Advanced Users
Guide

MassMeter Systems

Series
1205 1210 and 1220 Transmitters

K2–K15000 Flow Sensors

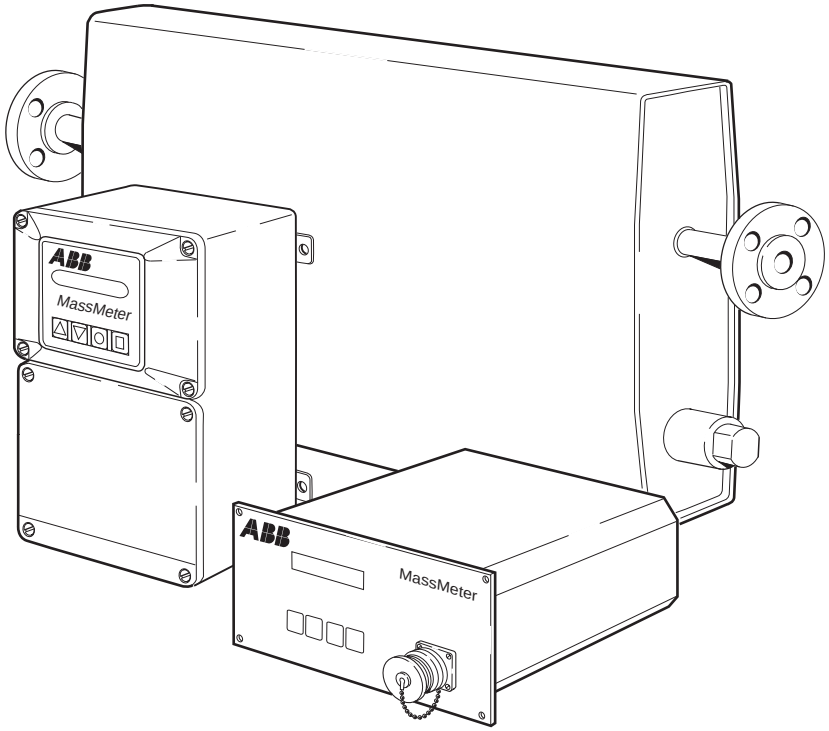

ABB Instrumentation

ABB INSTRUMENTATION

The Company

ABB Instrumentation is an established world force in the design and manufacture of instrumentation for industrial process control, flow measurement, gas and liquid analysis and environmental applications.

As a part of ABB, a world leader in process automation technology, we offer customers application expertise, service and support worldwide.

We are committed to teamwork, high quality manufacturing, advanced technology and unrivalled service and support.

The quality, accuracy and performance of the Company's products result from over 100 years experience, combined with a continuous program of innovative design and development to incorporate the latest technology.

The NAMAS Calibration Laboratory No. 0255(B) is just one of the ten flow calibration plants operated by the Company, and is indicative of ABB Instrumentation's dedication to quality and accuracy.

BS EN ISO 9001

St Neots, U.K. – Cert. No. Q5907
Stonehouse, U.K. – Cert. No. FM 21106

EN 29001 (ISO 9001)

Lenno, Italy – Cert. No. 9/90A

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Use of Instructions

Warning.
An instruction that draws attention to the risk of injury or death.

Caution.
An instruction that draws attention to the risk of damage to the product, process or surroundings.

Note.
Clarification of an instruction or additional information.

Information.
Further reference for more detailed information or technical details.

Although **Warning** hazards are related to personal injury, and **Caution** hazards are associated with equipment or property damage, it must be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process system performance leading to personal injury or death. Therefore, comply fully with all **Warning** and **Caution** notices.

Health and Safety

To ensure that our products are safe and without risk to health, the following points must be noted:

1. The relevant sections of these instructions must be read carefully before proceeding.
2. Warning labels on containers and packages must be observed.
3. Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the information given.
4. Normal safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and/or temperature.
5. Chemicals must be stored away from heat, protected from temperature extremes and powders kept dry. Normal safe handling procedures must be used.
6. When disposing of chemicals ensure that no two chemicals are mixed.

Safety advice concerning the use of the equipment described in this manual or any relevant hazard data sheets (where applicable) may be obtained from the Company address on the back cover, together with servicing and spares information.

CONTENTS

Note. THIS MANUAL SHOULD BE USED IN CONJUNCTION WITH THE INSTALLATION AND OPERATING MANUAL

1 BATCHING

1.1 Basics of Batching

Introduction
The term “batching” refers to the dispensing or transfer of a measured amount of process fluid from one point to another. The basic elements of a batching system include: a flow measuring device, a flow regulating device and a control unit. The operator enters a batch size into the control unit and starts the “batch sequence”. The control unit then sends out a control signal to the flow regulating device to begin dispensing fluid and measures the fluid flow from the flow sensing device. When the correct amount has been dispensed, the control unit stops the flow.

ABB MassMeters Series 1200 Transmitters with Version S7*H8 software include complete batch control capability which can be programmed by the user for a specific application. This section of the manual covers each of the basic batch control parameters and how to use them.

1.1.1 Batch Control Parameters

B+ Batch/Menu select (Set-Up Menu, Password 3), controls the Batch Menu and the type of batching.

- **B+** = 0 Batch Menu turned off (batching may still be controlled via Serial Port or Remote Input)
- **B+** = 1 Start/Stop batching
- **B+** = 2 Start/Suspend batching
- **B+** = 3 Batch until flow stops

Bm Batch parameter select (Batch Menu, pw3), selects the flow parameter to be controlled.

- **Bm** = 0 Mass batching (**Fx**)
- **Bm** = 1 %A mass batching (**%a**)
- **Bm** = 2 %B mass batching (**%b**)
- **Bm** = 3 Volumetric batching (**VF**)

Be Batch/Stop on error (Batch Menu, pw3) - The batch logic can be programmed to disable the batch from starting, or from continuing, if the sensor is out of the preset frequency limits (**fm** & **fM**). Note: The error condition must remain for more than 10 seconds before the batch is stopped.

- **Be** = 0 Disregard a frequency alarm
- **Be** = 1 Stop batch if frequency alarm occurs

Bα Batch Timing Pre-Trigger - This is used to trigger the relay drivers at a certain time before the batch would otherwise stop. An example of how this parameter would be used is in the case where a valve takes a long time to close, giving batch overrun. If this time is fixed, then a time can be entered into **B**α, thereby stopping the batch early. This time would usually be equal to the time required to pass 50% of the overrun mass, at the normal flow rate.

Using the formula

Bα (in sec). = 0.5 x overshoot (in mass/mass per second)

If **B**α is not being used it should be set to zero.

Bβ Batch Quantity Pre-Trigger (Batch Menu, pw3) - In certain applications, a fixed amount of liquid drains from the delivery pipework after the control valve closes. Batch pre-trigger allows the user to disable the batch driver early to compensate. This value is determined experimentally by running several test batches and recording the extra amount delivered. Program this value into **B**β.

Bσ Batch Preset (Batch Menu, pw3) - Used for 2-stage batching. The value of this parameter (also called the dribble feed amount) is subtracted from the Batch Limit (**BM**) and when the batch limit reaches this adjusted value, the primary batch driver is disabled. The secondary batch driver remains enabled until the batch limit (**BM**) is finally reached.

The batch function controls drivers 1 and 2. Typical connection to these drivers is discussed in later sections.

1.1.2 Batching Outputs

Series 1200 Transmitters have two drivers for two-stage control of “shutdown” to prevent overshoot of the setpoint. These drivers can be user programmed to reduce the batch feed rate as the setpoint is approached. The drivers can either operate two separate valves (fast and slow delivery rates), or operate a two-stage control valve.

Driver #2 (slow feed) - Closes at the start of a batch and remains closed until the final setpoint value (**BM**) is reached. For single-stage batching, only this driver is used. **B**α and **B**β still acts on this output.

Driver #1 (fast feed) - Also closes at the start of a batch, but it can be programmed to open at a user selected value (**B**σ) before the final setpoint is reached. For example, to deliver a 100 lb batch with the last 5 lbs to be delivered in the “dribble mode" we would set (**B**σ) at 5 lbs.

Driver #1 and Driver #2 are open collector relay drivers rated at 600 mA maximum current and 39 volts maximum voltage.

Caution. DO NOT APPLY 110 or 230 VOLTS AC TO THESE OUTPUTS.

Caution. Most applications require the use of external relays to handle the higher current and voltage of control valves, etc. Power to operate the coil of the external driver is available at the ‘User +15V’ terminal of the transmitter (50 mA max.). If transmitter power is used, the external relay coils should be rated at 12 volts DC, 50 mA maximum current (e.g., **Grayhill** #70S2-04-B-06-S or equivalent). Wiring diagrams for Driver #1 and Driver #2 are included at the rear of this section.

1.1.3 Remote Inputs

ABB MassMeter Series 1200 Transmitters have two Remote Input lines which can control batching via momentary contact switches mounted in another location. Both Remote Inputs are transistors and do require a voltage to be applied by the remote contact switch to operate. The +15 volts DC available

at the 'User +15V' terminal can be used in conjunction with the momentary contact switches to activate the input transistors. Wiring diagrams for the Remote Inputs are shown at the end of this section.

The standard software package supplied with Series 1200 Transmitters uses both Remote Inputs for batching functions. These inputs operate in tandem with the keyboard batching modes selected by **B+** (Set-Up Menu).

B+ = 1 **Start/Stop batching** - Remote Input #1 starts the batch. Remote Input #2 stops the batch in process. Pressing Remote Input #1 again resets the Batch Totalizer (**B**) and starts another batch.

B+ = 2 **Start/Suspend batching** - Remote Input #1 starts the batch. Remote Input #2 suspends the batch in process. If the total batch amount (**BM**) has not been reached, then Remote Input #1 resumes batching. If the total batch amount (**BM**) has been reached, then Remote Input #1 resets the Batch Totalizer (**B**) and starts another batch.

B+ = 3 **The Batch Totalizer (B)** continues to increment until the flow rate actually stops. The batch can be suspended but does not stop until the flow rate becomes less than the low flow cutoff (**FL**) value.

B+ = 0 **"Blind" Start/Stop batching** - This mode turns off the Batching Menu and disables transmitter keyboard batch control. However, the Remote Inputs are still active and operate in the Start/Stop mode.

Note. The Remote Input functions described above are those supplied with standard transmitter software. Certain custom software options, specially ordered from the factory, may use one or both Remote Inputs for other functions. Check the Calibration/Configuration documents supplied with your flowmeter.

1.1.4 Batch Indicator

Series 1200 Transmitters have a display indicator which shows the operator that a batch is in progress. When a batch is started, the letter "**b**" appears at the extreme left of the top line of the display. This indicator remains visible until the batch stops. If the batch ("**b**") suspends, a "**B**" replaces this symbol.

1.1.5 Keyboard Batch Control

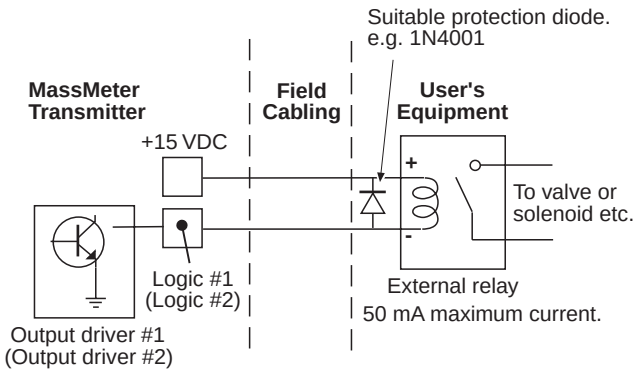
Batching can be started and stopped using the keyboard controls as follows:

a) Enter the Batch Menu by pressing the ● key. The display shows the prompt, "▲▼● START BATCH".

b) To start the batch press all three keys ▲▼●.

c) The display now shows **BM**, (the batch limit) and the batch indicator **b** appears at the left side of the display showing that the batch has started. The batch now runs until the batch limit is reached and then stops automatically.

