTPUTS *	
4							FOUR OUTPUTS *	
PULSE-BRD								
0							NO PULSE OUTPUTS	
1							ONE OUTPUT *	
2							TWO OUTPUTS *	
3							THREE OUTPUTS *	
4							FOUR OUTPUTS *	
TOTAL-BRD								
0							NO TOTAL OUTPUTS	
1							ONE OUTPUT **	
2							TWO OUTPUTS **	
3							THREE OUTPUTS **	
4							FOUR OUTPUTS **	

* Note: Maximum total of four (4) outputs in a Datamate 2100 (i.e., DM2100-81230 is not possible). If selected, the Datamate Printer Card (p. 12) occupies one of the output locations.

** Note: For W&M applications requiring a pulse output, order the proper number of totalizer pulse outputs.

VI.4 PERFORMANCE SPECIFICATIONS

m012-1/8" \dot{m} ® MASS FLOW METER with Datamate 2100™

METERING ELEMENT	
Connections:	
Connection type	Swagelok® CAJON VCO®: 3/8" female ANSI: 1/2"; 150#, 300#RF Flange 3A-Authorized: 1-1/2" Tri-Clamp®
Tube material	316L SST or HASTELLOY® C-22 optional
Tube shape	Twin Omega tubes
Nominal element bore	3 mm (1/8")
Minimum tube ID	2.95 mm (0.116")
Housing	304L SST
Hazardous area classification (option)	Transducer is intrinsically safe when connected to an approved mass flow computer. See Table 1 (page 3) for ratings.
Mass accuracy	±0.15% of rate ±zero stability ¹
Mass repeatability	±0.10% of rate
Mass zero stability	±0.0012 kg/min (±0.0027 lb/min)
Turndown ratio	100:1
Density range	0.4 to 2.0 gm/cc
Density accuracy	±0.005 gm/cc
Density repeatability	±0.0005 gm/cc
Temperature measurement	100 ohm platinum resistance sensor
Temperature accuracy	±0.56°C (±1°F)
Signal output	8-conductor cable, 4 shielded twisted-pairs
Weight	4.6 kg (10 lb)
Fluid:	
Flow rate	0.09 to 9.0 kg/min (0.2 to 20 lb/min)
Max. temperature	204°C (400°F)
Min. temperature	-45°C (-50°F)
Max. operating pressure	137 bar (2,000 psi); limited by flange/connection rating
ASSOCIATED INSTRUMENT	
Max. length of signal cable	150m (500 ft) Belden 89892, 8 conductor, 4 shielded twisted pairs
Electrical connections	Screw terminal
Manufacturer	ÜÜT
Meter model number	m012-XXXXX (refer to Ordering Information)
Instrument model number	Refer to Table 12
1 Calibrations are traceable to N.I.S.T.	

ÜÜT pursues a policy of continuous development and product improvement. The specifications above may therefore be changed without notice.

m025-1/4" m³ MASS FLOW METER with Datamate 2100™

METERING ELEMENT	
Connections: Connection type	Swagelok® CAJON VCO®: 3/8" female ANSI: 1/2"; 150#, 300#, 600# RF Flange DIN: DN15; PN40, PN100 3A-Authorized: 1-1/2" Tri-Clamp® Industrial Tri-Clamp®: 1-1/2"
Tube material Tube shape Nominal element bore Minimum tube ID Housing Hazardous area classification (option) Mass accuracy Mass repeatability Mass zero stability Turndown ratio Density range Density accuracy Density repeatability Temperature measurement Temperature accuracy Signal output Weight	316L SST or HASTELLOY® C-22 optional Twin Omega tubes 6.4 mm (1/4") 6.50 mm (0.256") 304L SST Transducer is intrinsically safe when connected to an approved mass flow computer. See Table 1 (page 3) for ratings. ±0.15% of rate ±zero stability ¹ ±0.10% of rate ±0.0064 kg/min (±0.014 lb/min) 100:1 0.4 to 2.0 gm/cc ±0.002 gm/cc ±0.0005 gm/cc 100 ohm platinum resistance sensor ±0.56°C (±1°F) 8-conductor cable, 4 shielded twisted-pairs 6.8 kg (15 lb)
Fluid: Flow rate Max. temperature Min. temperature Max. operating pressure	0.36 to 36.0 kg/min (0.8 to 80 lb/min) 204°C (400°F) -45°C (-50°F) 250 bar (3,600 psi); limited by flange/connection rating
ASSOCIATED INSTRUMENT	
Max. length of signal cable Electrical connections Manufacturer Meter model number Instrument model number	150m (500 ft) Belden 89892, 8 conductor, 4 shielded twisted pairs Screw terminal ÜÜT m025-XXXXX (refer to Ordering Information) Refer to Table 12
2 Calibrations are traceable to N.I.S.T.	

ÜÜT pursues a policy of continuous development and product improvement. The specifications above may therefore be changed without notice.

m050-1/2" \dot{m} ® MASS FLOW METER with Datamate 2100™

METERING ELEMENT	
Connections:	
Connection type	Swagelok® CAJON VCO®: 1" female ANSI: 1/2", 3/4", 1"; 150#, 300#, 600# RF Flange DIN: DN15, DN25; PN40, PN100 3A-Authorized: 2" Tri-Clamp® Industrial Tri-Clamp®: 1-1/2"
Tube material	316L SST or HASTELLOY® C-22 optional
Tube shape	Twin Omega tubes
Nominal element bore	12.7 mm (1/2")
Minimum tube ID	11.9 mm (0.470")
Housing	304L SST
Hazardous area classification (option)	Transducer is intrinsically safe when connected to an approved mass flow computer. See Table 1 (page 3) for ratings.
Mass accuracy	±0.15% of rate ±zero stability ¹
Mass repeatability	±0.10% of rate
Mass zero stability	±0.0168 kg/min (±0.037 lb/min)
Turndown ratio	100:1
Density range	0.4 to 2.0 gm/cc
Density accuracy	±0.002 gm/cc
Density repeatability	±0.0005 gm/cc
Temperature measurement	100 ohm platinum resistance sensor
Temperature accuracy	±0.56°C (±1°F)
Signal output	8-conductor cable, 4 shielded twisted-pairs
Weight	11.3 kg (25 lb)
Fluid:	
Flow rate	1.36 to 136 kg/min (3 to 300 lb/min)
Max. temperature	204°C (400°F)
Min. temperature	-45°C (-50°F)
Max. operating pressure	250 bar (3,600 psi); limited by flange/connection rating
ASSOCIATED INSTRUMENT	
Max. length of signal cable	150m (500 ft) Belden 89892, 8 conductor, 4 shielded twisted pairs
Electrical connections	Screw terminal
Manufacturer	ÜÜT
Meter model number	m050-XXXXX (refer to Ordering Information)
Instrument model number	Refer to Table 12
1 Calibrations are traceable to N.I.S.T.	

ÜÜT pursues a policy of continuous development and product improvement. The specifications above may therefore be changed without notice.

m100-1" m[®] MASS FLOW METER with Datamate 2100™

METERING ELEMENT	
Connections:	
Connection type	ANSI: 1", 1-1/2", 2"; 150#, 300#, 600# RF Flange DIN: DN25, DN50; PN40, PN100 3A-Authorized: 2-1/2" Tri-Clamp [®] Industrial Tri-Clamp [®] : 2"
Tube material	316L SST or HASTELLOY [®] C-22 optional
Tube shape	Twin Omega tubes
Nominal element bore	25.4 mm (1.0")
Minimum tube ID	18.9 mm (0.745")
Housing	304L SST
Hazardous area classification (option)	Transducer is intrinsically safe when connected to an approved mass flow computer. See Table 1 (page 3) for ratings.
Mass accuracy	±0.15% of rate ±zero stability ¹
Mass repeatability	±0.10% of rate
Mass zero stability	±0.0612 kg/min (±0.135 lb/min)
Turndown ratio	100:1
Density range	0.4 to 2.0 gm/cc
Density accuracy	±0.001 gm/cc
Density repeatability	±0.0005 gm/cc
Temperature measurement	100 ohm platinum resistance sensor
Temperature accuracy	±0.56°C (±1°F)
Signal output	8-conductor cable, 4 shielded twisted-pairs
Weight	26.4 kg (58 lb)
Fluid:	
Flow rate	5.0 to 500 kg/min (11 to 1,100 lb/min)
Max. temperature	204°C (400°F)
Min. temperature	-45°C (-50°F)
Max. operating pressure	83 bar (1,200 psi); limited by flange/connection rating
ASSOCIATED INSTRUMENT	
Max. length of signal cable	150m (500 ft) Belden 89892, 8 conductor, 4 shielded twisted pairs
Electrical connections	Screw terminal
Manufacturer	ÜÜT s
Meter model number	m100-XXXXX (refer to Ordering Information)
Instrument model number	Refer to Table 12
Calibrations are traceable to N.I.S.T.	

ÜÜT s pursues a policy of continuous development and product improvement. The specifications above may therefore be changed without notice.

m200-2" \dot{m} ® MASS FLOW METER with Datamate 2100™

METERING ELEMENT	
Connections: Connection type	ANSI: 2", 3", 4"; 150#, 300#, 600# RF DIN: DN50, DN80, DN100; PN40, PN100 3A-Authorized: 4" Tri-Clamp® Industrial Tri-Clamp®: 3", 4"
Tube material Tube shape Nominal element bore Minimum tube ID Housing Hazardous area classification (option) Mass accuracy Mass repeatability Mass zero stability Turndown ratio Density range Density accuracy Density repeatability Temperature measurement Temperature accuracy Signal output Weight	316L SST or HASTELLOY® C-22 optional Twin Omega tubes 51 mm (2.0") 33.3 mm (1.31") 304L SST Transducer is intrinsically safe when connected to an approved mass flow computer. See Table 1 (page 3) for ratings. ±0.15% of rate ±zero stability ¹ ±0.10% of rate ±0.1901 kg/min (±0.419 lb/min) 100:1 0.4 to 2.0 gm/cc ±0.001 gm/cc ±0.0005 gm/cc 100 ohm platinum resistance sensor ±0.56°C (±1°F) 8-conductor cable, 4 shielded twisted-pairs 58.9 kg (130 lb)
Fluid: Flow rate Max. temperature Min. temperature Max. operating pressure	14.5 to 1,450 kg/min (32 to 3,200 lb/min) 204°C (400°F) -45°C (-50°F) 68 bar (1,000 psi); limited by flange/connection rating
ASSOCIATED INSTRUMENT	
Max. length of signal cable Electrical connections Manufacturer Meter model number Instrument model number	150m (500 ft) Belden 89892, 8 conductor, 4 shielded twisted pairs Screw terminal ÜÜT m200-XXXXX (refer to Ordering Information) Refer to Table 12
1 Calibrations are traceable to N.I.S.T.	

ÜÜT pursues a policy of continuous development and product improvement. The specifications above may therefore be changed without notice.

m300-3" m³® MASS FLOW METER with Datamate 2100™

METERING ELEMENT	
Connections:	
Connection type	ANSI: 3", 4", 6"; 150#, 300#, 600#, 900# RF DIN: DN80, DN100, DN150; PN40, PN100
Tube material	316L SST
Tube shape	Twin Omega tubes
Nominal element bore	76.2 mm (3.0")
Minimum tube ID	57.4 mm (2.26")
Housing	304L SST
Hazardous area classification (option)	Transducer is intrinsically safe when connected to an approved mass flow computer. See Table 1 (page 3) for ratings.
Mass accuracy ¹	±0.15% of rate ±zero stability
Mass repeatability	±0.05% of rate
Mass zero stability	± .453 kg/m (±1.0 lb/m)
Turndown ratio	100:1
Density range	0.4 to 2.0 gm/cc
Density accuracy	±0.001 gm/cc
Density repeatability	±0.0002 gm/cc
Temperature measurement	100 ohm platinum resistance sensor
Temperature accuracy	±0.56°C (±1°F)
Signal output	8-conductor cable, 4 shielded twisted-pairs
Weight	95 kg (210 lb)
Fluid:	
Flow rate	45.4 to 4,536 kg/min (90 to 9,000 lb/min)
Max. temperature	204°C (400°F)
Min. temperature	-45°C (-50°F)
Max. operating pressure	103 bar (1,500 psi); limited by flange/connection rating
ASSOCIATED INSTRUMENT	
Max. length of signal cable	150m (500 ft) Belden 89892, 8 conductor, 4 shielded twisted pairs
Electrical connections	Screw terminal
Manufacturer	ÜÜT
Meter model number	m300-XXXXX (refer to Ordering Information)
Instrument model number	Refer to Table 12
1 Calibrations are traceable to N.I.S.T.	

ÜÜT pursues a policy of continuous development and product improvement. The specifications above may therefore be changed without notice.

m400-4" \dot{m} ® MASS FLOW METER with Datamate 2100™

METERING ELEMENT	
Connections:	
Connection type	ANSI: 4", 6", 8"; 150#, 300#, 600#, 900# RF
Tube material	DIN: DN100, DN150, DN200; PN40, PN100 316L SST or HASTELLOY® C-22 optional
Tube shape	Twin Omega tubes
Nominal element bore	102 mm (4.0")
Minimum tube ID	67.0 mm (2.64")
Housing	304L SST
Hazardous area classification (option)	Transducer is intrinsically safe when connected to an approved mass flow computer. See Table 1 (page 3) for ratings.
Mass accuracy	±0.15% of rate ±zero stability ¹
Mass repeatability	±0.05% of rate
Mass zero stability	±0.9072 kg/min (±2.0 lb/min)
Turndown ratio	100:1
Density range	0.4 to 2.0 gm/cc
Density accuracy	±0.0008 gm/cc
Density repeatability	±0.0002 gm/cc
Temperature measurement	100 ohm platinum resistance sensor
Temperature accuracy	±0.56°C (±1°F)
Signal output	8-conductor cable, 4 shielded twisted-pairs
Weight	163 kg (360 lb)
Fluid:	
Flow rate	68 to 6,800 kg/min (150 to 15,000 lb/min)
Max. temperature	204°C (400°F)
Min. temperature	-45°C (-50°F)
Max. operating pressure	103 bar (1,500 psi); limited by flange/connection rating
ASSOCIATED INSTRUMENT	
Max. length of signal cable	150m (500 ft) Belden 89892, 8 conductor, 4 shielded twisted pairs
Electrical connections	Screw terminal
Manufacturer	ÜÜT
Meter model number	m400-XXXXX (refer to Ordering Information)
Instrument model number	Refer to Table 12
1 Calibrations are traceable to N.I.S.T.	

ÜÜT pursues a policy of continuous development and product improvement. The specifications above may therefore be changed without notice.

