

Accu-Wave Radar Gauge

Radar-Based Continuous Level Measurement

Operation Manual

DRAFT

Part No. 717790



TN Technologies

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Chapter 1 Introduction

The Accu-Wave Model 1440 Radar Level Gauge uses a microwave signal to continuously measure the level of the process material. The Accu-Wave can often provide better performance than sonic measurement systems, particularly in hostile environments, because the microwave signal is unaffected by mist, surface agitation, temperature changes, or pressure changes. The menu-driven user interface, with built-in help screens, is designed to make the gauge easy to set up and operate.

The Accu-Wave transmits a microwave signal that is reflected from the surface of the process material. The reflected signal or echo is received by the Accu-Wave. The Digital Signal Processing (DSP) software detects the echo and computes the distance to the liquid or solid material in the tank. The Accu-Wave firmware uses the distance measurement to calculate level, volume, and other user-selected measurements.

Description

The Accu-Wave Radar Level *gauge* consists of an integrated *sensor* and *transmitter* with the microwave sensor and transmitter circuitry combined on a single electronics board. The microwave signal is launched from the bottom of the board via the cup/probe assembly into the antenna (or probe). The antenna serves to focus the transmitted signal as well as to receive the reflected echo. Currently, the Accu-Wave is available with dielectric rod antennas (probes). Horn antennas will be available as a future option.

Antennas

The standard antenna configuration for the Accu-Wave gauge consists of a dielectric-filled, 1 inch O.D. stainless steel waveguide with a dielectric rod antenna. The dielectric rod antenna is available in either polypropylene or Teflon (PTFE). The stainless steel (SS 316) waveguide material is swaged (crimped) over the dielectric-fill material. The swage serves both as a process seal as well as a pressure seal. The PTFE antenna design also uses o-rings to ensure the integrity of the process seal at low temperatures. Both Viton and Kalrez o-rings are available.

Horn antennas will be as a future option, with diameters ranging from 2 to 8 inches.

Mounting Configurations

The dielectric rod antennas are fitted with a 1-inch NPT threaded bushing, welded to the waveguide. Welded flanges are also available – 150 lb. or 300 lb., with diameters ranging from 2 to 8 inches. Waveguides are available in 6, 9, 12, or 15 inch lengths, where the length refers to the portion of the waveguide that extends below the bushing or the flange. For optimum performance the end of the waveguide should reach to the bottom of the nozzle.

Level measurements can be continue to be made as the level of the process material rise above the bottom of the antenna to within ~3.5 inches of the bottom of the waveguide.

Measurement accuracy, however, is degraded when the process level is above the bottom of the probe.

Approvals

The Accu-Wave has been certified for use in hazardous locations as follows (approvals are pending as of 1 March 2000):

FM

- Class I, II, III, Division 1, Groups B, C, D, E, F, G
- Class I, II, III, Division 2, Groups B, C, D, F, G
- NEMA 4X

CSA

- Class I, II, III, Division 1, Groups B, C, D, E, F, G
- Class I, II, III, Division 2, Groups B, C, D, E, F, G
- TYPE 4X

CENELEC

- EEx d IIB + H₂
- Eex n IIB + H₂

See Appendix C for additional information regarding specifications and safety approvals.

Note: Verification of chemical compatibility with the exposed antenna materials is ultimately the responsibility of the customer.

Sensor-Transmitter

The sensor and transmitter are integrated on the single electronics board. The transmitter detects the signal reflected from the process material. The detected echo is used to measure the distance to the process material and to calculate other measurement values. These values can be displayed, sent to the serial ports (RS-485 standard, RS-232 optional), and can be used to drive the current output or process alarms.

The RS-485 and optional RS-232 serial ports support communications from a PC with the Accu-Wave Window's based Setup Software, a PC with terminal emulation software, or a TN Technologies' Hand Held Terminal a remote terminal.

The Accu-Wave supports 4-20 mA current output, serial communications, contact closure input, and a 2-line local/remote display. The Accu-Wave inputs and outputs are summarized in the following Input/Output Characteristics Table.