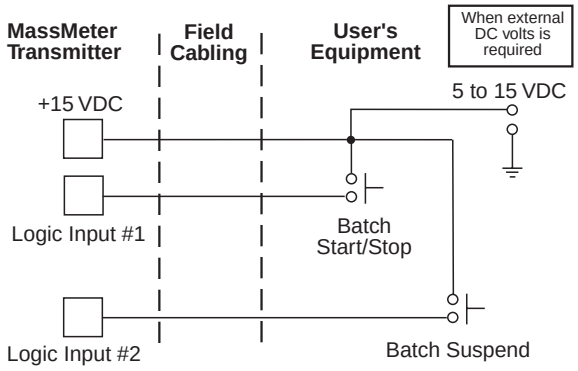
d) To stop the batch before it is complete, press the ● key two times. This display now shows the prompt, "▲▼● STOP BATCH". To stop the batch press all three keys ▲▼●.



See Installation and Operating Instructions for Terminal Numbers

Fig. 1.1 Batching Output Drivers Wiring Connections

Caution. Use 'User +15V' supply with 'Logic #1' and 'Logic #2' terminals for Drivers #1 and #2 respectively. These drivers are solid state devices with maximum rating of 50mA. Wire external relay (Solid State, Grayhill 70S2 Series or equivalent.) as shown.



See Installation and Operating Instructions for Terminal Numbers

Fig. 1.2 Remote Input (Batch Start/Stop) Wiring Diagram

Note. Batch Start/Stop/Suspend switches are Normally Open (NO) Momentary Contact switches.

The Batch Menu can be expanded by using passwords 2 and 3. Password 2 allows the user to set the batch limit BM. Password 3 enables the user to set up the batch mode and associated parameters.

...1 BATCHING

Table 1.1 Batch Menu

Password Level 0 (No access to Batch Menu).

Password Level 1 (Fixed batch only.)

Symbol	Description	Units
stl	Starts Batch (User prompt)	
BM	Batch limit	mass
B	Batch totalizer	mass
S	Total	mass
Fx	Mass flow rate	mass/time
T	Temperature	temperature

Password Level 2 (Lets user change size of batches.)

Symbol	Description	Units
stl	Starts Batch	
BM	Permits changes in Batch size	mass
B	Running Batch totalizer	mass
S	Total	mass
B1	Program	
B2	Program	
B3	Program	
B4	Program	
B5	Program	
B6	Program	
Fx	Mass flow rate	mass/time
T	Temperature	temperature

Password Level 3

Symbol	Description	Units
▲▼●	Starts Batch	
BM	Batch limit	mass
B	Batch totalizer	mass
Σ	Totalizer	mass
B1	Program	
B2	Program	
B3	Program	
B4	Program	
B5	Program	
B6	Program	
Fx	Dampened flow rate	mass/time
T	Temperature	temperature
Bα	Valve timing comp.	time
Bβ	Batch stop drain	mass
Bσ	Batch preset	mass
Bm	Batch mode	0, 1, 2, 3
Be	Batch stop on error	0 or 1
Re	Batch relay control	
2B	Second line in Batch	symbol

2 PID

2.1 PID Setup

Series 1200 transmitters are supplied with a built-in P.I.D. controller which can be used for a large number of control applications.

To find the response time of the system, measure the time it takes to go from zero to 100% full scale stabilized flow and also the time from 100% flow back to zero.

If a valve is used instead of a pump, record the time it takes to go from fully closed to fully open and also from fully open back to fully closed.

This is the limiting factor of the response of the system.

Multiply the lesser of the two measured times (in seconds). This gives the required Ct in ms. Enter this value for Ct. 10 ms is the minimum value.

e.g. if the minimum measured time was 3 seconds, Ct would be 3 x 20 = 60 ms.

After arriving at the response time of the system to full scale flow the remaining variables Cg, Cd, Ci and Ct, need to be set.

Ct

Ct is the time taken between each update cycle.

Cg

Cg is the controller gain value. It determines the rate of acceleration that the “loop” reaches when trying to “correct” itself from one setpoint to another. The “loop” is the entire system (pump, valves, controller, etc.). A high Cg tries to reach the setpoint faster than a low Cg. Care should be taken not to set Cg to a value which over shoots the setpoint and requires a large value of Cd and Ci to correct for it. A change in Cg always has the largest effect on the systems response.

Cd

Cd is the derivative control term. Its effect is to slow the rate of change of the measured value towards the setpoint. It is normally used to reduce setpoint overshoot. The larger the value, the greater the damping effect.

Ci

Ci is the integral control term. Its effect is to remove any offset between the measured value and the setpoint value. Without integral control, all control loops come to rest with an offset between the measured value and the setpoint. This is because the gain and the derivative term are only active when either the measured value or the setpoint are changing. If Ci is set too high, the system oscillates.

2.1.1 Getting Started

The first thing that must be done is to span the outputs (ex. I1, I2, fr). Whichever output is to be used must be configured for the appropriate setpoints according to the process. The values of Ct, Cg, Cd and Ci are set at the factory for average PID control rates. Depending on the response of the system, the initial values may need to be increased or decreased. This determination is up to the individual who sets up the system since each process has its own unique characteristics.

The best way to tune a PID loop is to log each change to the parameters and see what happens to the process. Since all processes are different there is not a standard set of numbers to use as set up values. The system must be tuned with a trial and error type of approach. This is why it is important that each change to the parameters is logged and the resulting change is noted. Expect to spend quite some time to completely set up a PID system for each application.

Set up Examples:

Below is an example of how to set up the MassMeter's outputs for PID controls:

Current #1 Output Menu	PID Menu
ID = C	CS = 25 kg
EN - 1	Fx = Current flow rate
Om = 4 mA	C = Current PID output
Om = 20 mA	C+ = 1
Vm = 0%	CI = Setpoint value (ex: Fx = mass, VF=volumetric)
VM = 100%	Cg = 2
Oa = 4 mA	Cd = 0.5
1^r = 0	Ci = 0.25
	Ct = 50 msec

Note. All PID Setup should be done with **C+=0** in PID Menu. After setup is complete, set **EN=1** in Current 1 Menu, then set **C+=1**. When disabling PID function, always set **C+=0**, first.

Table 2.1 PID Menu

Symbol	Description	Units
Password Levels 0,1 and 2		
PID Parameters		
Cs	Setpoint	mass/time
Fx	Mass flow rate	mass/time
C	PID output	percent
Password Level 3		
PID Parameters		
Cs	Setpoint	mass/time
Fx	Mass flow rate	mass/time
C	PID output	percent
C+	PID enable	0 or 1
CI	Programmable ID	symbol
Cg	PID gain	number
Cd	PID deprivative time	number
Ci	PID integration time	number
Ct	PID sample time	number
C0	PID constant	percent
2C	PID menu second line	symbol

3 ALARMS

3.1 Introduction

ABB MassMeter Transmitters have two types of alarms: System Alarms and User Defined Alarms.

System Alarms indicate difficulty with the system and are not programmable by the user – see the Installation and Operating Instruction Manual.

3.2 User Defined Alarms

Series 1200 Transmitters with Version S7*H8 software include up to six User Defined Alarms. These alarms can be programmed to trigger when process parameters exceed preset limits set by the operator.

For example, if the typical flow rate for a particular process line is normally 30 to 60 lb/min. Large flow deviations outside this range usually mean there is a problem with the process. User Alarm A could be programmed to trip an alarm if the flow dropped below 10 lb/min or exceeded 70 lb/min; thus alerting the operator to a potential process problem.

3.3 General Information

User Alarms are labelled “A” through “F” and are initially set to the most commonly used parameters as shown in the User Alarm Menu. This menu also shows the message which appears on the display when the alarm occurs. Note that Alarm F shows a “generic” message.

It is important to note that each of the six alarms may be tied to one of the various parameters listed in Table 3.1. However, each alarm always displays the same message shown in the menu, regardless to which parameter it is tied (e.g., if Alarm D is tied to frequency (**fr**), the display message still reads **high batch** if the programmed frequency limit is exceeded).

In addition to displaying an alarm message on the display, all User Defined Alarms also output on Driver #3. This alarm output can then be used to trigger a remote annunciator or other peripheral device as shown in Figure 3.1.

3.3.1 User Alarm Menu

No passwords: Only allows the user to observe the alarm parameter, such as flow. The table below shows the 6 alarms and their default settings.

Table 3.1 User Alarm Menu

Symbol	Alarm Message	Default Setting
Alarm A	low/high flow	Flow alarm (ID symbol=Fx)
Alarm B	low/high total	Totalizer alarm (ID = Σ)
Alarm C	low/high density	Density alarm (ID = D)
Alarm D	low/high batch	Batch alarm (ID = B)
Alarm E	low/high temperature	Temperature alarm (ID = T)
Alarm F	low/high limit alarm	Generic alarm (ID = si)

Password 1: Allows the user to preview the alarm variables.
Password 2: Allows the user to change alarm variables.

3.3.2 Alarm Parameters

Table 3.2 lists the parameters which can be selected for the User Alarms. Please note that parameters marked with a diamond (◆) are functional only when certain options have been enabled (e.g., density, volumetric flow, %Mass, etc.)

Table 3.2 Alarm Parameters

Symbol	Description	Units
Fx	Mass flow rate	mass/time
fr	Tube frequency	Hz
T	Temperature	temperature
D	◆ Density	density
SG	◆ Specific gravity	SGU
Σ	Resettable totalizer	mass
ΣΣ	Non-resettable totalizer	mass
RΣ	Reverse total	mass
NΣ	Net mass total	mass
B	Batch totalizer	mass
VF	◆ Volumetric flow rate	volumetric flow
VΣ	◆ Volumetric total	volume
RV	◆ Reverse volumetric total	volume
NV	◆ Net volumetric total	volume
Fa	◆ Flow rate of phase A	flow
Fb	◆ Flow rate of phase B	flow
Σa	◆ Totalized flow for phase A	mass
Σb	◆ Totalized flow for phase B	mass
%a	◆ % phase A make up by weight	percent
%b	◆ % phase B make up by weight	percent
a%	◆ Density for phase A	density
b%	◆ Density for phase B	density
C	Controller output (PID)	percent
W1	Reserved work parameter	percent
si	Sensor signal voltage	millivolts
Vw	Net Oil function (special programming)	
Vo	" "	
Sw	" "	
So	" "	
%w	" "	
%o	" "	
Dw	" "	
Do	" "	
Ts	" "	
Aw	" "	
Ww	" "	
Wo	" "	
GF	" "	
GS	" "	
An	Analog input	
W3	Reserved work parameter	mass/time
W4	Reserved work parameter	mass
W5	Reserved work parameter	density
W6	Reserved work parameter	temperature
$\Omega\overline{x}$	Filtered phase	time
Ωf	Normalization factor	frequency
F	Internal mass flow in kg/sec.	mass/time
NF	Net mass flow rate	mass/time
Nv	◆ Net volumetric flow rate	volumetric flow
F%	Percent full scale flow rate	percent

3.3.3 Setting User Alarms

a) To enter the Alarm Menu, press the ● key. The first alarm is Alarm - “A”. To sequence to different alarms, press ▲ or ▼.

b) No passwords enabled only allows the user to view the alarm parameter. To view the alarm parameter, press ▲▼● with the selected “alarm” on the display. For example, when Alarm A is displayed and the ▲▼● are pressed the display shows:

F XX.XXX lb/min.

c) Password 1 allows the user to view all alarm variables but not change them. Again to view the variables for a certain alarm, press ▲▼● for the selected alarm. The display shows the alarm pointer ID symbol with the actual alarm parameter pointed to. You can then scroll up or down to view the following variables for each alarm.