Datamate 2100 with \dot{m} ® MASS FLOW METER

Housing Standard Temperature limitations	Fiberglass IP 66, NEMA 4X [5.4 kg (12 lb)]
Housing LCD display Power display	–40 to 65°C (–40 to 150°F) –20 to 65°C (–4 to 150°F) 110/240 VAC, 50–60 Hz 20–40 VA depending on number of analog outputs, batching relays, etc.
Max. length of signal cable between \dot{m} ® transducer and DATAMATE	150m (500 ft) Belden 89892, 8 conductor, 4 shielded twisted-pairs.
Hazardous Area Approvals (Optional)	See Table 1 (page 3) for ratings
Operator interface	Front panel keypad RS-422 serial communications
Configuration (via keypad or RS-4221)	Display format, engineering units, system constants, scaling factors, output ranges, alarm set points, serial communication parameters, batch presets
Function commands	Display, interrogate, run, program, zero, calibrate, reset totals, clear alarms, initiate measurement
Local display Flow range Data retention Fault diagnostics High and low alarms Serial communications	2-line, 20-character alphanumeric, variable contrast LCD: Displays mass and volume flow rate and totals, density, temperature, percent solids and solids flow rate Complements the \dot{m} ® mass flow meter Battery-backed RAM for 10 years in absence of power Error message display and/or alarm outputs Four user-configured, open collector, 50 VDC and 100 mA maximum; programmable for all variables (“Local display,” above), plus batch total and diagnostics RS-422-selectable: baud rate; 1200, 2400, 4800, 9600 parity; odd, even, or none
Optional outputs Up to four user-selected outputs Mass flow rate Mass flow total Density Temperature Percent solids content Volume flow rate Standard volume flow Two-stage batch control	4-20 mA: Isolated, 50 to 800 ohms load Frequency Pulse: Scaled square wave, 0.0025 to 9990 Hz Full Scale Totalizer Pulse: Quadrature 0.0025 to 10,000 Hz full scale g, kg, oz, lb in time units of seconds, minutes or hours g, kg, oz, lb g/cc °C, °F % Liters, US gal, Imp. gal, in time units of seconds, minutes or hours Liters, US gal, Imp. gal, in time units of seconds, minutes or hours Standard: Dual SPST rated 10 A at 40 VDC resistive or 7A at 240 VAC inductive CSA/US I.S.: Dual SPST relays rated 200 mA at 24 VDC resistive or 12.8 mA at 120 VAC resistive NOT APPROVED FOR INDUCTIVE LOADS Remote Start/Stop inputs: Independent momentary contact
Manufacturer Instrument model number	ÜÜT DM2100-XXXX (refer to Order Information, page 47)

Note 1: Disabled V5.1X software Version, if unit is sealed by W&M.

Note 2: Only Batch Total in V5.1X software version, if unit is sealed by W&M.

ÜÜT pursues a policy of continuous development and product improvement. The specifications above may therefore be changed without notice.