Input/Output Characteristics		
Type	Characteristics	Comments
Current output	0-20 mA dc (adjustable range) Isolated, Loop-Powered, 24 Vdc Nominal Supply Voltage, 700 ohm max. load	Default range is 4-20 mA dc. One current output is provided.
Serial communications	RS485: One terminal block and one RJ11 Jack RS 232: One terminal block (Requires optional board.)	Half-duplex party line communication to host computer or Hand-Held Terminal. Full duplex communication with a remote terminal or PC.
Contact closure input	One (1) contact closure input is provided.	The user can assign a command to execute based on user-provided contact opening or closure input to the gauge.
Remote Display	2 Line x 16 Character Display - Backlit	

Features and Benefits

Dynamic Menu System

You see only the menu options pertinent to your application. The initial “Set up level, ...” menu takes you through a basic setup to get your instrument up and running quickly. Help screens are available at appropriate points.

Built-in Volume Measurement

Select one of the pre-defined tank shapes, enter its dimensions, and the gauge computes volume from an internal equation library. Alternately, you can define volume as a polynomial expression based on the level (height) or as a break table of volume and height value pairs.

Instantaneous Response

TN Technologies Dynamic Process Tracking™ (DPT) ensures no lag time in the system response to level changes. When sudden process changes occur, the DPT feature reduces the normal averaging time constant by a factor of eight, ensuring a smooth and rapid output response. When the process stabilizes, the longer time constant is applied to reduce spurious fluctuations in the measurement. In this way, actual changes in process level are immediately reflected in the transmitter output, while the effects of signal variations from turbulence and other short term factors on the measurement are greatly reduced.

Extensive Alarms

You can set up as many as 16 process alarms in addition to system fault alarms and warning alarms.

Quick and Easy Setup

The menus take you through the setup procedure step-by-step. Built-in help screens are provided at appropriate points in the menu structure.

Multiple Readouts

You can select up to six of the following values for display: level, distance, volume, unfilled volume, percent full, percent empty, percent level, signal strength, or alarm relay status. The screen automatically displays the measurement values three at a time in alternation. The measurement values can also be sent to a remote terminal or a computer.

Marker Sweep Software

TN Technologies' patented Marker Sweep software continually adjusts the transmitter output signal to maintain linearity. This highly consistent microwave signal ensures reliable, stable system operation and accurate level measurements.

Digital Signal Processing (DSP)

The gauge uses DSP hardware and software to process the received microwave signal (the echo) and to provide accurate, real-time measurements of the distance to the surface of the process material.

How the Accu-Wave Works

The sensor generates a microwave signal composed of electromagnetic waves – two perpendicular oscillating fields (electric and magnetic) that travel together. The transmitted signal is reflected from the surface of the process material. This echo is detected and evaluated for changes in frequency to determine the distance to the liquid or solid material in the tank.

The Marker Sweep software continually adjusts the signal output to maintain the linearity of the transmitted frequency sweep. This highly consistent microwave signal ensures that changes in level are reported accurately in real-time. Dynamic Process Tracking software ensures quick system response to changing process levels by automatically reducing the response time when level changes occur. A variety of tools are provided in the menus to “fine tune” the signal in order to eliminate many of the problems associated with measuring levels in an active process.

TN's exclusive DSP software processes the microwave signal and converts it to measurement information displayed in the readout. You can also program measurements to

drive alarms, or open and close switches. The alarms, user inputs, and selected outputs are saved in non-volatile memory.

Automatic verification and error correction software continuously monitors system operations. System faults can be programmed to set off alarms.

How to Use This Manual

For hardware mounting and installation wiring procedures refer to the “Accu-Wave Installation Manual” provided with your gauge.

This manual, “Accu-Wave Operation Manual” describes how to set up and operate the Accu-Wave gauge. Chapter 1, “Introduction,” provides an overview of the Accu-Wave gauge and its features.

Note: This manual describes Version 4.31 of the Accu-Wave software. Earlier versions of the software do not support all of the tools and functions described in this manual.