Table 3.4 Password 1

Symbol	Description	Units
ID	Alarm pointer item	ID symbol
EN	Enable or disable alarm	0 or 1
LV	Low limit	units of item pointed to
HV	High limit	units of item pointed to
F	Pointed to parameter	units of item pointed to

d) Password 2 enabled allows the user to change the variables under an alarm. The variables are again accessed by pressing ▲▼● for the selected alarm. To change a variable follow the standard procedure for changing an item. The variables are the same as described in the previous section.

e) To change alarm settings under Password 2. Pressing the three keys, ▲▼● allows the user to view the alarm parameter, in the case of Alarm - “A” the parameter is automatically mass flow **F**.

Note that now the user is able to see the exact ID symbol that the alarm is set to.

ID	F	mass flow
EN	0 or 1	to enable or disable the output

Then by sequencing the "up" key, alarm low and high values can be viewed.

Symbol	Number	Units (programmable)		
	Lv	0.00	kg/hr	Low Limit
	Hv	5000.00	kg/hr	High Limit
	F	(blank)	kg/hr	

f) Sequence the display by pressing the up ▲ key until the required symbol displays.

g) To change a value - pressing the three keys, ▲▼● allows data to be changed.

h) To enter the new number, press the ● key.

i) Make sure that the proper units are selected, that is, lbs, kgs or liters. This can be done by pressing the ▼● keys.

3.3.4 User Alarm Outputs

All User Defined Alarms output on Driver #3, which can be used to trigger a remote annunciator or other peripheral device, when alarm conditions occur. Driver #3 has an open collector output, which requires a "pull-up" voltage to operate, and is capable of switching up to 600 mA maximum current/39V maximum.

If the peripheral device connected to Driver #3 is TTL/CMOS compatible, transmitter power can be used to actuate the device. Figure 3.1 illustrates a typical wiring diagram for this case.

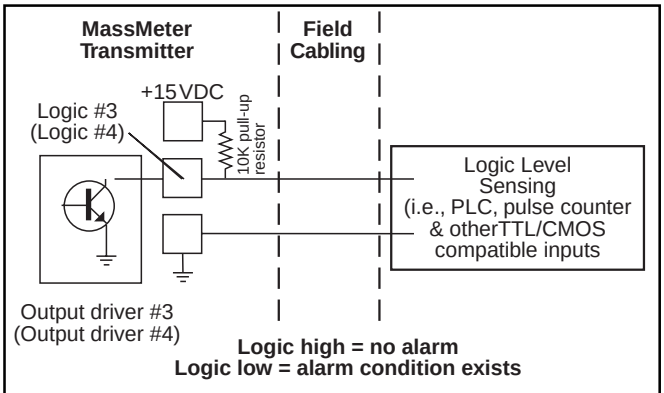


Fig. 3.1 Alarm Wiring Connections

Caution. Some peripheral devices may require more than 50 mA @ 15 VDC to operate. In this case, an external power relay must be used as shown in Fig. 3.2. Relay coil (e.g. Grayhill #70S2-04-B-06-S or equivalent) rated at 12VDC, 50 mA maximum current.

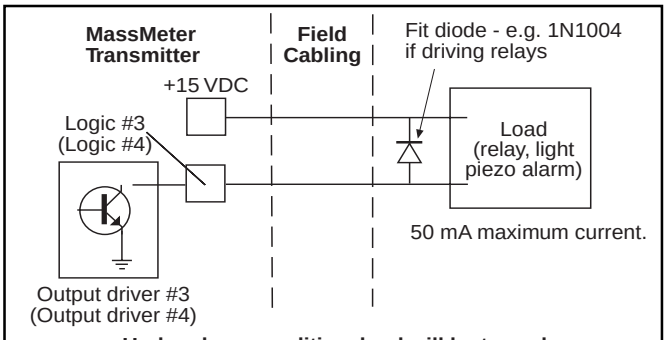


Fig. 3.2 Alarm Wiring Connections

Note. User Defined Alarms (process alarms) are limit alarms which can be programmed by the user and output on Driver #3 ('Logic #3' terminal). Error Alarms (system alarms), are factory preset and output on Driver #4 ('Logic #4' terminal).

4 TOTAL/VOLUME

4.1 Introduction

The Total/Volume Menu, as its name implies, serves a dual function. This menu contains all the various system Totalizers available (except for Batch). It also displays all the volumetric flow parameters when Density and/or Volumetric Flow options have been enabled.

The basic Total/Volume Menu displays only the mass flow totalizers, but it can be expanded using higher password levels and/or enabling density-related parameters. For simplicity, four separate types of Total/Volume Menus are listed according to the type of Density options enabled:

- Mass only (no Density enabled)
- Volumetric (Density or Volumetric options enabled)
- %Mass - Insoluble (Density with curve-fit option)
- %Mass - Soluble (Density with curve-fit option)

Each type of menu shows the various parameters available according to password level. A detailed listing of the entire Total/Volume Menu with all options and passwords enabled is shown in Section 6 of this manual.

4.2 Using the Totalizers

All of the totalizers displayed in the Total/Volume Menu contain the symbol (Σ) and automatically totalize their respective parameters whenever there is flow going through the sensor. These totalizers may all be simultaneously reset to zero at any time (except for ΣΣ) using a single key stroke. The Non-Resettable Totalizer (ΣΣ) cannot be reset, except with a factory level password.

To reset the Totalizers, enter the Total/Volume Menu (if you are already in this menu, press the ● key two times). You should see the display prompt "▲▼● RESET TOTAL". Press all three keys (▲▼●) to reset. All totalizers (except for ΣΣ) reset to zero and then begin counting.

4.3 "Wrap Limit"

The term "Totalizer Wrap Limit" originated with mechanical counters which would reset to zero after all the dials reached "9" (e.g., the odometer on a car reaching 99999.9 miles and then turning over to 00000.0). The "Wrap Limit" is simply the number at which the counter resets (in our odometer example, the "Wrap Limit" would be 100,000 miles).

The electronic totalizers in the ABB MassMeter Transmitter are much more versatile. The user can select the "Wrap Limit" of the mass flow totalizer (Σ) by setting Σ**o** in the Total/Volume Menu.

Note. When mass totalizer (Σ) wraps, **volumetric**, **%** and **%b** totalizers wrap at the same time. Wrap limits can be set up to 10,000,000 for maximum 8-digit resolution on the totalizer. Higher limits can be selected, but the display reverts to scientific notation format with 4-digit resolution up to a maximum of 9.999×10^{99}.

✶ **Note.** The wrap limit Σ**o** can only be set in kg units. For example, if a wrap limit of 10,000,000 lbs is desired, Σ**o** should be set to a value of 4535924 kg.

4.4 Reverse Flow Inhibit

ABB MassMeter transmitters have a Reverse flow selector (**R+** in the Setup Menu), which allows the user to select whether the unit displays a negative flow rate if there is backward flow through the sensor. Transmitters are initially set to display negative flow (**R+** = 1) to assist in start-up.

The Reverse flow setting is an important consideration for totalizer applications. With **R+** set to 1, any backward flow through the sensor displays as a negative flow rate and the totalizers **decrement**. For the majority of totalizer applications, **R+** should be set to 0. This prevents any backward flow from showing as a negative flow rate and affecting the totalizer readings.

Table 4.1 Total/Volume Menu (Mass Totalization Only)

Password Level 0, 1, 2

Symbol	Description	Units
▲▼●	Resets totalizer	prompt
Σ	Master resettable totalizer	mass
ΣΣ	Master non-resettable totalizer	mass
Σ+	Mass forward total	mass
Σ-	Mass reverse total	mass
Fx	Mass flow rate	mass/time

Password Level 3

Symbol	Description	Units
▲▼●	Resets totalizer	prompt
Σ	Master resettable totalizer	mass
ΣΣ	Master non-resettable totalizer	mass
Σo	Totalizer wrap limit	number
Σ+	Mass forward total	mass
Σ-	Mass reverse total	mass
Fx	Mass flow rate	flow
VΣ	Master Volumetric total	volume
VF	Master Volumetric flow rate	vol./time
RV	Reverse volume total	
NV	Net Volumetric total	volume
RΣ	Return (slave) mass total	mass
NΣ	Net Mass total	mass
RF	Return (slave) mass flow rate	mass/time
NF	Net Mass flow rate	mass/time
Nv	Net Volumetric flow rate	vol./time
2Σ	Second line in Total	symbol

4.5 Density/Volume Enabled

If **D+** (Density enable) is set to **1**, then the following display lists are enabled in the Total/Volume Menu. (Note the levels of passwords required for specific display lists.)

4.5.1 Density Modes (for versions 65 to 71)

In the latest release of the software for the K-Flow Transmitter, there are now 5 density modes (plus "density off") which are accessible under parameter D+. These are described as follows:

D+ = 0	Density off
D+ = 1	Standard Density ON
D+ = 2	API Gravity
D+ = 3	Degree Baume
D+ = 4	Gas Volumes at reduced conditions
D+ = 5	Normalized Liquid Density
D+ = 6	Net Oil

D+ = 0 (Density OFF)
The density displays are OFF. Values of density, SG, volume rate/total, etc. are not shown but are still computed and available using a PC and the program MFC (DOS) or Screwdriver (Windows™).

D+ = 1 (Standard Density ON)
The density displays are ON. The SG value is calculated as follows:

$$SG = \frac{\text{Density}}{GF} = \frac{\text{Measured Density}}{\text{Density of water at } 60^\circ F}$$

For reference, densities other than "water at 60°F", enter the reference density in g/cc into GF.

D+ = 2 (API Gravity)
The density displays are ON. The SG value displays the API Gravity, which is calculated from the liquid SG as follows:

$$API = \frac{141.5}{SG} - 131.5$$

For example, if the SG is 1, the API Gravity is 10. If the SG is 0.6112, the API Gravity is 100. The API Gravity only operates for SG values from 0.6112 up to 10.

D+ = 3 (Degrees Baume)
The density displays are ON. The SG value displays the Degrees Baume density. This has two different formulas depending upon whether the fluid has an SG above or below that of water.

For SG < 1; Baume = (140/SG) - 130
For SG > 1: Baume = 145 - (145/SG)

D+ = 4 (Gas Volumes at reduced conditions)
Density displays are ON. The SG display is normalized to the density at a certain reference temperature. For this function, the following must be entered:

a) Set the value of **a%** to the density of the gas at the chosen reference conditions (e.g., if the gas is air and the reference is NTP, set **a%** to 1.2928 kg/m3. This is a floating

point number, but full resolution is not available on the meter display. To obtain full resolution, the value should be entered using a PC and the K-Flow “MFC” or “Screwdriver” software utility.

b) Set the value of **DW** (**TD** in S70H8 software) to the reference temperature [for NTP, this is 0°C (32°F); for STP it is 15.5°C (60°F)].

The volume rate/total then displays in the appropriate reduced volume (i.e., volumes at NTP, STP, etc.)

D+ = 5 (Normalized Liquid Density)
Density displays are ON but the Density D displays the value of Density at a reference temperature, calculated using linear normalization as follow:

D = Actual Density [1 + **GF** (**T** - **DW****)]

** **DW** in software versions prior to S70H8, use **TD** in S70H8.

For this function to operate, the following must be entered:

a) Set **GF** = Value of the coefficient of expansion of the fluid (this is a negative number)

b) Set **DW** = Temperature base (prior to S70H8) (i.e., temperature at which no correction for temperature is to be made)

c) Set **TD** = Temperature base for density calculations in S70H8 (i.e., temperature at which no correction for temperature is to be made)

D+ = 6 (Net Oil functions)
Net Oil functions are described in the Net Oil Manual supplement .

Since an ABB MassMeter measures directly the mass flow rate and the absolute density of a fluid, it is a simple matter to calculate directly from these two parameters the volumetric flow rate. The base equation used is:

Volumetric Rate = Mass Rate ÷ Density

For example, if the mass rate of a fluid with an absolute density of 0.8 grams per cubic centimeter were to be 400.0 gr per minute, then the volumetric rate would be calculated to be 500.0 cubic centimeters per minute - at process pressure and temperature.

Various constants are also applied to transform the internal units of measure to other, perhaps more useful, display units - e.g., gallons per minute, barrels per hour, etc.