VI.5 Physical Lay-Out Diagrams

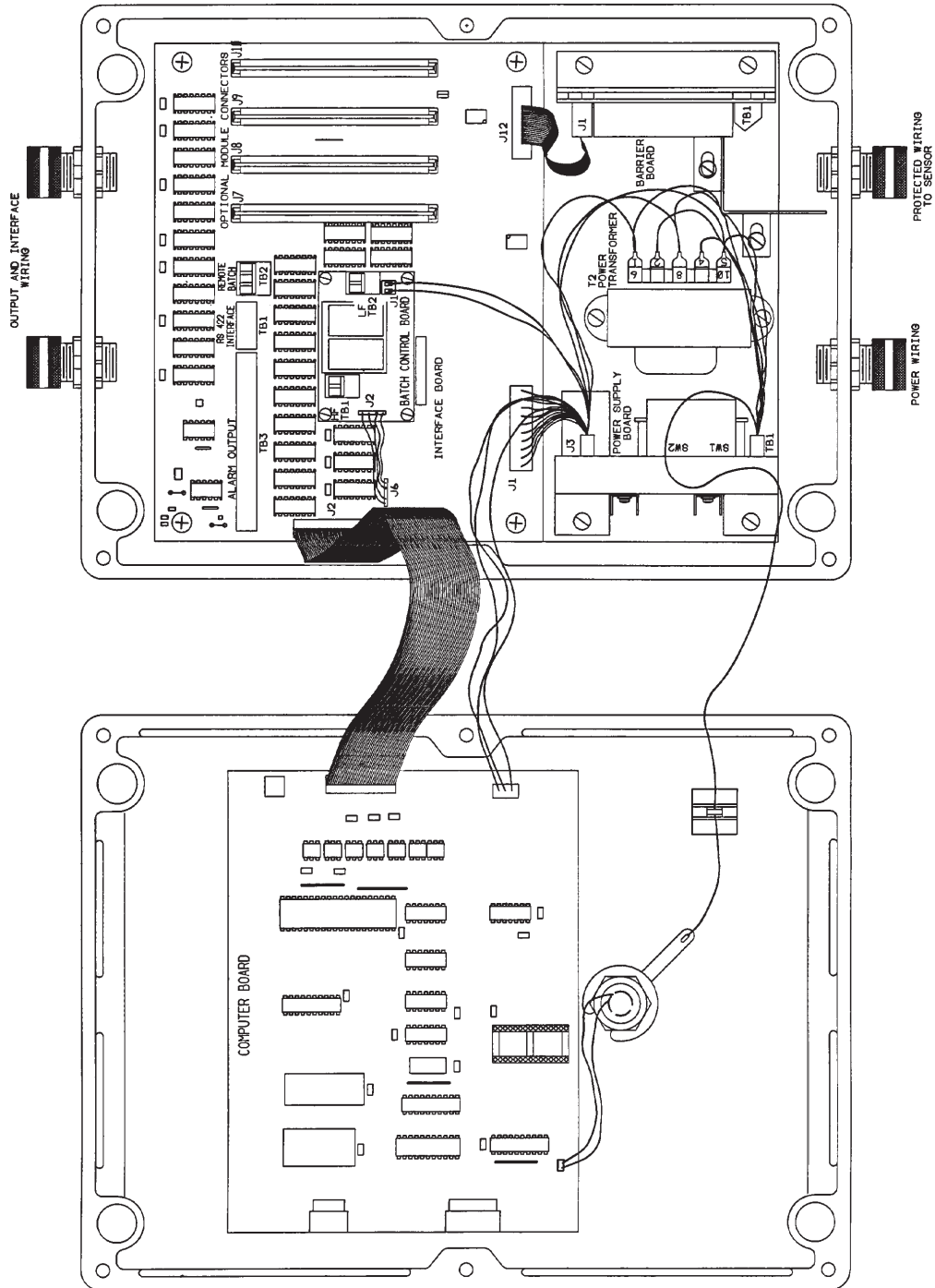


Figure 15
Datamate 2000™ Internal Layout

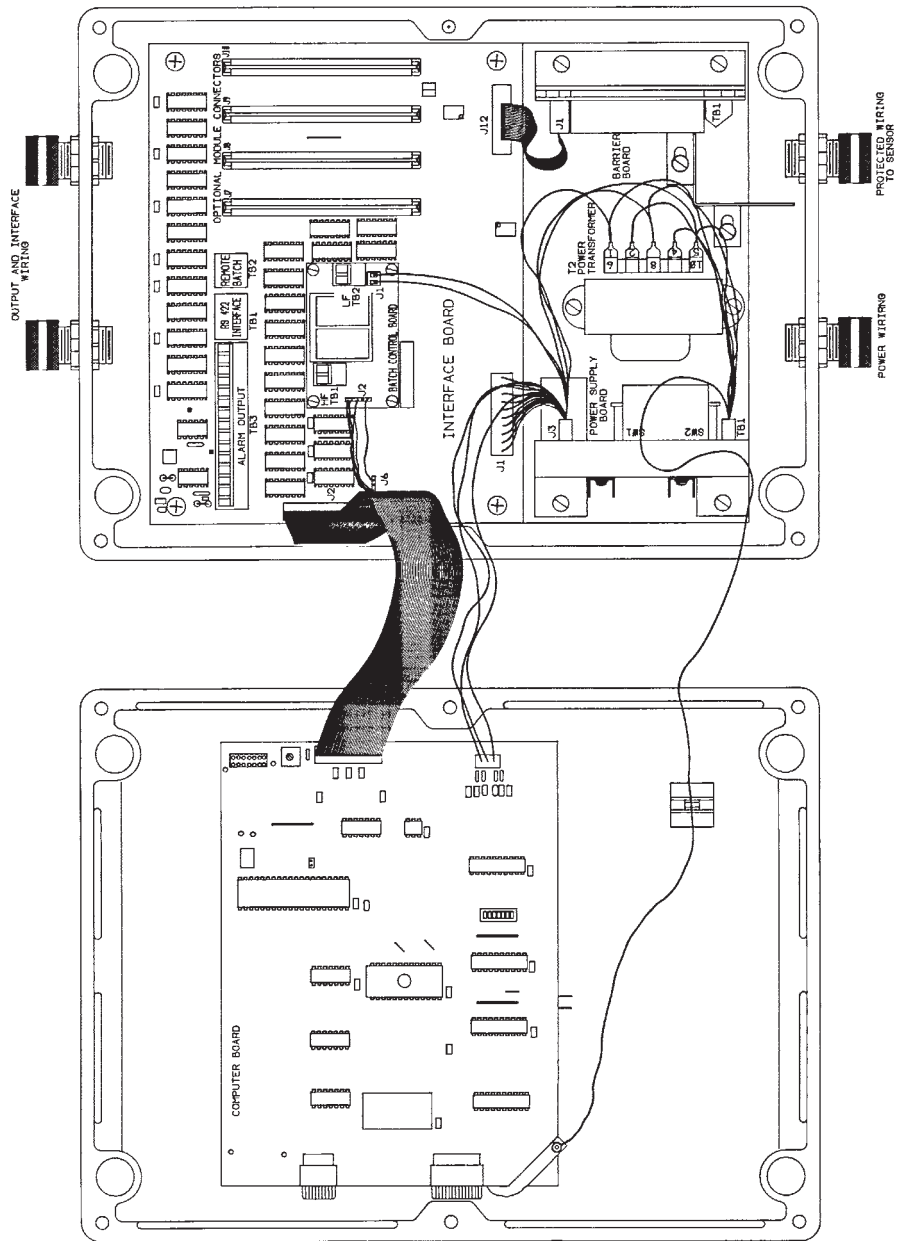


Figure 16
Datamate 2100™ Internal Layout

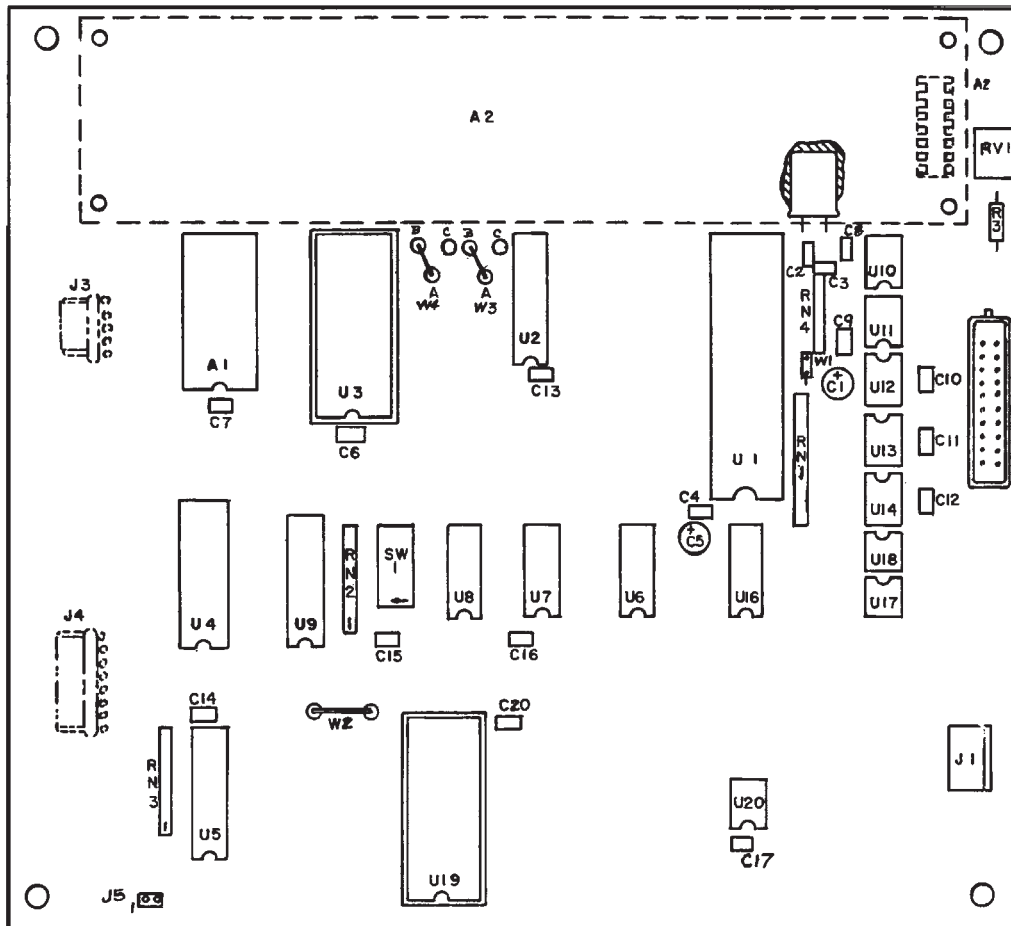


Figure 15
 Datamate 2000™ Computer/LCD Board Layout

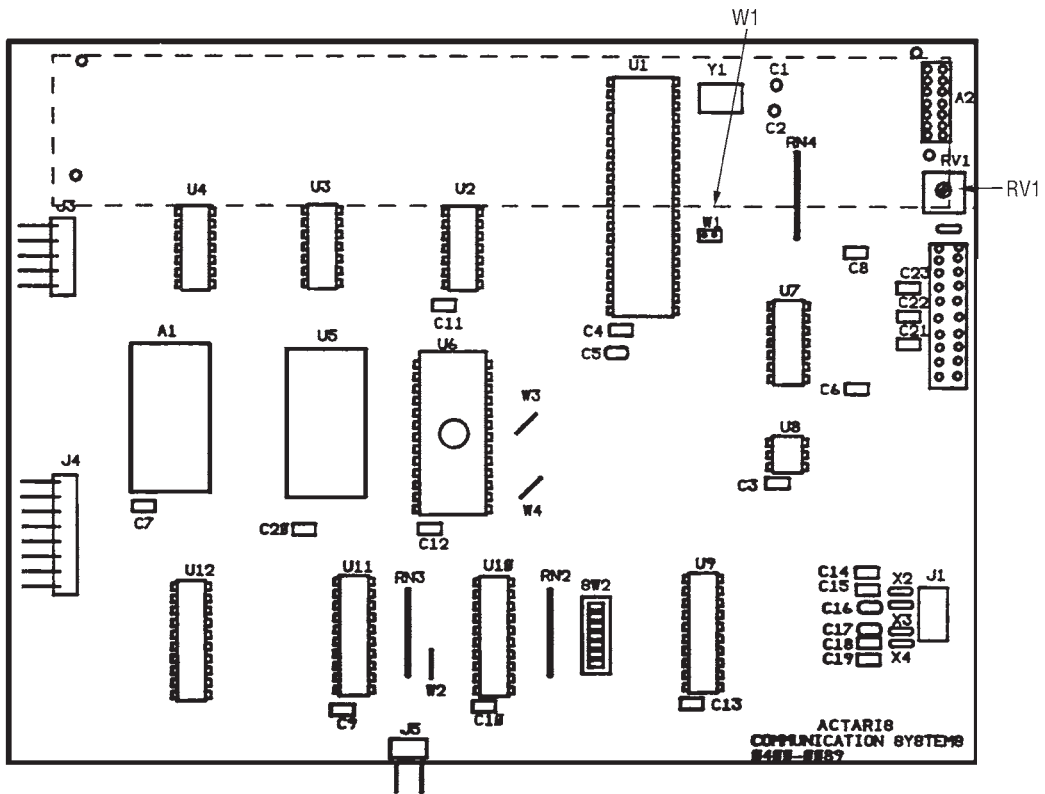
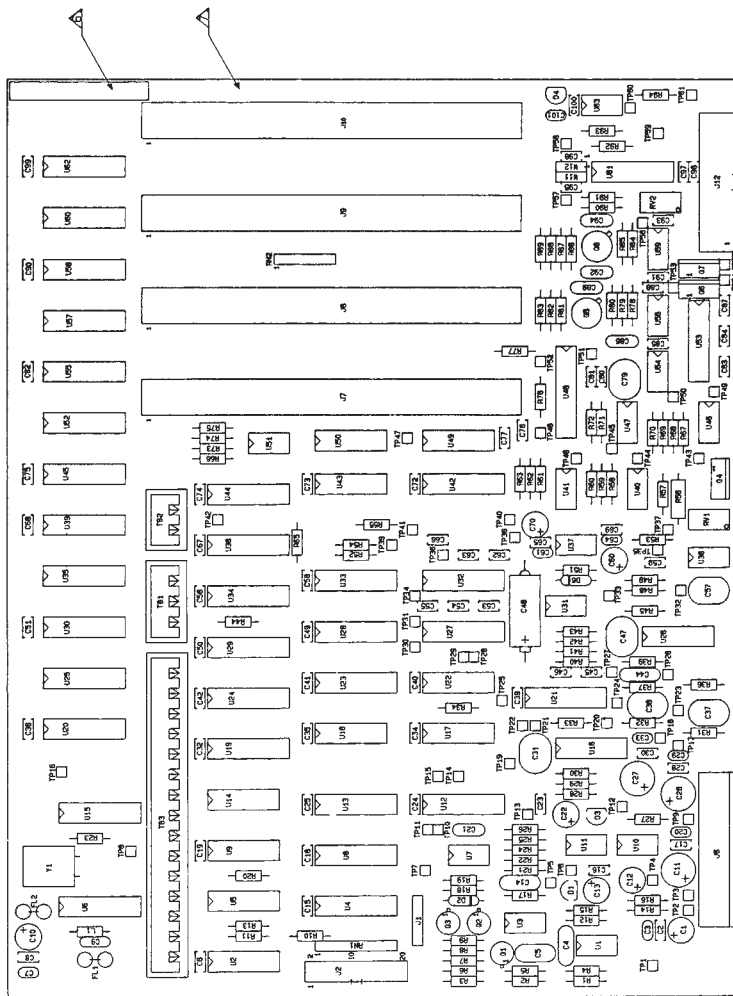


Figure 16
 Datamate 2100™ Computer/LCD Board Layout



- NOTES:
1. PCB ASSEMBLY TO BE CLEAN AND FREE OF EXCESS SOLDER.
 2. BILL OF MATERIALS ON "A" SIZE SHEET (SANG ASSY NO 1).
 3. PERFORM PCB ENGINEER TEST PROCEDURE 40400-0070-11 ON ASSEMBLY.
 4. SEAT ALL UNSPECIFIED COMPONENTS.
 5. ORIENTATE ALL COMPONENTS PER DRAWING.
 6. PCB ASSY DATE CODE TO BE STAMPED AT THIS LOCATION WITH WHITE EPOXY INK.
 7. TRACKING LEVEL TO BE STAMPED AT THIS LOCATION WITH WHITE EPOXY INK.
 8. THESE COMPONENTS MUST BE POSITIONED WITH EPoxy CONNECTORS J7, J8, J9, J10 (ITEM 20).
 9. CUT PIN OF J1 OFF FLUSH WITH CONNECTOR.
 10. FASTEN EDGE CONNECTORS J7, J8, J9 AND (ITEM 20) WITH HARDWARE (ITEM 111).
 11. JUMPPERS (ITEM 311) TO BE PLACED ON PINS 1 AND 2 FOR W11 AND W12.

Figure 17
Datamate 2000™ PLL Interface Board Layout

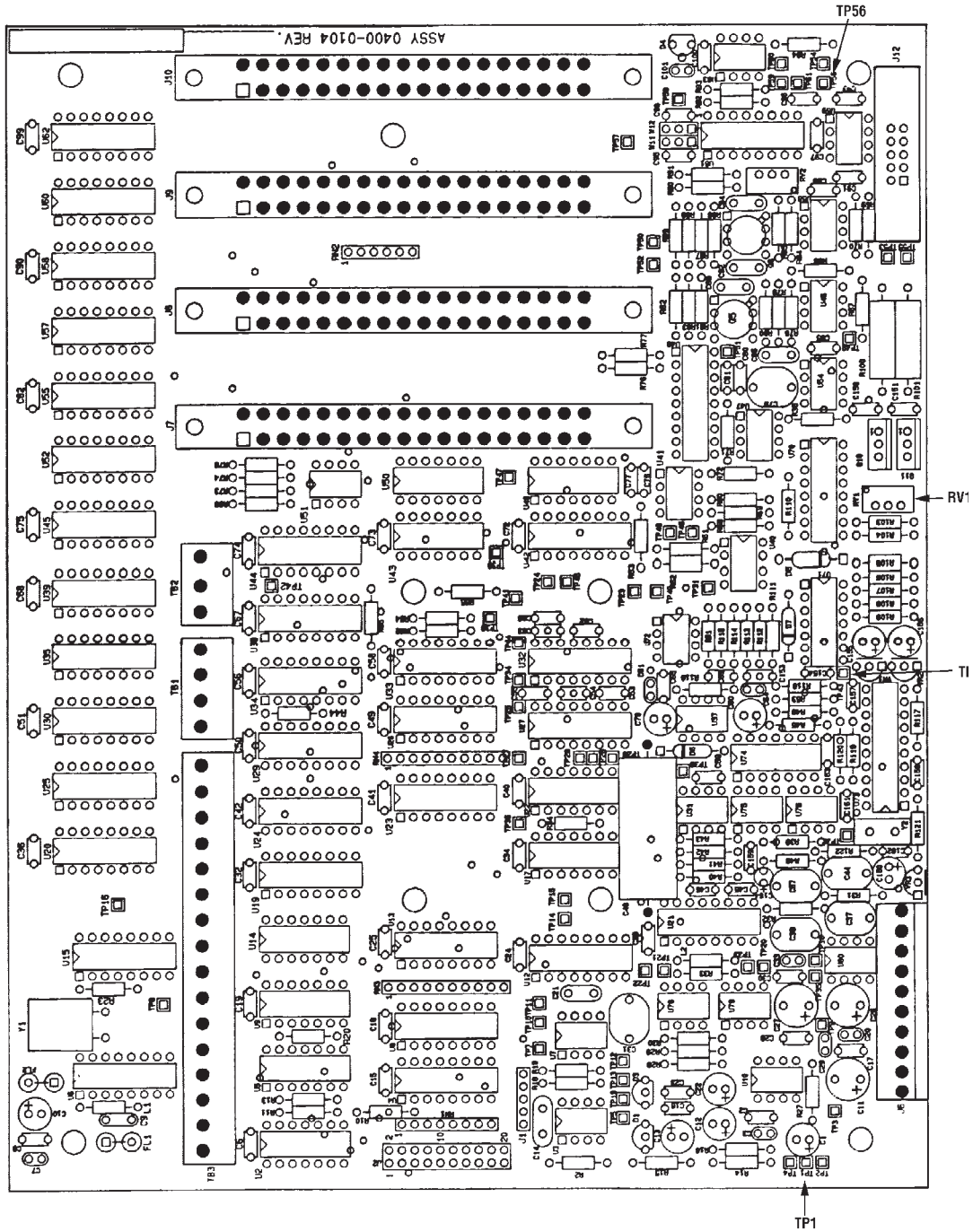


Figure 18
 Datamate 2100™ PLL Interface Board Layout

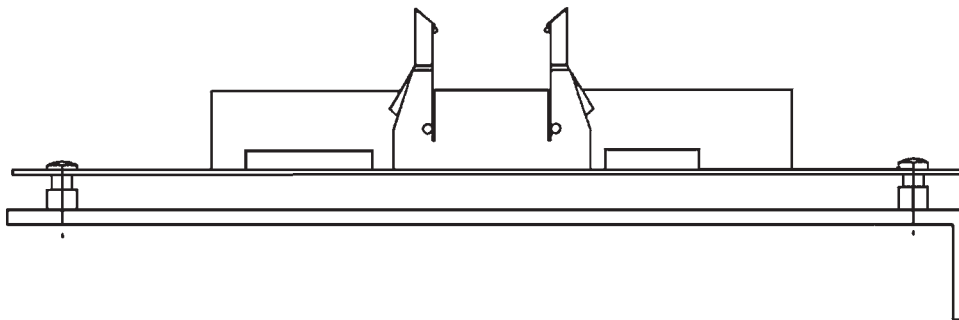
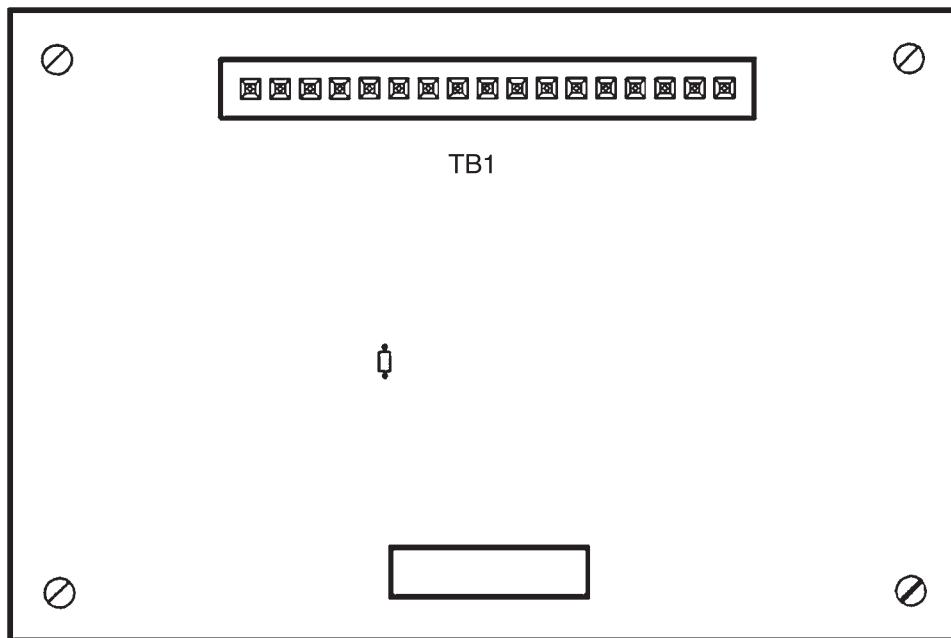


Figure 19
Connector Board

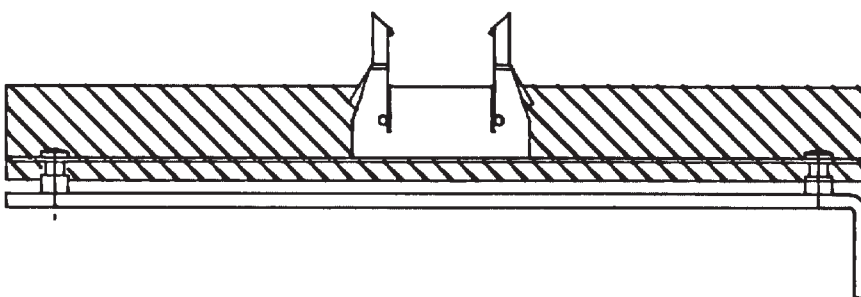
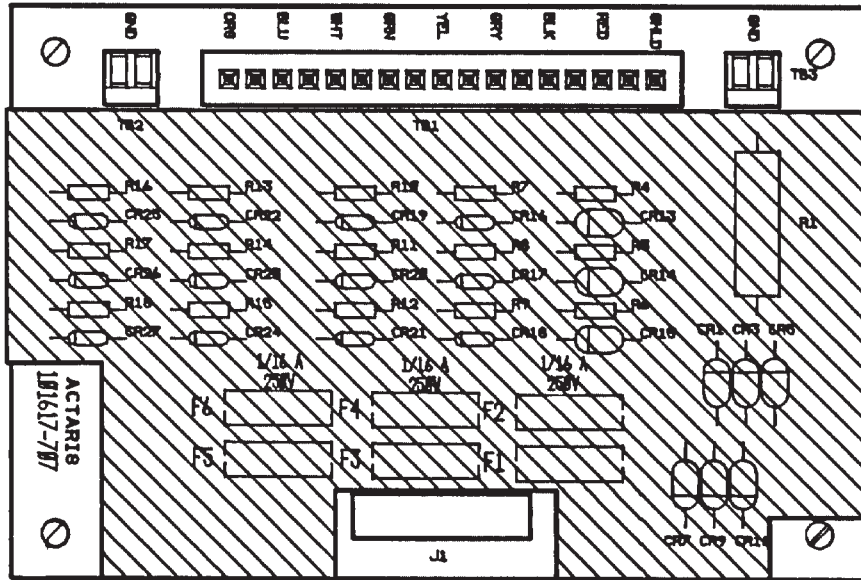
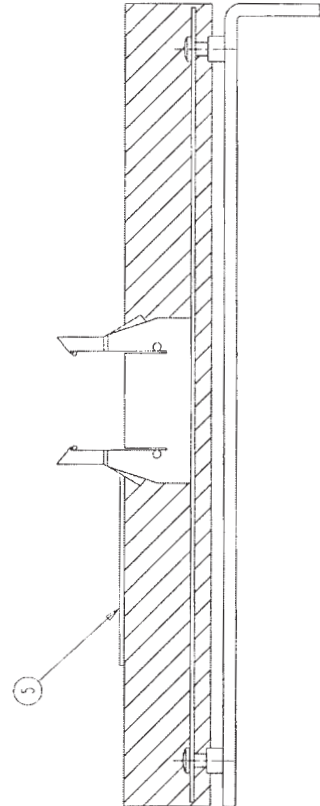
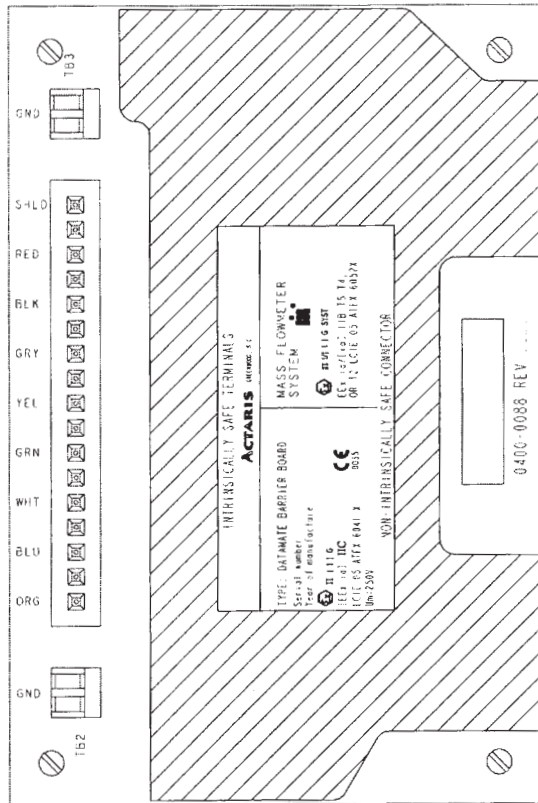