We suggest that you read the appropriate chapters before you begin to set up your gauge.

Setting Up the Gauge

Chapter 2, “How to Enter Data,” introduces the menu system and how to enter or modify the setup parameter values. The menu items are grouped into seven top level categories as described below. Chapters 3 through 9 provide detailed information on the menu items in each of these seven categories. For many applications, only the “Set up Level, Level Alarms, and Volume” menu items are required to set up the Accu-Wave gauge.

Chapter 3, “Set up Level, Level Alarms, and Volume,” explains how to set up the primary measurement (distance or level), measurement alarms, and the volume measurement (optional).

Chapter 4, “Set up Additional Measurements,” explains how to set up the following additional measurements:

- distance (outage), if the primary measurement is level
- level, if the primary measurement is distance
- percent distance
- percent level
- signal strength
- volume
- unfilled volume (ullage)
- percent full
- percent empty

Chapter 5, “Radar Fine Tuning,” explains the “Radar fine tuning” menu. Use this menu to adjust the setup when false echoes and clutter are present, or to extend the measurement range beyond the zero level point or above the maximum level point.

Chapter 6, “Current Outputs, Relays, and Alarms,” explains how to set up the current outputs and relays, and how to assign alarms to measurements other than the primary measurement using the “Outputs, relays and alarms” menus.

Chapter 7, “Action Items,” describes the serial ports and describes the frequently used commands in the “Action Items” menu. The commands are grouped by function:

- common action items
- alarm commands
- hold commands
- serial port commands

Chapter 8, “Serial Ports, Contact Inputs, and Special Functions,” describes the serial ports and how to communicate with the gauge via a personal computer (PC).

Chapter 9, “Security, Service, and Diagnostics,” contains security, diagnostic, and service information.

Additional Information

Appendix A, “How to Return Equipment for Service,” gives you shipping information for returning equipment to TN Technologies for service.

Appendix B, “Specifications,” contains the specifications for the Accu-Wave.

Appendix C, “Menu Flowcharts,” provides a flowchart of the main menus.

TN Technologies' Service Department

The TN Technical Services Department is available to help you, especially with the more complicated procedures such as eliminating spurious echoes. Call us with questions or comments:

Phone: (800) 736-0801 (US only)

Main Office: (512) 388-9100

FAX: (512) 388-9200

Chapter 2 How to Enter Data

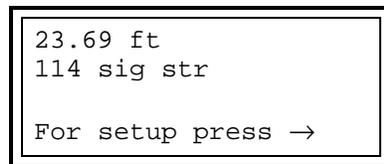
Several methods of entering data are available. You can scroll through the menus to reach the menu item you want, or you can use the direct entry code to access the desired menu item in a single step. For some data entry menu items you use the arrow keys to select from a list, while for other data entry items you enter numbers with the keypad.

RS-232 and RS-485 serial ports are provided to support communications with the gauge via a remote terminal, a PC with terminal emulation software, or a TN Technologies' Hand Held Terminal.

Display

Note: Allow 2 minutes after start up for the readings to stabilize.

When power is first applied, the gauge measures and displays distance and signal strength on the measurement display as shown in Figure 2.1. The measurement display is shown continuously, except when you are in a menu.



```
23.69 ft
114 sig str

For setup press →
```

Figure 2.1 Measurement Display

If the display is blank when you apply power to the gauge, check the following:

1. Adjust the contrast by pressing the \uparrow or \downarrow on the keypad several times.
2. Verify the power supply at the source.
3. Disconnect all power to the transmitter, open the transmitter and verify:
 - the power supply is properly seated on the main board,
 - the power supply is properly connected (refer to the “Accu-Wave Installation and Maintenance Manual”),
 - the ribbon cable from the display is properly seated on the board, and
 - all boards are properly seated in the chassis notches and on the main board.
4. If you still have no display, contact TN Technologies (1-800-736-0801, US only, or 512-388-9100).

Keypad

Located below the display, the keypad is used to scroll through menus, change selections, enter data, and enter commands. Figure 2.2 shows the keypad layout.