✶ **Note.** All internal calculations are completed in a matter of milliseconds; the entire string of calculations is continuously repeated.

4.5.2 Density Modes (Versions after S71H8)

(D+=0 to D+=5, as for previous versions)
D+ = 6 Normalized Density
This Density mode ‘normalizes the density to a value defined by the density calculation temperature base (**TD**) using polynomial coefficient **a1**.

The formula is:

Density = Measured density(1+a1(T–TD))

The measured density is copied to **W5**. This provides the actual density in **W5** for use as required, and the normalized density in **D**, which is effectively in the volumetric totalizer.

D+ = 7 (Net Oil functions)
As for **D+ = 6** in previous versions.

Table 4.2 Total/Volume Menu

Password Level 0, 1 or 2

Symbol	Description	Units
▲▼●	Resets the resettable totalizer	prompt
Σ	Resettable totalizer	mass
ΣΣ	Non-resettable totalizer	mass
Σ+	Positive flow totalizer	mass
Σ-	Negative flow totalizer	mass
Fx	Mass flow rate	mass/time
VΣ	Volumetric total	volume
VF	Volumetric flow rate	vol./time

Password Level 3

Symbol	Description	Units
▲▼●	Resets the resettable totalizer	prompt
Σ	Resettable totalizer	mass
ΣΣ	Non-resettable totalizer	mass
Σo	Totalizer “reset-to-zero” value	mass
Σ+	Positive flow totalizer	mass
Σ-	Negative flow totalizer	mass
Fx	Mass flow rate	mass/time
VS	Volumetric total	volume
VF	Volumetric flow rate	vol./time
2Σ	Total menu second line	symbol

4.6 %Soluble Calculations (with D+ = 1)

The Total/Volume Menu contains the calculated %Mass of the soluble target fluid, as well as its flow rate. These are displayed under the headings **% a, % b**, **Fa** and **Fb** - the percent-by-mass and flow rate of the target fluid and the carrier fluid(s), respectively.

To configure the software as a soluble %Mass, use the **brix/ fraction** switch, **bm,** found in the Set-Up Menu. If it is set to **1**, the %Mass calculations assume a soluble mixture. (If it is set to **0**, the %Mass calculations assume an insoluble mixture.)

…4 TOTAL/VOLUME

Table 4.3 Total/Volume Menu

Password Level 0, 1 or 2

Symbol	Descriptions	Units
▲▼●	Resets totalizer	prompt
Σ	Resettable totalizer	mass
ΣΣ	Non-resettable totalizer	mass
Σ+	Positive flow totalizer	mass
Σ-	Negative flow totalizer	mass
Fx	Mass flow rate	mass/time
VF	Volumetric flow rate	vol./time
VΣ	Volumetric total	volume
D	Density	units
%a	Percent mass of component **a**	percent
%b	Percent mass of component **b**	percent
Fα	Flow rate of component **a**	mass/time
Fβ	Flow rate of component **b**	mass/time
Σa	Flow totalizer for component **a**	mass
Σb	Flow totalizer for component **b**	mass

Password Level 3

Symbol	Description	Units
▲▼●	Resets totalizer	prompt
Σ	Resettable totalizer	mass
ΣΣ	Non-resettable totalizer	mass
Σo	Totalizer overflow reset value	mass
Σ+	Positive flow totalizer	mass
Σ-	Negative flow totalizer	mass
Fx	Mass flow rate	mass/time
VF	Volumetric flow rate	vol./time
VS	Volumetric total	volume
D	Density	units
%a	Percent mass of component **a**	percent
%b	Percent mass of component **b**	percent
Fα	Flow rate of component **a**	mass/time
Fβ	Flow rate of component **b**	mass/time
Σa	Flow totalizer for component **a**	mass
Σb	Flow totalizer for component **b**	mass
2Σ	Total menu second line	symbol

5 SERIAL PROTOCOL

5.1 Introduction

The ABB MassMeter's standard serial protocol is an ASCII coded poll/response procedure. The standard setup is 1200 baud full duplex mode, 7 bits of data with even parity and one stop bit.

The following paragraphs define the message structure.

5.2 The Poll

The poll from the host can have one of four formats as follows:

Read Data - Reads any RAM data
SOH, ADR, 'R', ID, DIM, CR.

Write Data - Write data to the RAM only
SOH, ADR, 'C', ID, DIM, DATA, CR.

Write EE Data - Writes data into the EE as well as RAM
SOH, ADR, 'E', ID, DIM, DATA, CR.

Write control flag - Sets or clears control flags
SOH, ADR, 'I', ID, FLAG, CR.

These messages initialize actions in the mass flow meter as indicated above and a response back to the host. The responses are outlined below.

5.3 The Response Message

The response to each command/poll is given below:

Response to Read Data - Response to 'R' message
SOH, ADR, ERR, ID, DIM, DATA, CR.

Response to Write to RAM - Response to 'C' message
SOH, ADR, ERR, ID, DATA, CR.

Response to Write to EE - Response to 'E' message
SOH, ADR, ERR, ID, DIM, DATA, CR.

Response to Write to flag - Response to 'I' message
SOH, ADR, ERR, ID, DATA, CR.

5.4 Codes

The codes referenced in Sections 5.2 and 5.3 are defined here:

SOH - Start of header, ASCII (1) or Chr$(1)

ADR - Mass flow meter address, this is one ASCII character. In a normal configuration each transmitter has a unique ADR. This character allows the programs to select any one of several meters. The default address which is '0' causes all meters to ignore their ADR and respond regardless of their address setting.

✶ **Note.** If multiple meters are on line, sending commands to ADR '0' will cause all meters to obey the command immediately. This can be used to synchronise different meters in batching applications, for example. However, **DO NOT** send commands to ADR '0' which would cause the meters to output data, otherwise all meters attempt to talk simultaneously, causing communication errors.

ID - Parameter identification number. This is a one byte number ASCII encoded hex number from 0 to 255 sent high nibble first.

DIM - This variable defines the Units attribute within the defined type. The defined type for each item number should be retained in a table. Appendix B is a listing of the current table of types by item number. Appendix A is a list of all possible data types, and their corresponding list of units by DIM.

ERR - Error status byte. This is a single byte sent as two ASCII characters with the high nibble sent first. This byte represents the General Error level status of the transmitter. Below is a list of all possible general error readings and their meanings.

General error level's are defined as follows:

Level	Condition
00	No error condition present
01	User programmable field Low limit exceeded
02	User programmable field High limit exceeded
04	Serial communication error Type A
08	Serial communication error Type B
10	Output High or Low limits exceeded
20	Hardware limits exceeded
40	Serious fault detected
80	Fatal hardware fault

For information on errors please reference Appendix C which defines the 56 possible error conditions that a transmitter can report and how to properly interpret them.

DATA - The data has a length depending on type. Text characters are sent in an ASCII string of (Example: software version). Other types can be floating point or two byte numbers sent high byte high nibble first, continuing in that order, as well as single bytes or bits.

FLAG - This is sent as one byte, either an ASCII '1' (clear) or '0' (set).

CR - Carriage Return, ASCII (13) or Chr$(13)

5.5 Examples

The IBM PC program MFC implements this procedure for calibration, control and monitoring functions. The program User MFC is a platform on which you can easily develop your own custom applications using basic or a Quick Basic compiler. The manual, source disk, and cable are available from the ABB MassMeter Sales Department. The disk has the program file MFC.EXE that is an executable file. This program was written and compiled using the version 4.5 of the Microsoft™ Quick Basic Compiler. Also provided is the source file for the User MFC program. This source code can be used as a starting platform on which you can build custom applications in basic or quick basic, or as a reference for programming other types of computer systems.

5.6 Conversion of Floating Point to Decimal

Floating point data from the mass flow meter can be converted to a decimal number in the PC as shown in the following example written in BASIC. The number, labelled NB$ is treated as a string. The converted number in decimal is labelled R. The line numbers represent those used in the User MFC program.

```
1100 '****CONVERT MFC FLOATING POINT NUMBER TO A DECIMAL NUMBER****
1101 IF nb$ = "00000000" THEN R = 0: GOTO 1119
1102 BN$ = MID$(nb$, 1, 2): GOSUB 1120: B0 = BN
1103 BN$ = MID$(nb$, 3, 2): GOSUB 1120: B1 = BN
1104 BN$ = MID$(nb$, 5, 2): GOSUB 1120: B2 = BN
1106 BN$ = MID$(nb$, 7, 2): GOSUB 1120: B3 = BN
1110 SIGN = 1: IF B3 >= 128 THEN SIGN = -1: B3 = B3 - 128
1112 EX = (2 * B3): IF B2 >= 128 THEN EX = EX + 1: B2 = B2 - 128
1114 B2 = B2 + 128
1116 R = SIGN * (B2 * (2 ^ -7) + B1 * (2 ^ -15) + B0 * (2 ^ -23))
* 2 ^ (EX - 127)
1119 RETURN
1120 BB$ = LEFT$(BN$, 1): GOSUB 1130: BN = BB * 16
1122 BB$ = MID$(BN$, 2, 1): GOSUB 1130: BN = BN + BB
1129 RETURN
1130 BB = ASC(BB$)
1132 IF BB >= 48 AND BB <= 58 THEN BB = BB - 48: RETURN
1134 IF BB >= 65 AND BB <= 70 THEN BB = BB - 55: RETURN
1136 BB = 0
1139 RETURN
```

5.7 Decimal to Floating Point Conversion

Conversions from PC decimal number to the MassMeter floating point follow the next example. The number starts with R, a PC decimal number and completes the conversion to a string labelled NB$. The line numbers represent those used in the User MFC program.

```
1200 '****CONVERT A DECIMAL NUMBER TO MFC FLOATING POINT FORMAT****
1201 SIGN = 0: EX = 127
1202 IF R = 0 THEN nb$ = "00000000": GOTO 1239
1203 IF R < 0 THEN SIGN = 1: R = -R
1204 IF R < 1 THEN R = R * 2: EX = EX - 1: GOTO 1204
1206 IF R >= 2 THEN R = R / 2: EX = EX + 1: GOTO 1206
1208 R = R / 2
1210 B2 = INT(R * 256): R = (R - (B2 / 256)) * 256
1212 B1 = INT(R * 256): R = (R - (B1 / 256)) * 256
1213 B3 = (SIGN * 128) + (EX / 2)
1214 B0 = INT(R * 256)
1216 B3 = (SIGN * 128) + INT(EX / 2)
1218 B2 = (B2 AND 127) + ((EX AND 1) * 128)
1220 BN = B0: GOSUB 1230: nb$ = BN$
1222 BN = B1: GOSUB 1230: nb$ = nb$ + BN$
1224 BN = B2: GOSUB 1230: nb$ = nb$ + BN$
1226 BN = B3: GOSUB 1230: nb$ = nb$ + BN$
1229 RETURN
1230 BN$ = HEX$(BN)
1232 IF LEN(BN$) < 2 THEN BN$ = "0" + BN$: GOTO 1232
1239 RETURN
```

These two conversions are by far the most complex required. The other numbers in the flow meter are either single byte or two byte hex numbers; or single bit numbers. Their conversions can be found in the basic source code at the following line numbers.

a) Line 500 converts HEX to decimal
b) Line 600 converts decimal to HEX format.

5.8 Hints for Successful Use of RS-422/485 Communications

a) There have been questions as to which terminal is high and which is low. The specifications on the transceiver we are using (DS75176B) does not show a high or low, it shows "output" and "output not". We have marked "output" as high and "output not" as low. If one configuration is not working with the current polarity, try the other. You can not damage the device by hooking it up with improper polarity.

b) Do not rule out a software problem. You would be tempted to think that if communication works from the front jack, any software flaws would be eliminated. Actually that is not necessarily so. When talking through the RS-232 the transmit and receive lines are separate. RS-232 is generally “Full Duplex” this simply means that the interface can talk and listen at the same time. RS-422 on the other hand is a 2 wire system, it is “Half Duplex”. By design it can talk or listen but not both simultaneously. The potential problem occurs when you convert from RS-232 to RS-422. The converter often combines the transmit and receive lines. This causes any message sent into the converter through the transmit line to feed back as received data through the receive line. Since the RS-232 side is still operating in Full Duplex, this data is now in the receive buffer. The program needs to be smart enough to know that any data it sends, is echoed back, and must be ignored.