Figure 20
CSA/US I.S. Barrier Board



<p>THE DATA, DRAWINGS, SPECIFICATIONS AND OTHER INFORMATION CONTAINED HEREIN IS CONFIDENTIAL AND PROPRIETARY TO ACTARIS AND SHOULD NOT BE REPRODUCED, DISCLOSED, COPIED, OR USED IN ANY MANNER WITHOUT THE WRITTEN PERMISSION OF ACTARIS.</p> <p>GREENWOOD, SOUTH CAROLINA USA</p> <p>Copyright 1991. All Rights Reserved.</p>	<p>MATERIAL:</p>		<p>UNLESS OTHERWISE SPECIFIED:</p>		<p>DWG. NO. 1-DWG-11-11-91</p>		<p>TITLE</p>		
	<p>HEAT TREAT</p>		<p>PREAR EDGES .005/ .015</p> <p>SURFACE FINISH .007</p>		<p>SHEET 2/2</p>		<p>LCIE I.S. BARRIER BOARD</p>		
<p>FINISH SPECIFICATION</p>		<p>ALLOWABLE TOLERANCES</p>		<p>SCALE</p>		<p>NO.</p>		<p>ACTARIS</p>	
<p>DO NOT SCALE DRAWING</p>		<p>FRACTIONS DECIMALS ANGLES</p> <p>±.125 2 PL. 01 1"</p> <p>±.156 3 PL. 005 1"</p>		<p>3-161617-101</p>		<p>GREENWOOD, SOUTH CAROLINA</p>		<p>ACTARIS</p>	

Figure 21
LCIE I.S. Barrier Board

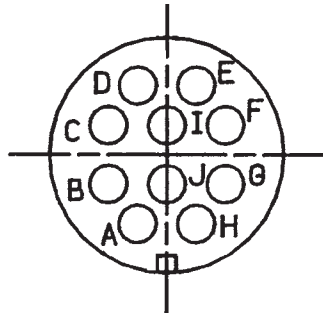
Table 10. Allowable Resistances in Ohms
 (Configuration or Datamate 2100™ Transducer Configuration
 when test with or without transducer cable)

Pin Pairs	Transducer Size (ins.)						
	1/8	1/4	1/2	1	2	3	4
C - D	72 - 88	80 - 96	74 - 90	46 - 55	46 - 55	33 - 39	33 - 39
E - A	128 - 144	80 - 96	10 - 12	10 - 12	10 - 12	78 - 94	80 - 96
E - H	128 - 144	80 - 96	10 - 12	10 - 12	10 - 12	78 - 94	80 - 96
B - G	RTD - 108 ohms @ 75°F for all transducer sizes						
J - case	Less than 1.0 ohm all sizes						
Any other - Case	Over 100 Mohms for all transducer sizes						

Connector Board Cable Connection Table

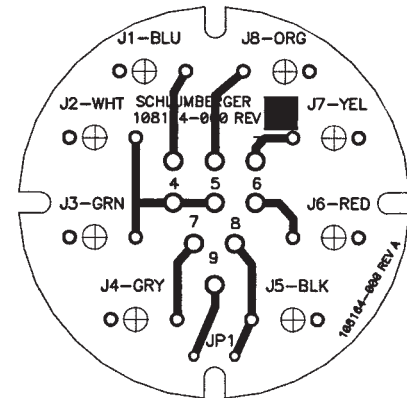
Terminal Block	Pin Number	Label	Conductor Color	Transducer Connector Pin	m300 Old Terminal Connection	Function
TB1	1	SHLD	Bare	None		Ground
TB1	2		No Connect			Ground
TB1	3	RED	Red	C	J6	Tube Drive
TB1	4		No Connect.			Ground
TB1	5	BLK	Black	D	J5	Drive Return
TB1	6		No Connect.			Ground
TB1	7	GRY	Gray	F	J4	RTD Excite +
TB1	8		No Connect.			Ground
TB1	9	YEL	Yellow	G	J7	RTD Sense +
TB1	10		No Connect.			Ground
TB1	11	GRN	Green	B	J3	RTD Sense -
TB1	12		No Connect.			Ground
TB1	13	WHT	White	E	J2	RTD Excite -/ Sensor Common
TB1	14		No Connect.			Ground
TB1	15	BLU	Blue	A	J1	Sensor A
TB1	16		No Connect.			Ground
TB1	17	ORG	Orange	H	J8	Sensor B

Figure 24
 Transducer Receptacle
 and Plug Pin Designations



- A - BLUE
- B - GREEN
- C - RED
- D - BLACK
- E - WHITE
- F - GRAY
- G - YELLOW
- H - ORANGE
- I - OPEN
- J - OPEN

Figure 24.5
 M300 Transducer
 Old Connection Designations



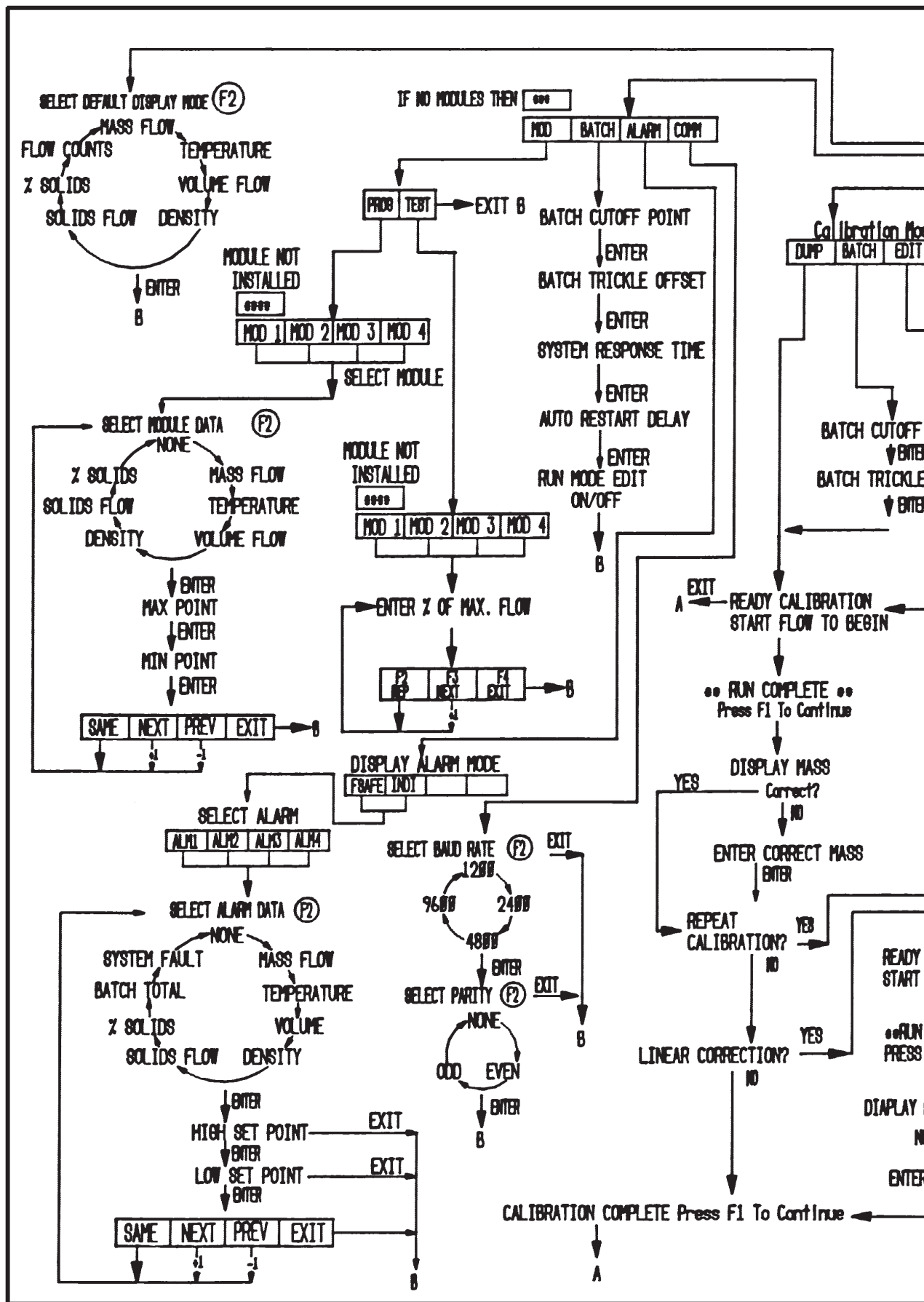
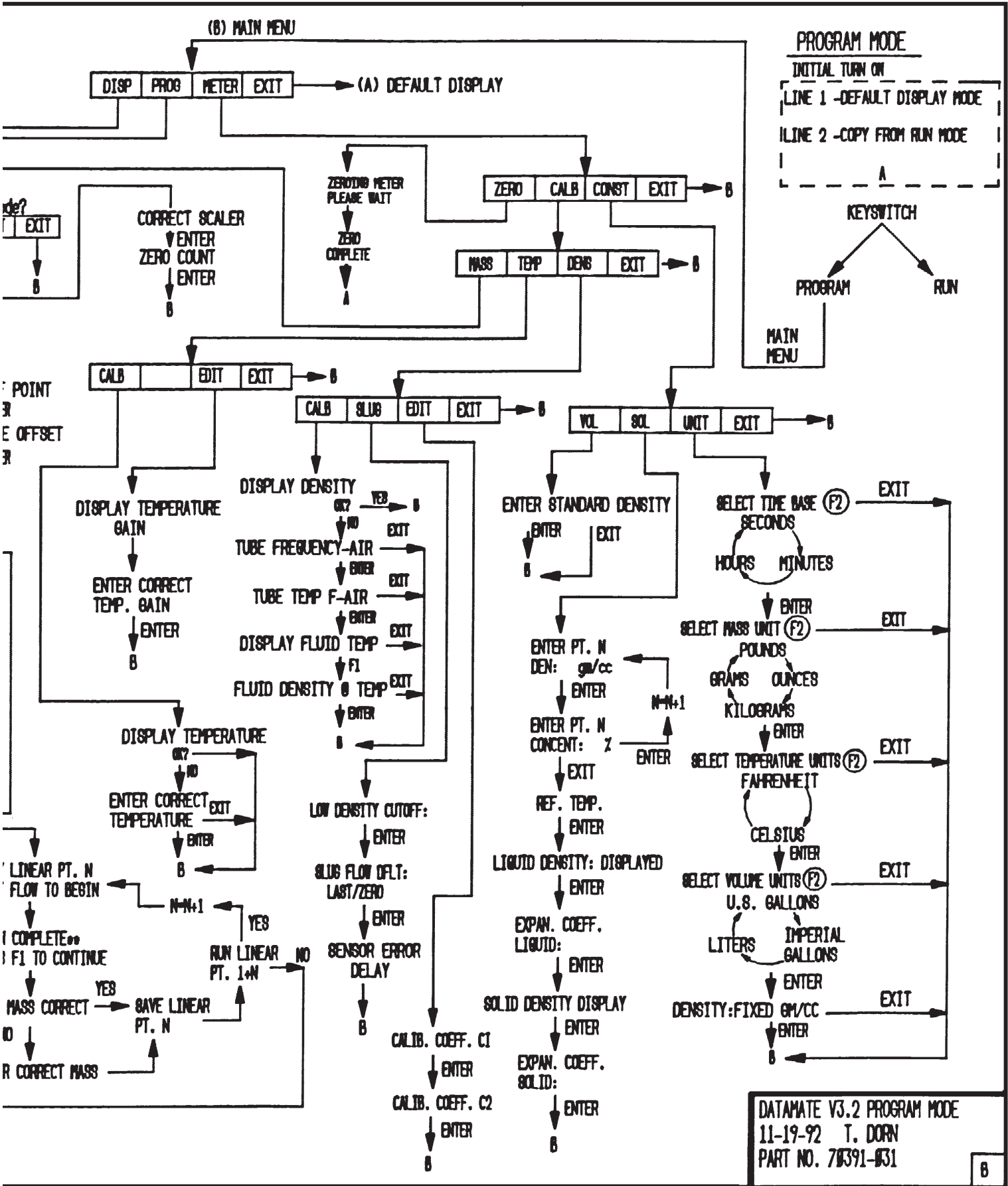