5.9 Appendix A

DIM - This variable defines the Units attribute within the defined type. The defined type for each item number should be retained in a table. This is a listing of the current table of types by item number.

Table No.	Description	Table Data [Format]
1	Percent	0 = “Data” 1 = “%”
2	Time1 (3 Choices)	0 = “Sec” 1 = “ms” 2 = “us”
3	Density	0 = “gr/cc” 1 = “kg/m3” 2 = “lb/ft3” 3 = “lb/gal”
4	Flow	0 = “kg/s” 1 = “k/m” 2 = “kg/h” 3 = “g/m” 4 = “lb/s” 5 = “lb/m” 6 = “lb/h” 7 = “oz/m”
5	Current	0 = “mA”
6	Frequency	0 = “Hz” [***.**] 1 = “Hz” [***]
7	Temperature	0 = “deg C” 1 = “deg F” 2 = “deg R” 3 = “deg K”
8	Mass	0 = “kg” [*.**] 1 = “lbs” [*.**] 2 = “kg” [*.***] 3 = “kg” [*.*] 4 = “lbs” [*.***] 5 = “mT” 6 = “oz”
9	Floating Point	0 = data 1 = data/1000 2 = data*1000 3 = data/1000000 4 = data*1000000
10	Volume	0 = “liters” 1 = “gal” 2 = “bbl”
11	Volumetric Flow	0 = “L/min” 1 = “L/hr” 2 = “cc/m” 3 = “gps” 4 = “gpm” 5 = “gph” 6 = “bb/h” 7 = “bb/m”
12	Voltage	0 = “V” 1 = “mV”
13	D to A	0 = “ ” 1 = “%”
14	Volt Time (Phase)	0 = “VSec” 1 = “mVs” 2 = “uVs”
15	Time 2 (2 Choices)	0 = “Sec” 1 = “ms”

Table No.	Description	Table Data [Format]
16	Byte	0 = “ ”
17	Text	0 = “ ”
18	Bit	0 = “ ”
19	Wait (Delay)	0 = “*10 ms”
20	2 Byte Integer	0 = “ ”
21	Record	0 = “ ”
22	ID	0 = “ ”
23	Temporary	0 = “ ”
24	1 Byte Integer	0 = “ ”

5.10 Appendix B

The ABB MassMeter Transmitter has 56 reportable error conditions. The Error information can be interpreted in 2 ways, general or detail. The general error information is offered each time the transmitter communicates. This is called the Error Status Byte. It is shown as ERR in the communication string definition. This error byte contains a hex number that indicates which error levels have errors present. Errors are broken into groups, referred to as levels.

Each of the 8 Levels contain up to 8 individual errors. General error level’s are defined as follows:

Level	Condition
00	No error condition present
01	User programmable field. Low limit exceeded
02	User programmable field. High limit exceeded
04	Serial communication error Type A
08	Serial communication error Type B
10	Output High or Low limits exceeded
20	Hardware limits exceeded
40	Serious fault detected
80	Fatal hardware fault

To obtain the detail error information the user must send a read data request for Error Bytes (Item 13) using the standard MFC read data poll. The transmitter responds as follows:

|————DATA————|

Trans. Response:									
SOH, ADR,									
ERR, ID, DIM,	XX	XX	XX	XX	XX	XX	XX	XX	CR
	^^	^^	^^	^^	^^	^^	^^	^^	^^
Error Byte	L1	L2	L3	L4	L5	L6	L7	L8	

Each of the values of L1 through L8 is a hex number representing the status of the 8 detailed errors within that level. The Detailed errors, with respect to the bit settings for each level, are as follows:

Level 1 Errors ... User programmable field. Low limit exceeded

Bit	Condition
00	No Error Condition Within This Level
01	User Alarm A Exceeds Low Limit
02	User Alarm B Exceeds Low Limit
04	User Alarm C Exceeds Low Limit
08	User Alarm D Exceeds Low Limit
10	User Alarm E Exceeds Low Limit
20	User Alarm F Exceeds Low Limit
40	User Alarm G Exceeds Low Limit
80	User Alarm H Exceeds Low Limit

Level 2 Errors ... User programmable field High limit exceeded

Bit	Condition
00	No Error Condition Within This Level
01	User Alarm A Exceeds High Limit
02	User Alarm B Exceeds High Limit
04	User Alarm C Exceeds High Limit
08	User Alarm D Exceeds High Limit
10	User Alarm E Exceeds High Limit
20	User Alarm F Exceeds High Limit
40	User Alarm G Exceeds High Limit
80	User Alarm H Exceeds High Limit

Level 3 Errors ... Serial communication error type A

Bit	Condition
01	Full Duplex Error
02	Command Error
04	ID Error
08	Unit Error
10	Long Message Error
20	Conversion Error
40	SOH Sequence Error
80	Short Message Error

Level 4 Errors ... Serial communication error type B

Bit	Condition
01	Receive Time-out
02	Overrun Error
04	Answer Error
08	Master Timeout
10	Master Duplex Error
20	Not Defined
40	Not Defined
80	Not Defined

Level 5 Errors ... Output Low or High Limits Exceeded

Bit	Condition
01	Current #1 Low Limit
02	Current #2 Low Limit
04	Frequency Low Limit
08	PID Low Limit
10	Current #1 High Limit
20	Current #2 High Limit
40	Frequency High Limit
80	PID High Limit

Level 6 Errors ... Hardware Limits Exceeded

Bit	Condition
01	Current #1 Limit
02	Current #2 Limit
04	Frequency Limit
08	Total Error
10	Total Cleared
20	Backup Warning
40	X-RAM Warning
80	Flow Condition

Level 7 Errors ... Serious Fault Detected

Bit	Condition
01	Measurement Error
02	Resonance Error
04	RTD Error
08	No Sensor Signal
10	Driver Error
20	Not Defined
40	Not Defined
80	Not Defined

Level 8 Errors ... Fatal Hardware Fault

Bit	Condition
01	Code Error
02	X-RAM Error
04	EEProm Error
08	Backup Error
10	Not Defined
20	Not Defined
40	Not Defined
80	Not Defined

5.11 Appendix C

UnTbl(0)	=	17
UnTbl(1)	=	24
UnTbl(2)	=	9
UnTbl(3)	=	17
UnTbl(4)	=	17
UnTbl(5)	=	17
UnTbl(6)	=	17
UnTbl(7)	=	18
UnTbl(8)	=	18
UnTbl(9)	=	18
UnTbl(10)	=	16
UnTbl(11)	=	16
UnTbl(12)	=	16
UnTbl(13)	=	16
UnTbl(14)	=	16
UnTbl(15)	=	16
UnTbl(16)	=	18
UnTbl(17)	=	24
UnTbl(18)	=	17
UnTbl(19)	=	17
UnTbl(20)	=	14
UnTbl(21)	=	18
UnTbl(22)	=	18
UnTbl(23)	=	14
UnTbl(24)	=	1
UnTbl(25)	=	14
UnTbl(26)	=	9
UnTbl(27)	=	24
UnTbl(28)	=	24
UnTbl(29)	=	1
UnTbl(30)	=	14
UnTbl(31)	=	18
UnTbl(32)	=	18
UnTbl(33)	=	14
UnTbl(34)	=	14
UnTbl(35)	=	1
UnTbl(36)	=	18
UnTbl(37)	=	1
UnTbl(38)	=	18
UnTbl(39)	=	14
UnTbl(40)	=	24
UnTbl(41)	=	14
UnTbl(42)	=	24
UnTbl(43)	=	24
UnTbl(44)	=	9
UnTbl(45)	=	4
UnTbl(46)	=	9
UnTbl(47)	=	4
UnTbl(48)	=	1
UnTbl(49)	=	9
UnTbl(50)	=	9
UnTbl(51)	=	23
UnTbl(52)	=	9
UnTbl(53)	=	9
UnTbl(54)	=	24
UnTbl(55)	=	4
UnTbl(56)	=	4
UnTbl(57)	=	11
UnTbl(58)	=	1
UnTbl(59)	=	4
UnTbl(60)	=	6
UnTbl(61)	=	2
UnTbl(62)	=	6
UnTbl(63)	=	6
UnTbl(64)	=	9
UnTbl(65)	=	7
UnTbl(66)	=	7
UnTbl(67)	=	7
UnTbl(68)	=	7
UnTbl(69)	=	24
UnTbl(70)	=	3
UnTbl(71)	=	9
UnTbl(72)	=	9
UnTbl(73)	=	9
UnTbl(74)	=	9
UnTbl(75)	=	9
UnTbl(76)	=	7
UnTbl(77)	=	24
UnTbl(78)	=	24
UnTbl(79)	=	23
UnTbl(80)	=	8
UnTbl(81)	=	18
UnTbl(82)	=	8
UnTbl(83)	=	9
UnTbl(84)	=	8
UnTbl(85)	=	8
UnTbl(86)	=	24
UnTbl(87)	=	24
UnTbl(88)	=	24
UnTbl(89)	=	24
UnTbl(90)	=	8
UnTbl(91)	=	18
UnTbl(92)	=	18
UnTbl(93)	=	8
UnTbl(94)	=	24
UnTbl(95)	=	15
UnTbl(96)	=	8
UnTbl(97)	=	8
UnTbl(98)	=	18
UnTbl(99)	=	24
UnTbl(100)	=	11
UnTbl(101)	=	10
UnTbl(102)	=	10
UnTbl(103)	=	10
UnTbl(104)	=	4
UnTbl(105)	=	4
UnTbl(106)	=	8
UnTbl(107)	=	8
UnTbl(108)	=	1
UnTbl(109)	=	1
UnTbl(110)	=	3
UnTbl(111)	=	3
UnTbl(112)	=	18
UnTbl(113)	=	9
UnTbl(114)	=	9
UnTbl(115)	=	9
UnTbl(116)	=	9
UnTbl(117)	=	9
UnTbl(118)	=	9
UnTbl(119)	=	6
UnTbl(120)	=	5
UnTbl(121)	=	5

UnTbl(122) = 6
UnTbl(123) = 21
UnTbl(124) = 21
UnTbl(125) = 21
UnTbl(126) = 18
UnTbl(127) = 18
UnTbl(128) = 18
UnTbl(129) = 18
UnTbl(130) = 18
UnTbl(131) = 22
UnTbl(132) = 8
UnTbl(133) = 20
UnTbl(134) = 9
UnTbl(135) = 19
UnTbl(136) = 21
UnTbl(137) = 21
UnTbl(138) = 19
UnTbl(139) = 24
UnTbl(140) = 16
UnTbl(141) = 21
UnTbl(142) = 20
UnTbl(143) = 20
UnTbl(144) = 20
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UnTbl(152) = 1
UnTbl(153) = 9
UnTbl(154) = 9
UnTbl(155) = 9
UnTbl(156) = 19
UnTbl(157) = 1
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UnTbl(159) = 24
UnTbl(160) = 24
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UnTbl(162) = 22
UnTbl(163) = 22
UnTbl(164) = 22
UnTbl(165) = 22
UnTbl(166) = 22
UnTbl(167) = 22
UnTbl(168) = 22
UnTbl(169) = 22
UnTbl(170) = 20
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UnTbl(173) = 16
UnTbl(174) = 18
UnTbl(175) = 9
UnTbl(176) = 24
UnTbl(177) = 24
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UnTbl(189) = 13
UnTbl(190) = 12
UnTbl(191) = 13
UnTbl(192) = 12
UnTbl(193) = 22
UnTbl(194) = 22
UnTbl(195) = 22
UnTbl(196) = 22
UnTbl(197) = 22
UnTbl(198) = 22
UnTbl(199) = 22

6 MENUS

6.1 Password Menu

Keys	Display	Description
	● = Password	Password menu
●	pw	Display activated passwords. Here, none are activated.
▲	p1 0	Password p1
▲	p2 0	Password p2
▲ ▼ ●	p2 00000	Activate changing the p2 password.
▲ ●(2x)	p2 00000	Increments cursor to right twice.
▲ (6x)	p2 00600	Increments value up 6.
▲ ●	p2 00600	Increments cursor to right.
▲ ●	p2 00600	Increments cursor to right.
▲ (4x)	p2 00604	Increments value up to 4.
●	pw2	Accepts value and shows password p2 is enabled.

6.2 Measurement Menu

Symbol	Password Level	Description	Units
Fx	1,2,3,4	Mass flow through the meter.	mass/time
F%	1,2,3,4	Percent full scale flow rate. It is the percent of **FM,** the mass flow maximum rate.	percent
Σ	1,2,3,4	Reset mass flow totalizer	mass
Σ+	1,2,3,4	Forward Totalizer	mass
Σ-	1,2,3,4	Reverse Totalizer	mass
SG	1,2,3,4	Specific Gravity	
T	1,2,3,4	Temperature of flow tubes	temp.
D	1,2,3,4	Density	density
B	1,2,3,4	Batch	
BM	1,2,3,4	Batch setpoint	
fr	1,2,3,4	Tube resonant frequency	freq.
Ωx̄	4	Filtered phase	time
Ωf	3,4	Average value for phase with no zero phase deducted.	time
FF	3,4	Flow factor for mass flow based on mass flow - phase relationship.	mass
Fα	3,4	Flow “alpha” scaler to adjust mass flow rate.	number
FT	4	Flow temperature factor.	flow
TB	4	Flow temperature base	temp.
Ωc	3,4	Normalization coefficient (factory adjustment)	mv
a%	3,4	Phase A density	density
b%	3,4	Phase B density	density
Dα	4	Density coeff. A	number
Dβ	4	Density coeff. B	number
GF	4	Specific gravity factor (SGU=density/ [SGU factor])	SGU
DT	4	Temp. coeff. for density	number
DW	4	Temp. base used for density	temp.
TD	4	Temp. base used for SG	temp.

Symbol	Password Level	Description	Units
Δf	3,4	Slug flow trigger used to detect slug flow. A slug of air causes a moderate change in frequency that could cause an erroneous flow reading. When frequency instability exceeds this value it causes the flow reading and outputs to lock on last reading until frequency comes back into limits.	freq.
FM	3,4	Full Scale Flow	
FL	3,4	Low flow cut off, expressed as a percentage of **FM.** When measured flow rate is below this limit, it is considered to be zero. Display and outputs will indicate zero flow rate and totalizers will remain static.	
Fd	3,4	Flow rate dampening coefficient used to stabilize the digital display. Does not dampen outputs. 0 - no dampening. 250 max dampening.	number
Td	3,4	Temperature dampening - same as **Fd** but for temperature indication.	number
Dd	3,4	Density dampening	number
An	1,2,3,4	Analog input %	
Ad	4	Analog input dampening	
si	1,2,3,4	Sensor coil voltage reading	mv
do	1,2,3,4	Drive level reading	percent
2M	3,4	Pointer for second line in Measurement Menu. Points to the **ID** for the item to be displayed on second line.	symbol

6.3 Batch Menu

Symbol	Password Level	Description	Units
▲▼●	1,2,3	Starts Batch	prompt
BM	1,2,3	Batch limit	mass
B	1,2,3	Batch totalizer	mass
Σ	1,2,3	Total	mass
B1	2,3,4	Program	
B2	2,3,4	Program	
B3	2,3,4	Program	
B4	2,3,4	Program	
B5	2,3,4	Program	
B6	2,3,4	Program	
Fx	1,2,3,4	Mass flow rate	mass/time
T	1,2,3,4	Temperature	temp.
Bα	3,4	Valve timing comp.	time
Bβ	3,4	Batch stop drain	mass
Bσ	3,4	Batch preset	mass
Bm	3,4	Batch mode	0, 1, 2, 3
Be	3,4	Batch stop on error	0 or 1
FF	4	K-factor	number
fr	4	Frequency	frequency
Re	3,4	Batch relay control	
2B	3,4	Pointer for second line in Batch Menu. Points to the **ID** for the item to be displayed on second line.	symbol

✶ **Note.** Batch Menu is not accessible without a password.

6.4 PID Menu

Password Symbol	Level	Description	Units
Cs	1,2,3	Setpoint. This is the PID user controllable set point value.	mass/time
Fx	1,2,3	Mass flow rate	mass/time
C	1,2,3	PID output. This is the value on the output channel.	percent
C+	3	PID control function when set to 1. If set in 0, the function is disabled.	
CI	3	Programmable ID (i.e., Fx=Mass, VF=Volumetric)	symbol
Cg	3	PID gain. This is the “p” term.	number
Cd	3	PID derivative time. This is the “d” term.	number
Ci	3	PID integration time. This is the “I” term.	number
Ct	3	PID sample time. This is the refresh time used to pace the recalculation of the output.	number
C0	3	PID constant. This is a constant value to be output on the channel	percent
2C	3	Pointer for second line in PID Menu. Points to the **ID** for the item to be displayed on second line.	symbol

6.5 Calibrate Zero Menu

Password Symbol	Level	Description	Units
▲▼●	1,2,3,4	Starts zero	prompt
Δc	1,2,3,4	Zero cycle counter	number
Zo	1,2,3,4	Zero reference (engr. units)	mass/time
Δ	3,4	Zero reference in mVs (phase units)	time (var.)
ΔΔ	4	Zero phase in calibration	time (var.)
Ωx̄	3,4	Processed phase	time (var.)
T	1,2,3,4	Temperature	temp.
fr	1,2,3,4	Tube frequency	frequency
s%	4	Sensor warning setpoint	percent
Δe	3,4	Phase range in zero	time (var.)
ΔZ	3,4	Zero flow cutoff error % of FM	percent
ΔT	4	Zero temp. coeff.	flt.
2Z	3,4	Pointer for second line in Calibrate Zero Menu. Points to the **ID** for the item to be displayed on second line.	symbol

6.6 **Parameters Selection List** (for Alarm & Output Menus)

Password Symbol	Level	Description	Units
Fx	2,3,4	Mass flow rate	mass/time
fr	2,3,4	Tube frequency	Hz
T	2,3,4	Temperature	temp.
D	2,3,4	Density	density
SG	2,3,4	Specific gravity	SGU
Σ	2,3,4	Resettable totalizer	mass
ΣΣ	2,3,4	Non-resettable totalizer	mass
RΣ	2,3,4	Reverse total	mass
NΣ	2,3,4	Net mass total	mass
B	2,3,4	Batch totalizer	mass
VF	2,3,4	Volumetric flow rate	vol. flow
VΣ	2,3,4	Volumetric total	volume
RV	2,3,4	Reverse volumetric total	volume
NV	2,3,4	Net volumetric total	volume
Fa	2,3,4	Flow rate of phase A	flow
Fb	2,3,4	Flow rate of phase B	flow
Σa	2,3,4	Totalized flow for phase A	mass
Σb	2,3,4	Totalized flow for phase B	mass
%a	2,3,4	Percent phase A make up by weight	percent
%b	2,3,4	Percent phase B make up by weight	percent
a%	2,3,4	Density for phase A	density
b%	2,3,4	Density for phase B	density
C	2,3,4	Controller output (PID)	percent
W1	2,3,4	Reserved work parameter	prgrmble
si	2,3,4	Sensor signal voltage	millivolts
Vw	2,3,4	Volumetric flow - water phase NOC	
Vo	2,3,4	Volumetric flow - oil phase NOC	
Σw	2,3,4	Volumetric total - water phase NOC	
Σo	2,3,4	Volumetric total - oil phase NOC	
%w	2,3,4	NOC water content	
%o	2,3,4	NOC oil content	
Dw	2,3,4	NOC corrected water density	
Do	2,3,4	NOC corrected oil density	
Ts	2,3,4	NOC water cut test time	
Aw	2,3,4	NOC average water cut	
Ww	2,3,4	NOC current water density	
Wo	2,3,4	NOC current oil density	
GF	2,3,4	NOC gross vol. flow rate	
GΣ	2,3,4	NOC gross volumetric total	
An	2,3,4	Analog input %	
W3	2,3,4	FP Register #3	
W4	2,3,4	FP Register #4	
W5	2,3,4	FP Register #5	
W6	2,3,4	FP Register #6	
Ωx̄	2,3,4	Filtered phase	
Ωf	2,3,4		
F	2,3,4	Internal mass flow in kg/sec.	mass/time
NF	2,3,4	Net mass flow rate	mass/time
Nv	2,3,4	Net volumetric flow rate	vol. flow
F%	2,3,4	Percent full scale flow rate	percent

6.7 Application Menu

Symbol	Password Level	Description	Units
Fx	1,2,3,4	Mass flow rate	mass/time
Σ	1,2,3,4	Resettable totalizer	mass
D	1,2,3,4	Density	density
B	1,2,3,4	Batch totalizer	mass
Cs	1,2,3,4	PID Setpoint	flow
An	1,2,3,4	Analog input %	
W1	2,3,4	FP Register #1	
W3	2,3,4	FP Register #3	
W4	2,3,4	FP Register #4	
W5	2,3,4	FP Register #5	
W6	2,3,4	FP Register #6	
Wb	2,3,4	Work bit	
AΣ	2,3,4	Checksum of APP program	

6.8 Set Up Menu

Symbol	Password Level	Description	Units
▲▼●	1,2,3,4	Display test	prompt
SE	1,2,3,4	Serial number for the electronics. This can be viewed at any password level but only set at **p4.**	text
SN	1,2,3,4	Serial number for the sensor. This can be viewed at any password level but only set at **p4.**	text
#	1,2,3,4	Tag number	text
i	1,2,3,4	Not used	text
A#	1,2,3,4	Customer's process fluid. (User enter letters & numbers)	text
(Date)	1,2,3,4	Release date for this software version.	text
t	1,2,3,4	Time of day	time
d	1,2,3,4	Date	text
K-XXX	4	Sensor type. The data in this item is 2, 20, 100, 250, etc. Entering the exact format enables a “cold start”. This initializes all parameters in EEPROM. Once this takes place it cannot happen again until the model number is re-entered. This is independent of the fact that the correct data may be in the parameter.	text
CΣ	4	This in the program space checksum.	number
Ev	2,3,4	Event counter (Last time a critical output is changed for weight & meas. use.)	text
Ed	2,3,4	Last error date	text
Et	2,3,4	Last error time	time
E	2,3,4	Last error	
Zd	2,3,4	Zero calibration date	date
Zt	2,3,4	Zero calibration time	time
Qd	2,3,4	Flow factor calibrations date	date
Qt	2,3,4	Flow factor calibrations time	time
Σr	4	Totalizer reset. If set to one, causes the totalizer to reset. The 0 or 1 is then cleared automatically.	0 or 1

6.8 Setup Menu (continued)

Password Symbol	Level	Description	Units
EB	3,4	Backup. This parameter is normally 0. Setting it to a 1 initiates memory backup and verification. Once complete, the display automatically returns to zero. Note that this backup process is different than that for V5.04.	0 or 1
ER	4	Restore. Setting this to a 1 causes the memory to be restored from EE. After completion this parameter is reset to zero.	0 or 1
Wb	3,4	Work bit	
W1	3,4	Floating point register #1	number
W3	3,4	Floating point register #3	number
W4	3,4	Floating point register #4	number
W5	3,4	Floating point register #5	number
W6	3,4	Floating point register #6	number
si	4	Sensor coil voltage	millivolt
do	4	Driver level	percent
da	4	Driver control midpoint	
dm	4	Driver gain	
dl	4	Driver set limit	
ds	4	Driver step correction	
de	4	Driver start level	
dt	4	Driver update time	
sh	4	Driver hammer threshold	
Wt	4	Driver start-up wait time	
ss	4	Sensor coil setpoint	millivolt
sc	4	Millivolt scaler	number
Δ	4	Zero phase	time
ΔΔ	4	Original zero phase, recorder at end of last zero.	time
s%	4	Sensor warning limit % of 60mV	
Δe	4	Zero range filter in microsec.	time
ΔT	4	Zero temperature factor.	number
ΔZ	4	Zero flow enable. The current phase measurement must be less than this value or the zero process does not start in terms of **FM**, max. flow rate.	time