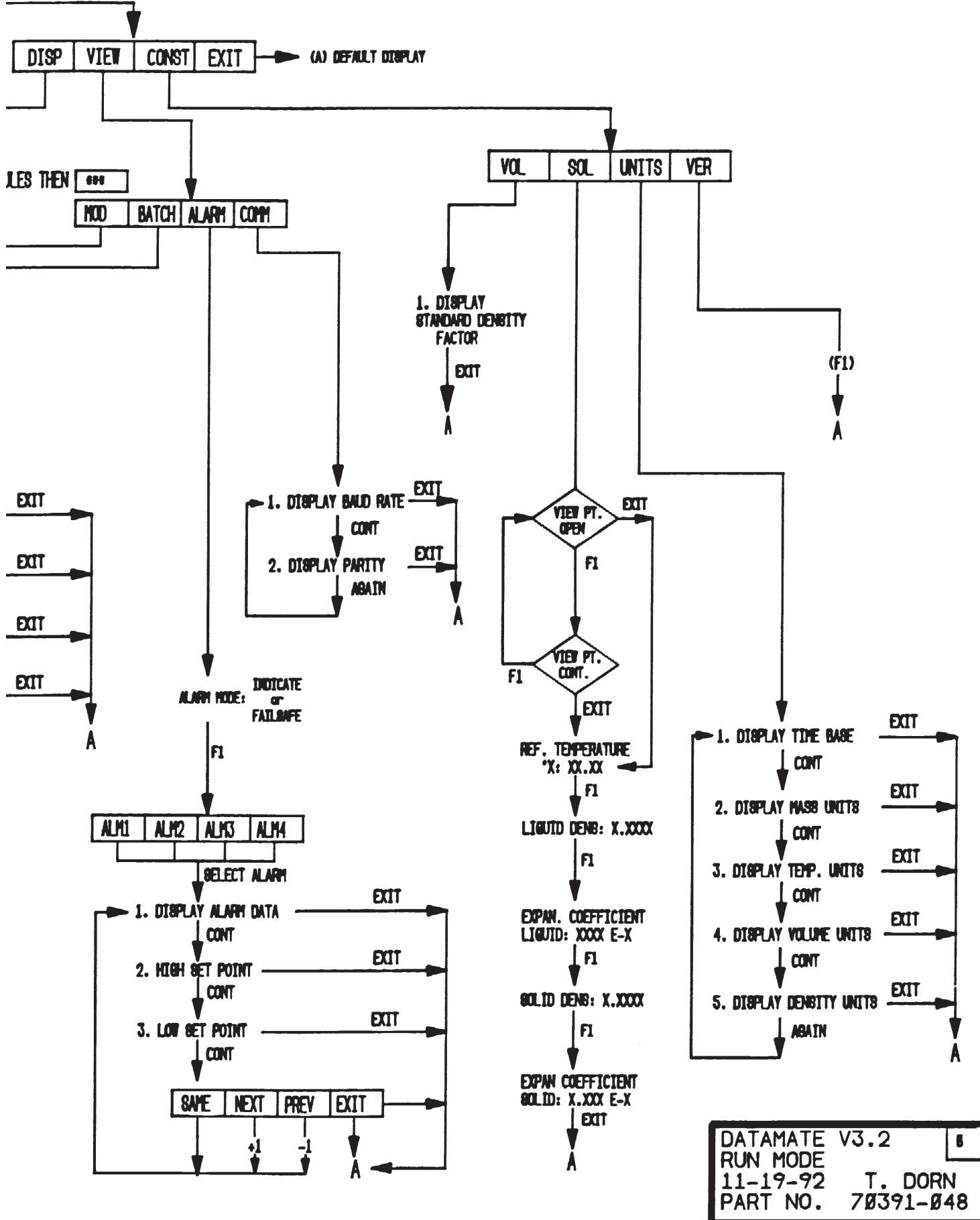
Figure 25
V3.2 Software Reference Chart (Program Mode)



DATAMATE V3.2 PROGRAM MODE
 11-19-92 T. DORN
 PART NO. 70391-031

B

MAIN MENU



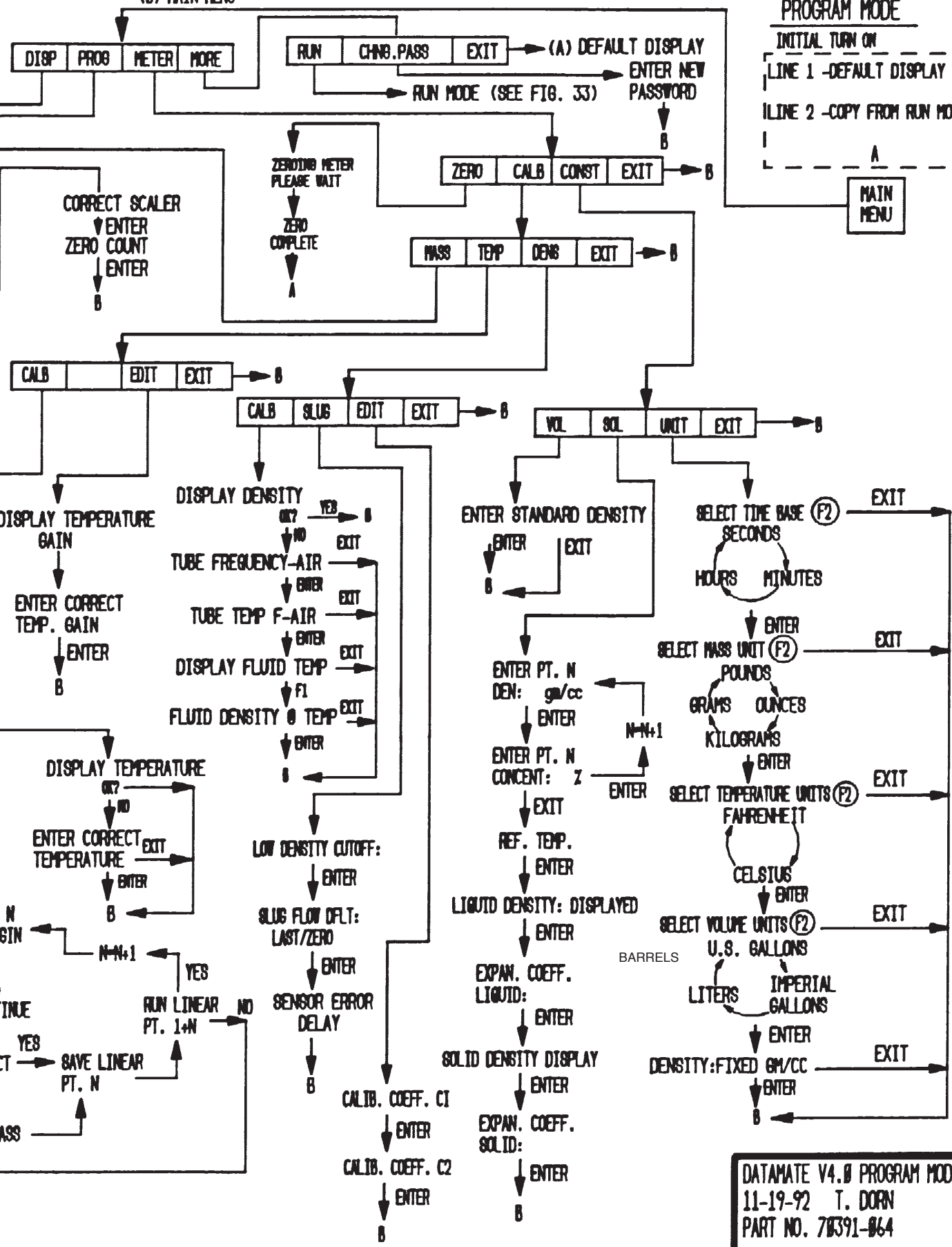
DATAMATE V3.2
 RUN MODE
 11-19-92 T. DORN
 PART NO. 70391-048

(B) MAIN MENU

PROGRAM MODE

INITIAL TURN ON
LINE 1 -DEFAULT DISPLAY MODE
LINE 2 -COPY FROM RUN MODE

MAIN MENU



DATAMATE V4.0 PROGRAM MODE
11-19-92 T. DORN
PART NO. 710391-064

A

RUN/BATCH MODE

INITIAL TURN ON
 LINE 1 -DEFAULT DISPLAY MODE
 LINE 2 -TOTALIZER FOR
 SELECTED DEFAULT
 DISPLAY

MAIN MENU

NOTE:
 WHEN IN RUN MODE THE USER
 CAN ONLY INTERROGATE
 PROGRAMMED PARAMETERS.

DEFAULT DISPLAY	VIEW SELECTED PARAMETERS FOR TEMPORARY DISPLAY						TOTALIZER	UNITS
MASS	TEMP	VOL	DENS	SOLF	ZSOL	MTOT	MASS	
TEMP	MASS	VOL	DENS	SOLF	ZSOL	MTOT	MASS	
VOL	MASS	TEMP	DENS	SOLF	ZSOL	VTOT	VOL	
DENS	MASS	TEMP	VOL	SOLF	ZSOL	MTOT	MASS	
SOLF	MASS	TEMP	VOL	DENS	ZSOL	STOT	MASS	
ZSOL	MASS	TEMP	VOL	DENS	SOLF	STOT	MASS	
COUNT	TEMP	VOL	DENS	SOLF	ZSOL	MTOT	MASS	



DISPLAY SELECT
 PARAMETER AND TOTALIZER



IF NO MODULES

- 1. CUTOFF MASS — EX
CONT
- 2. TRICKLE MASS — EX
CONT
- 3. RESPONSE TIME — EX
CONT
- 4. AUTO RESTART — EX
ABAIN

MODULE NOT INSTALLED



SELECT MODULE

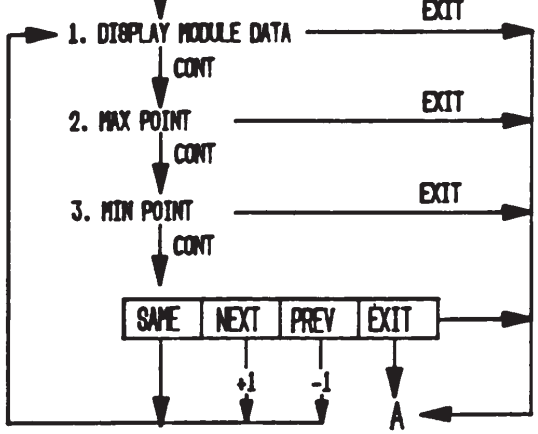
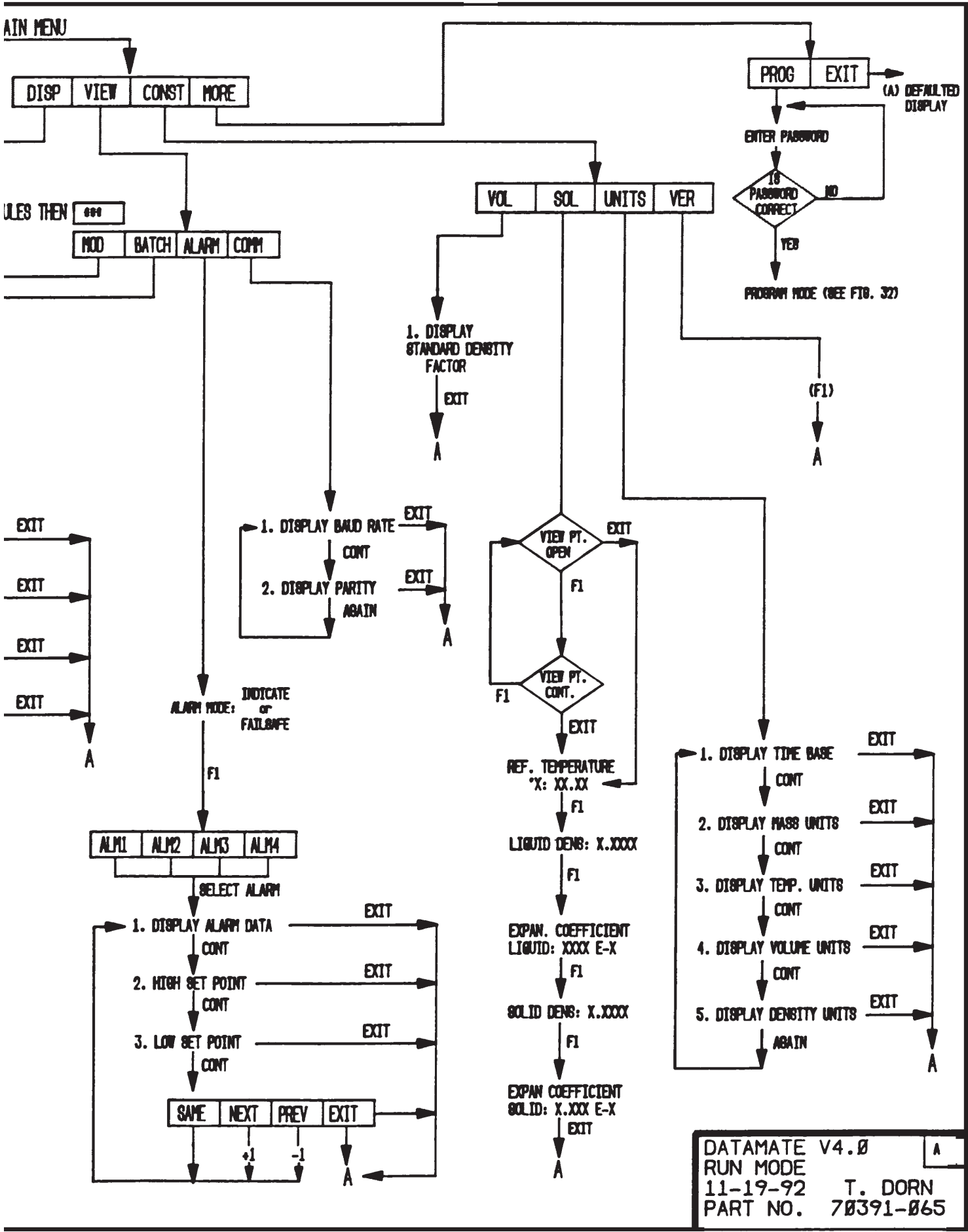


Figure 28

V4.0 Software Reference Chart (Run Mode)