Password Symbol	Level	Description	Units
Ωa	3,4	Phase filter ring buffer length.	number
Ωc	3,4	Normalization factor (flow)	number
Ωf	3,4	Normalization factor (frequency)	number
Ωk	4	Low end linearization factor in phase units.	number
Ωs	4	Slope in phase units of the low end correction factor.	number
FF	4	Flow factor, factory set	number
FM	4	Maximum flow rate	flow
FL	4	Low flow limit in percent of the maximum flow rate.	percent
Fα	4	This is factory set to 1.000 and can be accessed by a user to "fine tune" the calibration, like a rate multiplier as a function of 1.000.	number
FT	4	Flow rate temp. coefficient	number
Kd	4	Density coef. to the flow rate	number
Fd	4	Dampening on flow rate	number
TB	4	Temp. base flow, flow rate compensation	temp.
Δf	4	Slug flow trigger level -[Hz/sec] A rate-of-change frequency parameter that causes the outputs to hold and totalizations to continue at the hold level. Used for Transient slugs, causes an “s” alarm preset at .05 Hz/sec.	freq./time
Σo	4	Totalizer overflow wrap value set in kilograms.	number
Tm	4	Minimum temperature.	temp.
TM	4	Maximum temperature.	temp.
Tc	4	Zero temp. scaler	number
TC	4	Temp. slope scaler	number
Td	4	Dampening for temperature.	number
Dα	4	Density coefficient A.	number
Dβ	4	Density coefficient B.	number
GF	4	Specific gravity factor (SGU= density/[SGU factor]).	SGU
DT	4	Temp. coefficient for density.	number

Symbol	Password Level	Description	Units
DW	4	Temp. base used for density.	temp.
TD	4	Base temp. for SG	temp.
Dd	4	Dampening for density.	number
fm	3,4	Min. freq. (“f” alarm) - [Hz]: The low freq. alarm trigger level. This alarm suspends all totalization and sets the outputs to their alternate values.	freq.
fM	3,4	Max. freq. (“f” alarm) - [Hz]: The high freq. alarm trigger lever. This alarm suspends all totalization and sets all outputs to their alternate values.	freq.
C+	4	PID function enable.	0 or 1
Cs	4	PID set point. Setpoint for control mode - [kg/sec or as selected]: this is set to any desired flow rate. In the controller mode, the second (density) channel is used to drive a pump or valve. The output is automatically modulated to maintain the desired flow.	flow
Ct	4	PID sample time.	wait
Cg	4	PID gain on “position” error.	number
Cd	4	PID gain on “derivative” error.	number
Ci	4	PID gain on “integration” error.	number
a%	3,4	Phase a density (at temp. TW) Density for Fluid A - [g/cc or as selected] This is the density of the target fluid. It is used to calculate the % Solids of a two-component fluid (at temp. TW).	density
b%	3,4	Density for Fluid B - [g/cc or as selected]: This density of the carrier fluid is used to calculate (at temperature TW).	density
c3	3,4	Density c3	number
c2	3,4	Density c2	number
c1	3,4	Density c1	number

Symbol	Password Level	Description	Units
b3	3,4	Polynomial coef. [numbers]: these numbers are used to curve-fit %Mass applications, i.e., solutions. (Consult factory.)	number
b2	3,4	Same as b3, above. (Consult factory.)	number
b1	3,4	Density b1 polynomial.	number
a3	3,4	Density a3 polynomial.	number
a2	3,4	Density a2 polynomial.	number
a1	3,4	Density a1 polynomial.	number
We	1,2,3,4	NOC well data printer	
Ww	1,2,3,4	NOC current water density	
Wo	1,2,3,4	NOC current oil density	
An	1,2,3,4	Analog input %	
As	4	Analog slope	
Ao	4	Analog offset	
Ad	4	Analog dampening	
bm	3,4	Density/brix control switch.	0, 1 or 2
2Z	4	Parameter displayed in second line in Zero Menu.	symbol
2M	4	Parameter displayed in second line in Measurement Menu.	symbol
2B	4	Parameter displayed in secµond line in Batch Menu.	symbol
2Σ	4	Parameter displayed in second line in Total Menu.	symbol
2C	4	Parameter displayed in second line in PID Menu.	symbol
21	4	Parameter displayed in second line in Current 1 Menu.	symbol
22	4	Parameter displayed in second line in Current 2 Menu.	symbol
2f	4	Parameter displayed in second line in Frequency Menu.	symbol
2F	4	Frequency #2 second line	
2A	4	Parameter displayed in second line in Limit Menu.	symbol

6.8 Setup Menu (continued)

Symbol	Password Level	Description	Units
2m	3,4	Enables dual display mode in second display line. If set to zero it disables the second line. If set to 1, only the graphic alarm character shows during alarm conditions. If set to a 2, alarm messages in English override the second line of the display.	0, 1 or 2
D+	3,4	Density Menu enable.	0 or 1
%+	3,4	Percent Solids Menu enable.	0 or 1
N+	3,4	Net Flow Menu enable.	0 or 1
B+	3,4	Batch Menu enable. When set to a 1 enables the Batch Menu and the start/stop batch mode. When set to a 2 enables the Batch menu and the start/suspend mode via optical input 2.	0 or 1
P+	3,4	PID Menu enable.	0 or 1
R+	3,4	Enables bi-direction flow (reverse flow) including negative totalization.	0 or 1
Σ+	3,4	Enables the Total/Volume Menu.	0 or 1
A+	3,4	Enables the Alarm Menu.	0 or 1
f+	3,4	Enables the Frequency Output Menu.	0 or 1
a+	3,4	Application menu control	
F+	3,4	Frequency #2 out menu	
1+	3,4	Enables the Current #1 Menu.	0 or 1
2+	3,4	Enables the Current #2 Menu.	0 or 1
Z+	3,4	Enables the Zero Menu to display. NOTE: even though the menu is disabled the instrument may be zeroed via optical input 1.	0 or 1
Ii	3,4	If set to 1 the isolated card is enabled, if 0 the normal card is used.	0 or 1

Symbol	Password Level	Description	Units
K+	3,4	If set to 0, the keyboard reset is disabled, if set to 1, automatic reset is enabled. Returns unit to Measurement Menu.	0 or 1
At	3,4	Time out from keyboard inactivity to Measurement Menu.	time
Ai	3,4	Index into Measurement Menu at time out.	number
Re	3,4	Batch relay control	
ct	4	Communications timeout	number
BR	3,4	Communication baud rate.	number
CA	3,4	Communication address.	number
PA	3,4	Polling address	number
PR	3,4	Communications protocol	

6.9 Total/Volume Menu

Net Flow Enabled (D+ = 1) (N+ = 1)

Symbol	Password Level	Description	Units
▲▼●	1,2,3,4	Resets totalizer	prompt
Σ	1,2,3,4	Master Resettable totalizer	mass
ΣΣ	1,2,3,4	Master Non-resettable totalizer	mass
Σo	1,2,3,4	Totalizer wrap limit	number
Σ+	1,2,3,4	Mass forward total	mass
Σ-	1,2,3,4	Mass reverse total	mass
Fx	1,2,3,4	Master Mass flow rate	mass/time
VΣ	1,2,3,4	Master Volumetric total	volume
VF	1,2,3,4	Master Volumetric flow rate	vol./time
RV	1,2,3,4	Reverse volume total	
NV	1,2,3,4	Net Volumetric total	volume
RΣ	1,2,3,4	Return (slave) mass total	mass
NΣ	1,2,3,4	Net Mass total	mass
RF	1,2,3,4	Return (slave) mass flow rate	mass/time
NF	1,2,3,4	Net Mass flow rate	mass/time
Nv	1,2,3,4	Net Volumetric flow rate	vol./time
2Σ	1,2,3,4	Pointer for second line in Total/Volume Menu. Points to the **ID** for the item to be displayed on second line.	symbol

6.10 Current Outputs #1 (#2)

Symbol	Password Level	Description	Units
I1 (I2)	1,2,3,4	The value of the output current in mA.	current
ID	2,3,4	This is the selected item (e.g., **Fx**) represented on the output channel and allows the selection of the parameter to be used.	symbol
EN	2,3,4	This enables the Current 1 Out, if set to 1. If set to 0, it disables the output.	0 or 1
Om	2,3,4	The min. value selected as the output min. level. Usually 4 mA.	current
OM	2,3,4	The max. value selected as the output full scale level. Usually 20 mA.	current
Vm	2,3,4	The minimum **ID** value that corresponds to the output minimum. See note #1.	engr. units
VM	2,3,4	This is the max. **ID** value on the channel. (e.g., 100 kg/hr)	engr. units
Oa	2,3,4	This is the alternate value for the channel to be output during alarm conditions or when 1^r is set to a 1.	current
1^r (2^r)	2,3,4	Normally 0, but when set to 1, the transmitter forces the alternate output **Oa** to its set value. Good for simulating outputs.	0 or 1
21 (22)	3,4	Pointer for second line in Current Outputs #1 (#2) Menu. Points to the **ID** for the item to be displayed on second line.	symbol

Note #1: For example - if **ID** is tied to **Fx** (flow), then **VM** and **Vm** have units of mass per time (e.g., kg/hr)

6.11 Frequency Out #1 (#2) & Pulse Out #1 (#2)

Symbol	Password Level	Description	Units
f1 (f2)	1,2,3,4	This is the present frequency on the channel when operating in the Frequency mode.	Hz
ID	2,3,4	This is the selected item (e.g., **Fx** (mass flow) represented on the output channel.	symbol
EN	2,3,4	This enables Frequency Out, if set to 1. If set to 0, it disables the output.	0 or 1
Om	2,3,4	The minimum value selected as the output minimum level.	Hz
OM	2,3,4	The maximum value selected as the output full scale level.	Hz
Vm	2,3,4	The minimum **ID** value that corresponds to the output minimum. See note #1.	engr. units
VM	2,3,4	This is the maximum **ID** value tied to the channel.	engr. units
Oa	2,3,4	This is the alternate value for the channel to be output during alarm or test conditions; user definable.	engr. units
f^r	2,3,4	Normally 0. When set to 1, forces the alternate output **Oa** to its set value. Good for simulating outputs.	Hz
Pulse Mode Parameters			
Pi	2,3,4	Pulse **ID** symbol. This selects the parameter to be represented by each pulse. Usually tied to total (Σ) or volumetric (**V**Σ) total. To select different output parameters.	symbol
Pw	2,3,4	Pulse width in microseconds or milliseconds (10000 microseconds =10 milliseconds). This only applies in the pulse mode of operation.	time
Ps	2,3,4	Units per pulse. For example, if the total S is selected for this output then 1.0 pounds may be selected by this parameter to trigger each pulse.	engr.units
Pm	2,3,4	Pulse mode. If set to 0 the channel operates in the frequency mode, i.e.,Hz/kg/min. If set to 1, the output operates in the pulse mode, with a pulse width range of 0 - 30,000 micro-seconds. If set to 2, the output again operates in pulse mode, but the effective pulse width range is now 0 - 30,000 milliseconds.	0, 1 or 2
2f (2F)	2,3,4	Pointer for second line in Frequency Out #1 (#2) and Pulse Out #1 (#2) Menu. Points to the **ID** for the item to be displayed on second line.	symbol

Note #1: For example - if **ID** is tied to **Fx** (flow), then **VM** and **Vm** have units of mass per time (e.g., kg/hr).

✶ **Note**. Frequency 2 Menu is programmed the same as Frequency 1 Menu.