DATAMATE V4.0
 RUN MODE
 11-19-92 T. DORN
 PART NO. 70391-065

VI.6. Software Reference Chart Datamate 2100™ Version 5.XX

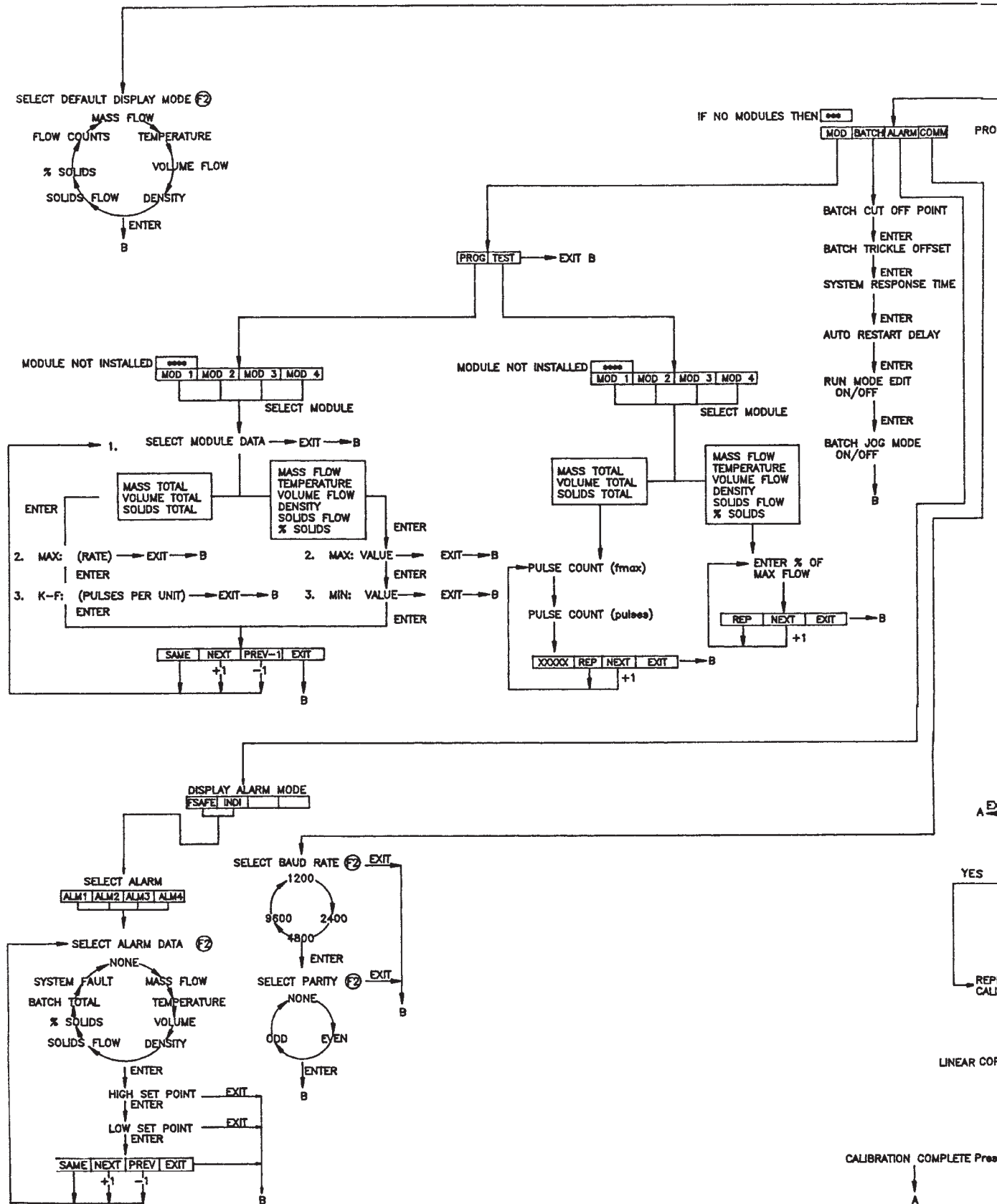
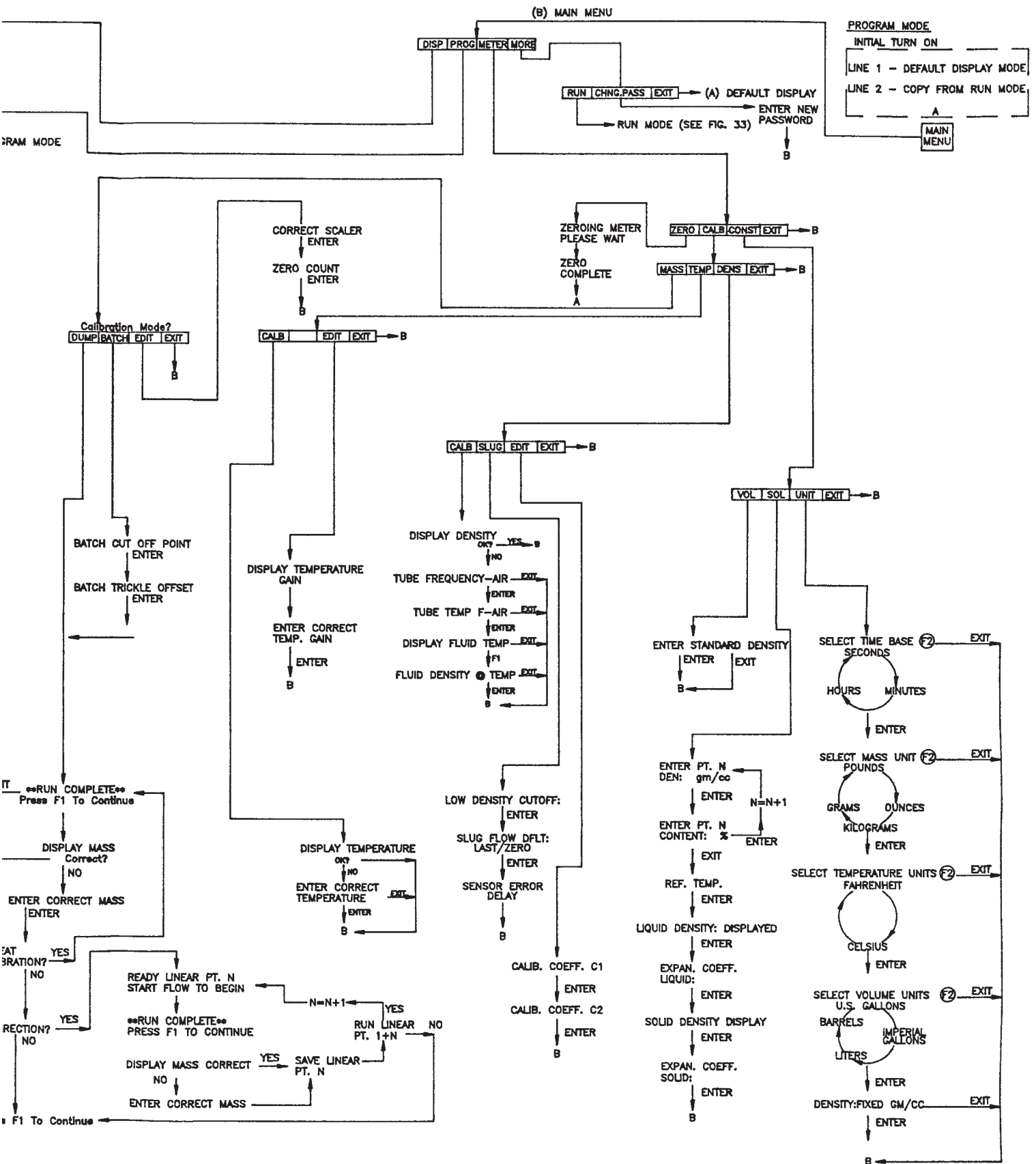


Figure 29
V5.XX Software Reference Chart (Program Mode)



(B) MAIN

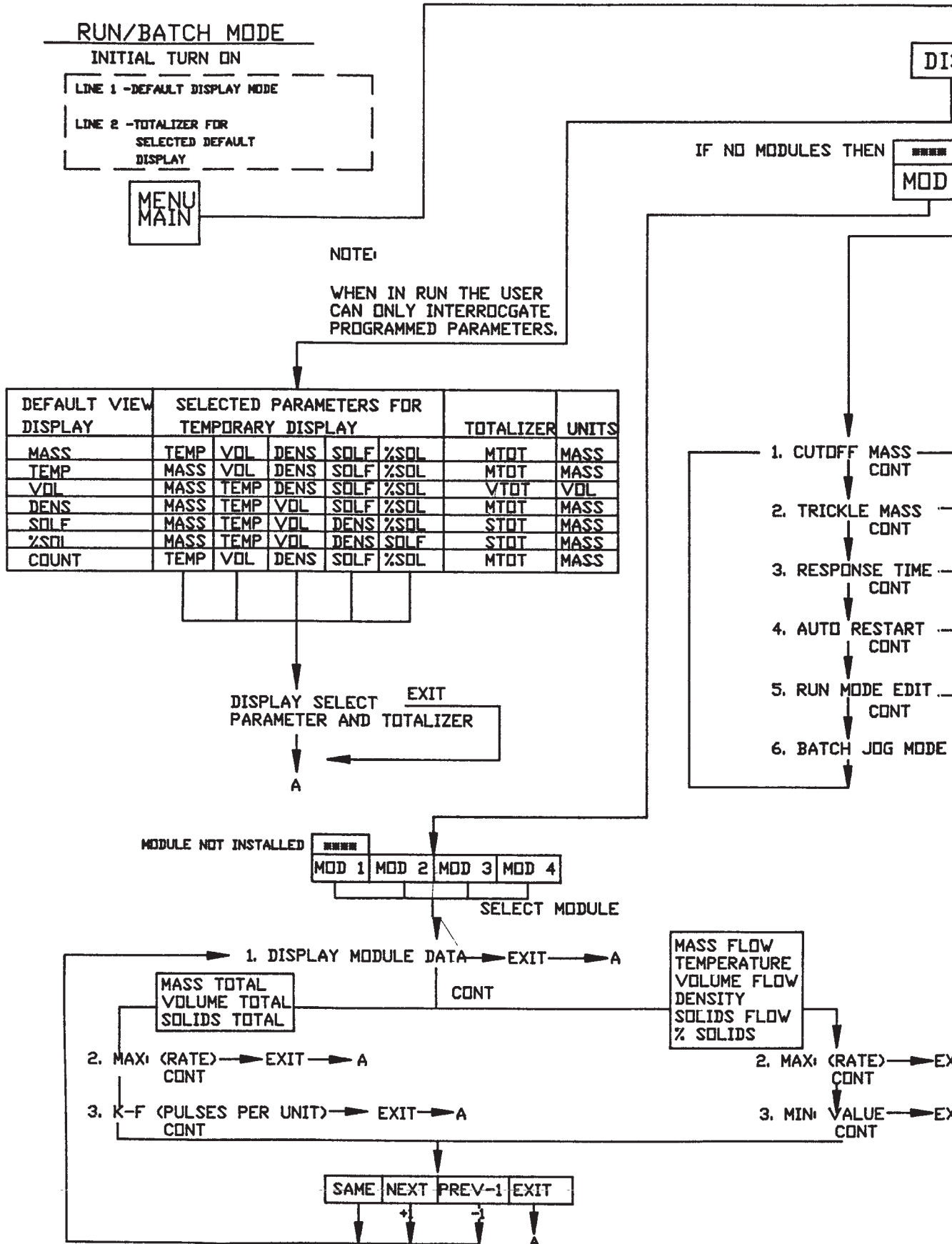
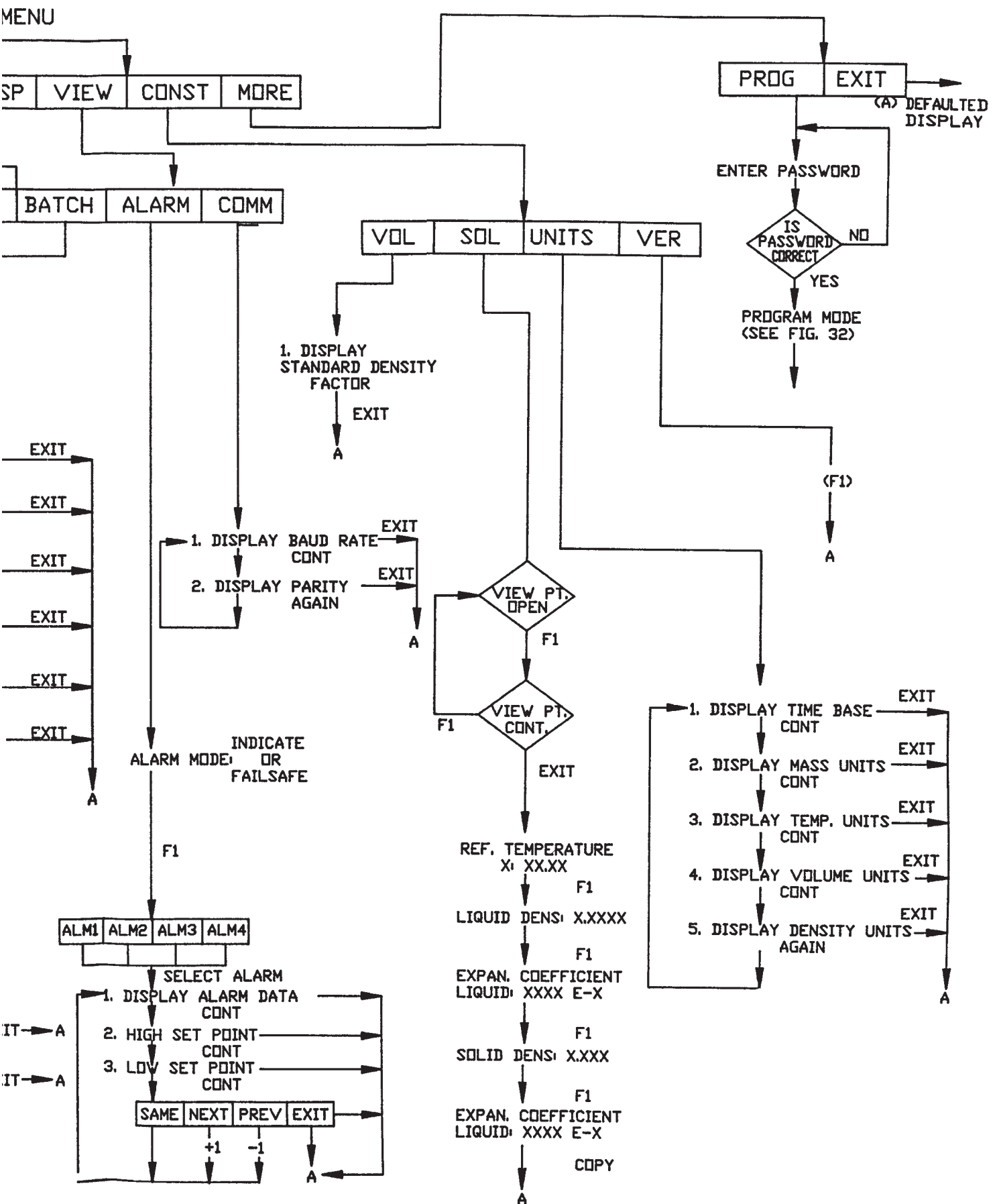


Figure 30

V5.XX Software Reference Chart (Run Mode)



VI.7. Parts List

DATAMATE REPLACEMENT PARTS

PART NUMBER	DESCRIPTION
	BOARDS Computer Board w/display w/o Software EPROM Datamate 2100 Interface Board w/o Batch Board (m012 to m200) Datamate 2100 Interface Board w/o Batch Board (m400) Connector Board w/Bracket, General Purpose I.S. Barrier Board w/Bracket (CSA/US) I.S. Barrier Board w/Bracket (LCIE) Batching Board w/relays, General Purpose Power Supply Kit Complete (transformer, PCB, capacitor assy, plate) Transformer Replacement Kit (Non CE Datamate) Power Supply/Capacitor Kit (CE Datamate)
106505-701 106525-701	DOORS/KEYPADS Datamate 2100 Keypad Datamate 2100 Door w/Keypad & Hinges
106527-701 106526-701 106530-701	OUTPUT BOARDS 4-20 mA Analog Output Board Frequency Pulse Output Board Totalizer Pulse Output Board
106511-701 106513-701 106522-701 106508-701 106512-701	CABLES (STANDARD ENCLOSURE) Interface Board/Barrier Boards Power Supply/Computer/Interface Boards Power Supply/Batching Boards Batch/Interface Boards Computer/Interface Boards
300008-005 300008-004 300008-007	CONNECTORS Power Supply Barrier Board Alarm
300047-009	BATCHING RELAYS Standard
300061-001 300022-002	MISCELLANEOUS PARTS Batch Board Standoff Kit Fuses (1 box)

SENSOR CABLE WITH CONNECTOR FOR m® and DATAMATE

Length, Ft	FM, Cenelec, & General Purpose P/N	CSA P/N
10	105541-010	105542-010
20	105541-020	105542-020
30	105541-030	105542-030
40	105541-040	105542-040
50	105541-050	105542-050
60	105541-060	105542-060
70	105541-070	105542-070
80	105541-080	105542-080
90	105541-090	105542-090
100	105541-100	105542-100
125	105541-125	105542-125
150	105541-150	105542-150
175	105541-175	105542-175
200	105541-200	105542-200
300	105541-300	105542-300
400	105541-400	105542-400
450	105541-450	105542-450
500	105541-500	105542-500

Belden Cable with 90 Degree Amphenol Connector

Length, Ft	FM, Cenelec, & General Purpose P/N	CSA P/N
10	160011-010	160010-010
20	160011-020	160010-020
30	160011-030	160010-030
40	160011-040	160010-040
50	160011-050	160010-050

Sensor Cable Without Connector

Part Number	Description
300007-002	m [®] Sensor Cable in one foot increments

Sensor Cable Connector Kit

Part Number	Description
105543-001	m [®] sensor cable connector kit for assembling connector to sensor cable (Belden 89892 or equal) on General Purpose, FM approved I.S. and FM approved X-Proof m [®] units only.
160012-001	Connector Kit: same as above with 90° connector

M300 MASS FLOWMETER SPARE PARTS

Part Number	Description
108172-901	M300 Terminal Box Cap
1000782	M300 Terminal Box Screws — Drilled

INSULATED m[®] TRANSDUCER COVERS

Part Number	Description
101615-905	Insulated Cover for M012
101615-903	Insulated Cover for M025
101615-901	Insulated Cover for M050
101615-902	Insulated Cover for M100
101615-904	Insulated Cover for M200
101615-907	Insulated Cover for M300
101615-906	Insulated Cover for M400

Note: For applications requiring heated covers, consult your ÜÜT representative.

MASS FLOWMETER STEAM HEAT-TRACING KITS (2-SIDED)

Part Number	Description
101615-805	Steam Heat Kit For M012
101615-803	Steam Heat Kit for M025
101615-801	Steam Heat Kit for M050
101615-802	Steam Heat Kit for M100
101615-804	Steam Heat Kit for M200
101615-807	Steam Heat Kit for M300
101615-806	Steam Heat Kit for M400

SOFTWARE EPROM KITS¹

Part Number	Description
106304-002	Datamate 2000 V3.2, PLL, SST
106304-003	Datamate 2000 V3.2, PLL, Hastelloy® C-22
106304-004	Datamate 2100 V5.0 SST (m012 to m200)
106304-005	Datamate 2100 V5.0 Hastelloy® C-22 (m012 to m200)
106304-006	Datamate 2100 V5.0 SST (m300, m400)
106304-007	Datamate 2100 V5.0 Hastelloy® C-22 (m400)
106304-008	Datamate 2100 V5.1 W&M SST (m012 to m200)
106304-009	Datamate 2100 V5.1 W&M Hastelloy® (m012 to m200)
106304-010	Datamate 2100 V5.1 W&M SST (m300, m400)
106304-011	Datamate 2100 V5.1 W&M Hastelloy® C-22 (m400)
M61000-001	Datamate 2000/2100™ V3.2/V5.XX O&M Manual

Note 1: The software EPROM kit includes EPROM, O&M manual, EPROM Registration Form and EPROM Replacement instructions.

VI.8. Calibration Data

Your meter has been calibrated on room-temperature water at the factory using a test stand that is traceable to NIST. Appended to the end of this manual are copies of the actual calibration sheet generated by these runs.

VII. APPENDIX

EXTERNAL COMPUTER COMMUNICATIONS

The DATAMATE has the capability to communicate with a host computer over an RS-422 link. This section describes the communications protocol, command set, and installation of the RS-422 link. Most data and constants that can be displayed and/or modified from the front panel can be accessed through RS-422 commands.

RS-422 Interface

The RS-422 Computer Interface is connected through the 4-terminal connector TB1 located on the upper left edge of the Interface Board. The terminals are numbered left to right, 1 to 4. The connections are shown in Table 1A.

Table 1A. RS-422 Wiring Connections

TB1 Pin	1	2	3	4
Signal	RXD(H)	RXD(L)	TXD(H)	TXD(L)

Figures 1A (single-drop) and 2A (multi-drop) show the proper connection of the Datamate/s to a computer RS-422 port. Note the line termination resistors.

Note: The labels of the signals in table 1A correspond to the signals as labeled on the RS-422 Card/Converter. These labels refer to which pin to connect on the Card/converter. It does not refer to the direction of the signal from the Datamate perspective.

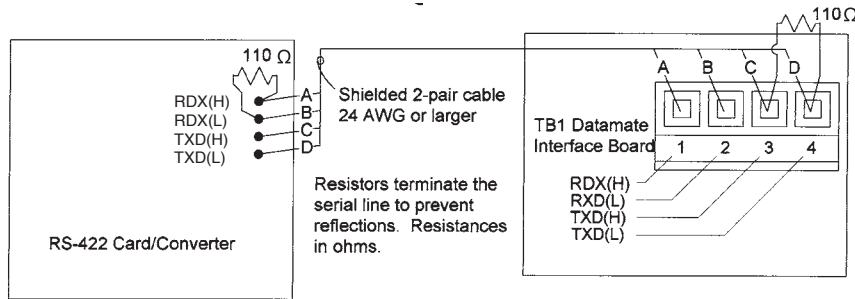


Figure 1A. Single-drop RS-422 Wiring

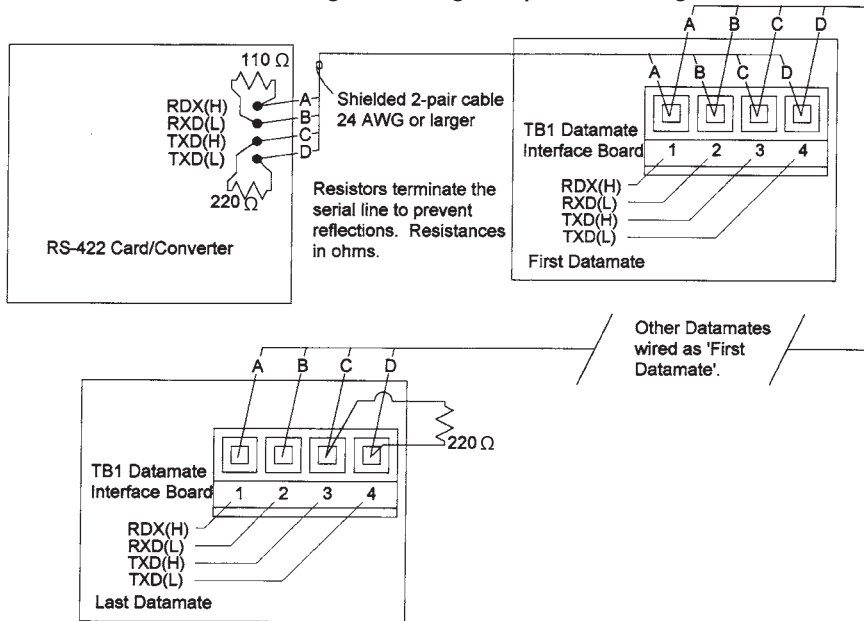


Figure 2A. Multi-drop RS-422 Wiring

Communication Protocol

All information transfers between the host computer and the DATAMATE must be in the form of ASCII strings (**8 data and 1 stop bit**). Every command code is two upper-case alpha characters. There are three types of command sequences: (1) interrogation; (2) operation; or (3) program. The DATAMATE will respond to every command by either echoing the command followed by the code for the error that was detected. All commands and responses will be terminated by CR, LF (carriage return, line feed).

Interrogation Command Sequence

Interrogation command sequences are used to query the DATAMATE for measured data (mass flow rate, temperature, density, etc.) and programmed data (module information, batch data, alarm set points, etc.) To initiate an interrogation sequence the host computer sends to the DATAMATE a two character command code to request the desired data. The Datamate responds with the command code followed by a comma, followed by the data requested.

Example: Density Request

Command: DN Response: DN,1.037

Control Command Sequence

Control command sequences are used to initiate an operation (starting batch, resetting the total, etc.) in the DATAMATE. The host computer triggers the desired operation by sending the two character code for the desired operation to the DATAMATE. If the operation can be performed, the DATAMATE will respond with the same code and initiate the operation. If the operation cannot be performed, the DATAMATE will respond with an error code.

Example: Reset Total Mass

Command: RT Response: RT

Program Command Sequence

Program command sequences are used to setup or configure the DATAMATE. To program a function in the DATAMATE, the host computer sends the two character code for the desired parameter set followed by the program data. Data values must be separated by commas. If all the data parameters are valid the DATAMATE will re-program itself, and echo the command followed by the new program data. If any data parameter is invalid, the DATAMATE will respond with an error code.

Example: Program Standard Density

Command: SD,1.045 Response: SD,1.045

Data Formats

All data returned will be in an ASCII format with commas used to separate different parameters. Numeric data will be in either integer form, fixed point (one, two, or three digits to the right of the decimal point), or engineering format (three significant digits plus and exponentiator digit). Leading zeros on numeric data, except mass totals, will be suppressed. The following is a list of the data formats used by the DATAMATE. Note that the number of characters used to represent a number corresponds to the maximum number digits.

Table 2A. Data Format

Type	Format	Description
INT	ZZD	Integer with leading zeros suppressed.
FLOW	D.DDEP DD.DEP DDD.EP	Flowrate, engineering format.
SCAL	DDDD.DDDD	Scaler, positive flowing-point number
TEMP	SZZD.DD	Temperature, fixed point real with leading zeros suppressed, one decimal place, and a minus sign character (if value is negative)
DENV	D.DDDD	Density variable, fixed point real with four decimal places.
DENC.	D.DDDD	Density constant, fixed point real with four decimal places.
PCNT	ZZD.D	Percent, fixed point real with leading zeros suppressed, and one decimal place.
ARTIME	ZD:DD	Auto-Restart time (Minute:Second), leading zeros of minutes suppressed.
BSET	ZZZZD.DD	Batch Mass Setpoint, fixed point real with leading zeros suppressed, and two decimal places.
SRTIME	ZD.DD	System Response Time (Seconds), leading zeros suppressed.
BMASS	DDDDDD.DD	Batch Mass, fixed point with two decimal places, and no suppression of leading zeros.
TMASS	DDDDDDDD.D D	Total Mass, fixed point with two decimal places, and no suppression of leading zeros.
TVOL	DDDDDDDD.D D	Total Volume, fixed point with two decimal places, and no suppression of leading zeros.
TSOL	DDDDDDDD.D D	Total Solids, fixed point with two decimal places, and no suppression of leading zeros.
ERR#	DD	Error code, two numeric characters, e.g., two digit integer, and no suppression of leading zeros.

D Digit that is always sent, indicates minimum of digits that could be sent.

Z Digit that will be suppressed if it is a "leading" zero.

P Exponentiator Digit

S Sign character, sent if number is minus.

Refer to "Software Setup" for additional information on data formats and acceptable values.

RS-422 ADDRESSING

The Datamate's RS-422 communications protocol has been set up to allow the unit to operate in both a single unit and a multiple unit environment. In the single unit mode the address comparison is masked and the Datamate's transmitter section is always enabled. In the multiple unit mode the Datamate's RS-422 interface protocol allows for the multiple units to reside on the same bus under control of a single host computer. To facilitate this, each unit is assigned a unique address. The address can be 0 to 31. The host computer then selects the unit to communicate with by sending the address of the unit out on the bus. All units compare the received address to their own, and only the unit with the matching address enables its transmitter section.

Setting the RS-422 Address

The mode and address are set by switch bank SW2 for Datamate 2100 (SW1 for Datamate 2000) located on the Computer Board as shown below. If switch 1 is in the off position, the address mode (multiple units) is disabled and switches 2 through 6 are ignored.

Table 3A. Addressing

Switch Position	SW1 Switch Number					
	1	2	3	4	5	6
On	Address Enabled	16	8	4	2	1
Off	Address Disabled	0	0	0	0	0

Example: Switches 1, 3, 5, and 6 are in the on position.
Switches 2 and 4 are in the off position.

Result: Address mode enabled, address = 8 + 2 + 1 = 11.

This address becomes defined in the Datamate's memory at power-up. This means that if the SW2 (SW1 for Datamate 2000) is changed after power-up, the Datamate will not acknowledge the change. The power would have to be re-cycled in order to re-assign an address.