7.1 Numeric Listing

Item	Symbol	Description	Units
0	Sd	Software date (mm-dd-yy)	text
1	CA	Comm Address	number
2	BR	Comm Baud rate	flt.
		-300	
		-600	
		-1200	
		-2400	
		-4800	
3	V?	Software Version	text
4	K-	Sensor type (K-xxxx)	text
		-2	
		-5	
		-20	
		-40	
		-100	
		-250	
		-500	
		-2500	
		-4000	
		-15000	
		-XXXX	
5	SE	Txm Serial Number	text
6	SN	Sensor Serial Number	text
7	.S	System reset	bit
8	LX	Factory init	bit
9	EL	Cold start	bit
10	^	Start bits	byte
11	_	Status bit	byte
12	.	Stop bits	byte
13	er	TXM Error	record
14	o	Opto inputs	byte
15	c	Relay/opto out	byte
16	i-	Keyboard control	bit
17	ic	Keyboard code	number
18	L1	Display line#1	text
19	L2	Display line#2	text
20	Δ	Meter Zero	time
21	^Δ	Start zero cal	bit
22	.Δ	End zero cal	bit
23	ΔΔ	Zero during cal	time
24	s%	Sensor Warning Limit	
25	Δε	DT zero range	
26	ΔT	Zero temp coef.	flt.
27	Ev	Event counter	
28	Δc	Zero cycle counter	number
29	ΔZ	Zero Flow Limit	percent
30	Ωt	Measured Phase	time
31	^M	Start measurement	bit
32	.M	End measurement	bit
33	Ω$\bar{x}$	Filtered phase	time
34	Mi	Modem init string	text
35	Qk	Critical phase	percent
36	Qs	Phase slope	bit
37	a+	Application Menu Control	
38	AΣ	Checksum of APP program	
39	TD	Base temperature for SG	

Item	Symbol	Description	Units
40	Ωa	Phase dampening	number
41	Ωf	CPU clock normalization	
42	Eh	Error History	
43	R+	Reverse flow control	
44	Ωc	Normalization factor	
45	F	Raw Flow (undampened mass flow)	flt.
46	FF	Flow Factor	flt.
47	FM	Full scale flow	flow
48	FL	Low Flow Cutoff	percent
49	FT	Flow temp factor	flt.
50	Fα	Flow scaler	
51	Tc	Temperature min corr	
52	TC	Temperature max corr	
53	Kd	Flow density corr	flt
54	Fd	Flow Damping	number
55	RF	Reverse mass flow rate	flow
56	NF	Net flow rate	flow
57	Nv	Net volumetric flow	vol. flow
58	F%	% of full scale flow	percent
59	Fx	Mass flow	flow
60	fr	Tube frequency	freq.
61	ft	Resonant period	
62	fm	Frequency low limit	freq.
63	fM	Frequency high limit	freq.
64	Zo	Zero in flow units	
65	T	Temperature	temp.
66	TB	Temperature base	temp.
67	Tm	Temp low limit	temp.
68	TM	Temp high limit	temp.
69	Td	Temp. Damping	temp.
70	D	Density	density
71	SG	Specific gravity	flt.
72	Dα	Dens. coef. a	flt.
73	Dβ	Dens. coef. b	flt.
74	GF	SG base	flt.
75	DT	Dens temp coef	flt.
76	DW	Dens temp base	temp.
77	Dd	Density dampening	number
78	D+	Dens. menu control	number
		0 = Off - No Density Display	
		1 = On - Standard	
		2 = On - API Gravity	
		3 = On - Degrees Baume	
		4 = On - Gas Volumes at Reduced Conditions	
		5 = On - Normalized Liquid Density	
		6 = On - Net Oil Computer	
79	Z+	Zero menu control	bit
		0 = Off	
		1 = On - V1.0 Zero Calibration	
		2 = On - V2.0 Zero Calibration	
80	Σ	Mass total {resettable}	mass
81	Σr	Totalizer reset	bit
82	ΣΣ	Non-resettable totalizer	mass
83	Σo	Totalizer wrap limit	flt.
84	RΣ	Reverse mass total	mass

7.1 Numeric Listing (continued)

Item	Symbol	Description	Units
85	NΣ	Net mass total	mass
86	%+	Brix/% sol. enable	number
		0 = Brix	
		1 = Percent Mass	
87	N+	Net flow enable	number
88	Σ+	Totalizer menu control	number
89	A+	Alarm menu control	number
90	B	Batch totalizer	mass
91	^B	Start batch	bit
92	.B	Stop batch	bit
93	BM	Batch setpoint	mass
94	Bm	Batch mode select	number
		0 = Mass Batching	
		1 = %A Batching	
		2 = %B Batching	
		3 = Volumetric Batching	
95	Bα	Batch adder (time)	mass
96	Bβ	Batch adder (amount)	mass
97	Bσ	Batch preset (dribble)	mass
98	Be	Batch stop on error	bit
99	B+	Batch menu control	number
		0 = Off	
		1 = On - Start/Stop Batching	
		2 = On - Start/Suspend Batching	
		3 = On - Start/Stop Until Flow Batching	
100	VF	Volumetric flow rate	vol. flow
101	VΣ	Volumetric total	volume
102	RV	Reverse vol. total	volume
103	NV	Net vol. total	volume
104	Fa	Flow of phase A	flow
105	Fb	Flow of phase B	flow
106	Σa	Phase A total	mass
107	Σb	Phase B total	mass
108	%a	% Part A	percent
109	%b	% Part B	percent
110	a%	Density Part A	density
111	b%	Density Part B	density
112	bm	Frac/brix switch	bit
		0 = Insoluble Mixture	
		1 = Soluble Mixture	
113	a1	Brix coef. A1	flt.
114	a2	Brix coef. A2	flt.
115	a3	Brix coef. A3	flt.
116	b1	Brix coef. B1	flt.
117	b2	Brix coef. B2	flt.
118	b3	Brix coef. B3	flt.
119	Δf	Slug flow trigger	freq.
120	I1	Current #1 output	current
121	I2	Current #2 output	current
122	f1	Frequency #1 output	freq.
123	C1	Current #1	record
124	C2	Current #2	record
125	F1	Frequency #1	record
126	1_r	EN Alt Cur#1	bit
127	2_r	EN Alt Cur#2	bit
128	f_r	EN Alt Freq #1	bit

Item	Symbol	Description	Units
129	f+	EN Freq output	bit
130	Pm	Pulse mode enable	bit
131	Pi	Pulse ID	symbol
132	Ps	Pulse scaler	mass
133	Pw	Pulse width	number
134	c3	Brix coef. C3	flt.
135	ct	Comm Timeout	wait
136	AP	Application program	record
137	AL	Alarm table	record
138	At	Activity timeout	wait
139	Ai	Timeout menu index	number
140	pw	Active passwords	byte
141	pE	Reference passwords	record
142	p1	Control password (#1)	number
143	p2	Scaling password (#2)	number
144	p3	Calibration password (#3)	number
145	p4	Factory password (#4)	number
146	p5	Password #5	number
147	p6	Password #6	number
148	p7	Password #7	number
149	p8	Password #8	number
150	C+	PID enable	bit
151	Cs	PID Set Point	flow
152	C	PID output	percent
153	Ct	PID sample time	wait
154	Cg	PID gain	flt.
155	Cd	PID derivative time	flt.
156	Ci	PID integration time	flt.
157	C0	PID constant	percent
158	P+	PID menu control	bit
159	CI	PID input item ID	symbol
160	2m	Display 2nd line mode	number
		0 = Disable 2nd line	
		1 = Show Alarm Character	
		2 = Show Error Messages	
		3 = Show Date/Time	
161	2Z	Zero 2nd line display.	symbol
162	2M	Meas. menu 2nd line	symbol
163	2B	Batch menu 2nd line	symbol
164	2S	Total 2nd line	symbol
165	2C	PID 2nd line	symbol
166	21	Cur. #1 2nd line	symbol
167	22	Cur. #2 2nd line	symbol
168	2f	Frequency 2nd line	symbol
169	2A	Alarms 2nd line	symbol
170	CS	Program checksum	number
171	EB	Backup memory	bit
172	ER	Memory restore	bit
173	E	Enable bits	
174	Wb	Work bit	bit
175	W1	FP Register #1	
176	f+	Freq#1 menu control	number
177	1+	Current #1 menu	number
178	2+	Current #2 menu	number
179	K+	Display timeout enable	number

Item	Symbol	Description	Units
180	Ii	Current out select {isol}	number
		0 = Non Isolated	
		1 = Isolated	
181	c1	Brix coef. C1	flt.
182	c2	Brix coef. C2	flt.
183	si	Sensor voltage	
184	do	Driver Output	
185	dl	Driver Step limit	
186	Wt	Startup wait time	
187	dt	Driver update time	
188	ds	Driver Step correction189	dm
Driver gain			
190	ss	Sensor drive setpoint	
191	da	Driver control midpoint	
192	sh	Driver hammer threshold	
193	de	Driver start level	
194	sc	Sensor voltage scaler	
195	B1	Batch preset #1	
196	B2	Batch preset #2	
197	B3	Batch preset #3	
198	B4	Batch preset #4	
199	B5	Batch preset #5	
200	B6	Batch preset #6	
201	PR	Comm Protocol	
		0 = K-Flow Protocol	
		1 = HART™ Protocol	
		2 = Modem initialization	
202	PA	Polling Address	
203	Vw	Volumetric flow-water phase NOC	
204	Vo	Volumetric flow-oil phase NOC	
205	Σw	Volumetric total-water phase NOC	
206	Σo	Volumetric total-Oil phase -NOC	
207	%w	NOC water content	
208	%o	NOC oil content	
209	Dw	NOC corrected water density	
210	Do	NOC corrected oil density	
211	Ts	NOC Water cut test time	
212	Aw	NOC average water cut	
213	We	NOC well data pointer	
214	Ww	NOC current water density	
215	Wo	NOC current oil density	
216	t	Time of day	
217	d	Date	
218	W+	NOC start/stop control	
219	Wt	NOC start time	
220	Wd	NOC start date	
221	GF	NOC gross volumetric flow rate	
222	GΣ	NOC gross volumetric total	
223	#	Tag number	
224	i	Descriptor	
225	A#	Account Number	
226	An	Analogue Input %	
227	As	Analogue Slope	
228	Ao	Analogue Offset	
229	f2	Frequency#2 out	
230	F2	Frequency#2 (Record)	

Item	Symbol	Description	Units
231	f_r	EN Alt Freq#2	
232	fe	EN Freq#2 output	
233	Pm	Pulse#2 mode	
234	Pi	Pulse#2 ID	symbol
235	Ps	Pulse#2 size	mass
236	Pw	Pulse#2 width	number
237	2F	Frequency#2 2nd line	symbol
238	F+	FREQ#2 OUT menu,	
239	Σ+	Mass Forward Total	
240	Σ-	Mass Reverse Total	
241	Re	Batch Relay Control	
		0 = None of Relays	
		1 = Relay#1	
		2 = Relay#2	
		3 = Relay#1 and Relay#2	
242	W3	FP Register #3	
243	W4	FP Register #4	
244	W5	FP Register #5	
245	W6	FP Register #6	
246	Ad	Analogue damping	
247	Ed	Last error date	
248	Et	Last error time	
249	E	Last error text	
250	Zd	Zero Cal date	
251	Zt	Zero Cal time	
252	Qd	FF Cal date	
253	Qt	FF Cal time	
254	—	Sampling time	
255		Calculated Error	

NOTES

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Client Warranty

Prior to installation, the equipment referred to in this manual must be stored in a clean, dry environment, in accordance with the Company's published specification. Periodic checks must be made on the equipment's condition.

In the event of a failure under warranty, the following documentation must be provided as substantiation:

1. A listing evidencing process operation and alarm logs at time of failure.
2. Copies of operating and maintenance records relating to the alleged faulty unit.

IM/MASSM/AUG Issue 2

 Printed in UK (2.98)

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