Enabling the DATAMATE Address

When the DATAMATE is used in the multiple unit RS-422 environment, it is necessary to enable the unit's transmitter before communications can proceed. During communications all messages and replies consist of upper case ASCII coded characters. ASCII coded characters are 7 bit long (bits 0 through 6); therefore, every transmitted byte will have the most significant bit (bit 7) equal to 0, i.e. all bytes will be 00H to 7FH (hexadecimal). When a byte is received with bit 7 set, it is interpreted as an address byte. Bits 0 through 4 transmit an address from 0 to 31. Using the address in the example above, the byte to communicate with a Datamate with address 11 would be 8BH or 10001011b (binary) or 139d (decimal). When an address byte is received the DATAMATE compares the address sent to its own. If the addresses do not match, the unit will disable its transmitter (if it was enabled) and not respond to any commands transmitted on the bus by the host. If the address does match, the DATAMATE will enable its transmitter and echo the address byte. The DATAMATE is now ready for further communications.

COMMAND DESCRIPTION

There are five categories of commands used by the DATAMATE: (1) Data Request Commands, (2) Configuration Commands, (3) Control Commands, (4) Status Commands, and (5) Error Commands. The commands are summarized below:

Data Request Commands

MF	Mass Flow rate request	AR	Auto-Restart time request
TM	TeMperature request	ID	IDentify request
VF	Volume Flow rate request	ST	% Solids Total request
DN	DeNsity request	FC	Flow Counts request
PS	Percent Solids request	SF	Solids Flow rate request
MT	Mass Total request	FR	tube FRequency request
BT	Batch Total request	VT	Volume Total request
ZC	Zero Count		

Configuration Commands

SD	Standards Density	DD	Default Display
PC	Percent solids Constants	DT	Display Time-out
UN	UNit flags	BA	set BAud rate
MD	Module program Data	PR	set PaRity
BD	Batch setpoint Data	SM	Sensor error tiMe delay
AD	Alarm program Data	SC	mass SCaler

Control Commands

RT	Reset Total
BB	Batch Begin
BE	Batch End
BR	Batch Reset
ZM	Zero Meter
ZA	Zero Abort

Status Commands

MP	Modules Present
AP	Alarms Programmed
AS	Alarm Status
US	Unit Status

Error Commands

ER command **E**Rror response
SE System **E**rror response

Data Request Commands

This section describes the commands that return data that is measured and/or computed by the DATAMATE. All data request commands are of the interrogation command sequence form.

Mass Flow Rate

This command returns the current mass flow rate measurement as a FLOW type number.

Command: MF Response: MF,FLOW

Temperature

This command returns the current temperature measurement as a TEMP type number.

Command: TM Response: TM,TEMP

Volumetric Flow Rate

This command returns the current volumetric flow rate measurement in FLOW format.

Command: VF Response: VF,FLOW

% Solids Flow Rate

This command returns the current % Solids flow rate measurement in FLOW format.

Command: SF Response: SF,FLOW

Density

This command returns the current density measurement in a DENV format.

Command: DN Response: DN,DENV

Percent Solids

This command returns the current percent solids measurement in a PERC format.

Command: PS Response: PS,PERC

Mass Total

This command returns the current mass total reading in TMASS format.

Command: MT Response: MT,TMASS

Volume Total

This command returns the current volume total reading in TVOL format.

Command: VT Response: VT,TVOL

Solids Total

This command returns the current solids total reading in TSOL format.

Command: ST Response: ST,TSOL

Batch Mass Total

This command returns the time to a batch mass total reading in a BMASS format.

Command: BT Response: BT,BMASS

Auto-Restart Time

This command returns the time to a batch automatic restart in minutes and seconds. If a restart is not pending, the DATAMATE returns 0:00. The data is in ARTIME format.

Command: AR Response: AR,ARTIME

Identify

This command is intended to be used to identify the unit as a DATAMATE or DATAMATE 2100 in computer controlled flow system.

Command: ID Response: D,DM2000 or ID,DM2100

Zero Count

This command retrieves the zero count stored in memory when the meter is zeroed.

Command: ZC Response: ZC,INT

CONFIGURATION COMMANDS

This section describes the commands that are used to program or interrogate the Datamate's configuration. These commands can be used in either the interrogation command sequence format to read the current configuration, or in the program command sequence to select a new configuration.

Standard Density

This command is used to read or set the Standard Density factor. The first form of this command returns current setting of the density factor. While the second programs a new setting. The data in this command is in DENC format.

(1) Command: SD Response: SD,DENC
(2) Command: SD,DENC Response: SD,DENC

Percent Solids Constants

This command is a leftover from a previous software version. It is used to read or program the two constants needed to compute Percent Solids and to read the percent solids output. The format is: (1) fluid density in DENC format, (2) solid/fluid density in DENC format, and (3) percent solids in PERC format.

Command: PC Response: PC,DENC,DENC,PERC

Module Program Data

This command is used to read or program the settings for the optional analog outputs. For V5.XX software the command has two formats.

The first format is the same for all software and is used when Data Outputs 0-6 are selected with a 4-20 mA and/or rate pulse card. In the interrogation form of this command, only the module number to be interrogated is supplied. The DATAMATE will then return the settings for this module. In the program command sequence, the data output type for the module, the maximum point, and the minimum point must also be supplied. If any of these data values are illegal or if the module is not present, the unit will respond with an error code. The data formats for the maximum and minimum points depend on the output selected for the module. The command and data formats are detailed below.

(1) Command: MD,MOD Response: MD,MOD,TYPE,MAX,MIN
(2) Command: MD,MOD,TYPE,MAX,MIN Response: MD,MOD,TYPE,MAX,MIN

Both the module number, MOD, and the output data type, TYPE, are INT data. The module number must be either 1, 2, 3, or 4, while the output type can be in the range of 0 to 6. The correspondence between type number and the data output to the module is given along with the data format for the MAX and MIN data.

Batch Setpoint Data

This command is used to read or program the Batch operation data. The Batch data consists of (1) the cutoff point, (2) the trickle offset point, (3) the system response time, (4) the auto- restart time, and (5) the batch Run Mode Edit flag. Both the cutoff and the trickle offset point are in BMASS format. The system response time is in SRTIME. The auto-restart time is in ARTIME format, and the batch Run Mode Edit flag is in the INT format. A value of 0 will turn the batch Run Mode Edit function "Off" while a value of 1 will turn the batch Run Mode Edit function "On". The first form of this command is the interrogation command sequence, while the second is the program command sequence.

(1) Command:	BD SRTIME,ARTIME,INT	Response:	BD,BMASS,BMASS, SRTIME,ARTIME,INT
(2) Command:	BD,BMASS,BMASS, SRTIME,ARTIME,INT	Response:	BD,BMASS,BMASS, SRTIME,ARTIME,INT

Display Time-out

This command is used to read or program the display time-out. The display time-out is a feature that allows the user to view a parameter other than the default display for the defined time-out time before returning to the default display. The time-out value is an INT value representing whole seconds. The first form of this command returns the current time-out, while the second programs a new time-out. The time-out must be less than or equal to 30 seconds.

(1) Command:	DT	Response:	DT,INT
(2) Command:	DT,INT	Response:	DT,INT

Alarm Program Data

This command is used to read or program settings for the alarm outputs. In the interrogation form of this command, the alarm number to interrogate must be supplied the DATAMATE will then return the set-points for this alarm. In the program command sequence, the data output type for the alarm, the high Setpoint, and the low Setpoint must also be supplied. If any of these data values are illegal the unit will respond with an error code. The data formats for the high and low setpoints depend on the data type selected for the module. The command and data formats are detailed below.

(1) Command:	AD,ALM TYPE,HIGH,LOW	Response:	AD,ALM, TYPE,HIGH,LOW
(2) Command:	AD,ALM, TYPE,HIGH,LOW	Response:	AD,ALM, TYPE,HIGH,LOW

Both the alarm number, ALM, and the output data type, TYPE, are INT, data. The alarm number must be either 1, 2, 3, or 4, while the output type can be in the range of 0 to 8. If the alarm type is either 0 or 8, then data for the setpoints is not expected or returned. The correspondence between type number and the alarm is give below along with the data format for the HIGH and LOW Setpoint data.

Table 11A. Alarm Type Parameter Codes and Data Format

Type	Alarm Data	HIGH, LOW Data Format
0	None	NO DATA
1	Mass Flow	FLOW
2	Temperature	TEMP
3	Volume Flow	FLOW
4	Density	DENC
5	Solids Flow	SFLO
6	Percent Solids	PERC
7	Batch Mass	BMASS
8	System Fault	No Data

Batch Begin

This command directs the DATAMATE to begin batch operation. This command is equivalent to pressing the START key on the front panel. If the batch operation can begin (refer to Batch Functions for the requirements to begin a batch), the DATAMATE will echo the command and energize the batch relays.

Command: BB Response: BB

Batch End

This command directs the DATAMATE to end a batch operation. This command is equivalent to pressing the STOP key on the front panel. The first time this command is sent the DATAMATE will de-energize the batch relays (provided the batch was in progress) and stop the batch. The batch can be restarted by sending the Batch Begin command. To abort a batch the first Batch End command must be followed by a Batch Reset command (described below) and then another Batch End command.

Command: BE Response: BE

Batch Reset

This command directs the DATAMATE to reset the batch total. The batch total can only be reset if the batch operation has been stopped. Once the batch total has been reset, a new run can be started or the batch operation can be aborted.

Command: BR Response: BR

Zero Meter

This command directs the Datamate to perform an automatic or manual zero. An automatic zero is performed when the command is not followed by a value for the new zero. The new zero is in the INT format.

(1) Command: ZM Response: ZM
(2) Command: ZM,INT Response: ZM,INT

Zero Abort

This command aborts the zeroing process in progress.

Command: ZA Response: ZA

Status Commands

This section describes the commands that return the Datamate's status. All status commands are of the interrogation command form. All status bytes are INT format.

Modules Present

This command returns a status code indicating which optional modules are installed. The correspondence between the modules installed and bits (value) is given below.

Table 14A. Module Present Byte

Bit	7	6	5	4	3	2	1	0
Value	128	64	32	16	8	4	2	1
Module	Not Used	Not Used	Not Used	Not Used	1	2	3	4

Bit	7	6	5	4	3	2	1	0
Value	128	64	32	16	8	4	2	1
Module	Not Used	Not Used	Not Used	Not Used	1	2	3	4

Bits 7, 6, 5, and 4, are not used.
 Bit 3 set indicates module 1 is installed.
 Bit 2 set indicates module 2 is installed.
 Bit 1 set indicates module 3 is installed.
 Bit 0 set indicates module 4 is installed.

Alarms Programmed

This command returns a status code indicating which alarms are programmed. The correspondence between the alarms and bit (value) is given below.

Table 15A. Alarms Programmed Byte

Bit	7	6	5	4	3	2	1	0
Value	128	64	32	16	8	4	2	1
Module	Not Used	Not Used	Not Used	Not Used	1	2	3	4

Bits 7, 6, 5, and 4, are not used.
 Bit 3 set indicates alarm 1 is programmed.
 Bit 2 set indicates alarm 2 is programmed.
 Bit 1 set indicates alarm 3 is programmed.
 Bit 0 set indicates alarm 4 is programmed.

Alarm Status

This command returns a status code indicating which alarms are active, i.e. the value measured is outside the programmed set points for the alarm. The correspondence between the alarms and bits (value) is given below.

Table 16A. Alarm Status Byte

Bit	7	6	5	4	3	2	1	0
Value	128	64	32	16	8	4	2	1
Alarm	1H	1L	2H	2L	3H	3L	4H	4L

- * Bits 7 set indicates alarm 1 high is active.
- * Bits 6 set indicates alarm 1 low is active.
- * Bits 5 set indicates alarm 2 high is active.
- * Bits 4 set indicates alarm 2 low is active.
- * Bits 3 set indicates alarm 3 high is active.
- * Bits 2 set indicates alarm 3 low is active.
- * Bits 1 set indicates alarm 4 high is active.
- * Bits 0 set indicates alarm 4 low is active.

This command returns a status code indicating the operational status of the DATAMATE. The bit meanings are given below.

Table 17A. Unit Status Byte

Bit	7	6	5	4	3	2	1	0
Value	128	64	32	16	8	4	2	1
Function	Auto-Restart	Batch Status	Batch Status	Key-Switch	System Error	Sensor Error	Zero Active	Calibrate Active

- * Bit 7 set indicates that the DATAMATE has completed a batch and is in the automatic batch restart time-out mode.
- * Bit 6 and 5 indicate the current batch mode or status as given in the table below.

Table 18A. Batch Status Bits

Bit 6	Bit 5	Batch Mode	Value
0	0	Batch not active; normal run mode	0
0	1	Batch in progress; product flowing.	32
1	0	Batch stopped before run complete.	64
1	1	Batch complete	96

* Bit 4 set indicates that the Datamate is in the PROGRAM mode. Bit 4 cleared indicates the Datamate is in the RUN mode.

* Bit 3 set indicates that the DATAMATE has detected a system error and has terminated operation. Refer to section VI.1 for more information on system errors.

* Bit 2 set indicates that a sensor error has been detected, i.e. the tubes are not vibrating.

* Bit 1 set indicates that meter is currently being zeroed. Note: During the zeroing process all commands, except the Unit Status command, will return an error message.

* Bit 0 indicates that the DATAMATE is currently being calibrated.

Error Commands

Upon receipt of an RS-422 command the Datamate will begin processing the command and checking the command for validity. If no error is detected, the DATAMATE will execute the command and respond to the host computer as described above. If an error is detected in the command or the DATAMATE has detected a system error, the unit will respond with an error sequence. These commands are not initiated by the host computer, but are substituted for the responses listed in the preceding sections whenever an error is detected.

Command Error Response

If an error is detected in the command format or a control command can not be executed, and a system error has not been detected, the DATAMATE will respond with a command error response indicating the type of error. The format for the command error response and the error codes are described below.

Response: ER,ERR#

Table 19A. Command Error Codes

ERR#	Error Description
00	Not used.
01	Illegal command code received.
02	Parity error detected in transmission.
03	Bad value in data supplied.
04	Illegal numeric character in data supplied.
05	Illegal command format
06	Module selected by command not installed.
07	Reset Total Jumper not installed.
08	Batch already started.
09	Batch can not be started.
10	Batch not active can not end.
11	Batch can not be aborted until batch is reset.
12	Zero in progress, no commands except US.

System Error Response

If a system error is detected by DATAMATE, the unit terminates operation and display the system error that occurred. When DATAMATE detects a system error, all commands, except the US command, are responded to with a system error response format and the error codes are given below. For additional information on system errors refer to "Error Message Summary".

Response: SE,ERR#

Table 20A. System Error Codes

ERR#	Error Description
00	Not used
01	Watchdog Timer Error
02	RAM Checksum Error
03	Internal Data Path Error
04	Sensor Error

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Specifications subject to change without prior notification.

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MEASUREMENT**