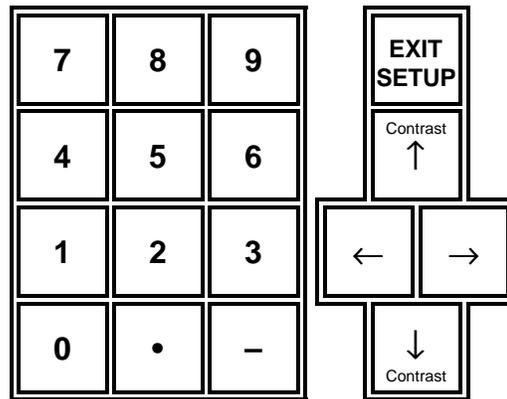


Figure 2.2 Transmitter Keypad Layout

Moving with the Arrow Keys

Use the arrow keys, ←, →, ↑ and ↓, to scroll through the menus, access HELP menu items, change selections, and execute commands. Each item in the menu will have directions for using the appropriate arrow keys.

In most cases, the ↓ key is used to scroll through the menu items. In many cases, you can use the ↑ key to return to the previous menu item, unless the display indicates otherwise. Use the → key to view HELP, when available, or to change an option. Use the ← key to return to the previous option. When the correct option is in the display, use ↓ to go to the next item in the menu. When you reach the bottom of a menu, press ↓ to return to the top of that menu.

Use the EXIT SETUP key at any time to save your entries and leave the menu display, returning to the measurement display.

Entering Numbers

Use the number keys to enter data and commands. Use the period key, “.”, for the decimal point and the dash key, “-”, for the sign for negative numbers. After keying in a number, press ↓ to indicate the end of the number.

Decimal values may be entered in scientific notation using the period, “.”, key in place of the “E” or exponent. For example,

To enter:	4.567E4
Press:	4.567.4

Press ↓ to complete the entry. The number will be displayed in the usual scientific notation, 4.567E4.

Saving Your Entries

Press the EXIT SETUP key at any time while you are using the menus to save your entries and to return to the measurement display.

If no entries are made for five minutes, the display times out. Any entries or changes you have made are saved and used by the Accu-Wave software, and the display returns to the measurement display.

Setup Menus

The setup menus provide a step-by-step procedure for entering the data required to operate the gauge. The dynamic menu system controls which menu items are displayed; only menu selections pertinent to your application are presented. Read the HELP screens provided at appropriate points within the menus.

In each menu item, the data value which can be entered or changed will be flashing. Enter the requested parameters in each applicable menu item as you come to it, otherwise related menu items that should appear later will not be displayed. For instance, to set up an alarm, you must enter a “set point” value when that menu item appears in order to activate the rest of the “Alarm Setup” menu. Appendix B shows a flowchart of the main menus.

Note: The appearance of the menu items as described in this manual will often vary slightly from the actual menu item displayed on your gauge. The appearance of many menu items (words and numbers) varies dynamically with context and will depend on the parameter values and selections you enter during setup.

The menu structure has two layers of menu items, the user layer (or default layer) which is adequate for most applications, and the service layer which provides a number of additional, special purpose menu items. These additional tools (service only items) can be enabled using the “Special functions” menu as described in Chapter 8, see page 8-19.

When you are using the setup menus, if no entries are made for five minutes, the display times out and returns to the measurement display. Any changes or entries you have made are saved and used by the Accu-Wave software. To continue with the setup procedure, use the arrow keys to return to your previous place in the menus.

Advanced Methods

Direct entry and programmable keys are provided primarily for diagnostics and service operations.

Note: Most menu items display a slightly different “message” when accessed by direct entry than the message shown in the setup menus. Direct entry

allows access to a single menu item, you are not able to scroll to the item which would normally appear next in the menus.

Direct Entry

In addition to the menu system, you can also access value entries, selection codes, and commands by direct entry. Direct entry is a short cut that bypasses the menu structure. After setup is complete, direct entry can be useful for executing often used commands, changing certain data entry values, or performing diagnostics.

Caution should be used when using direct entry codes to enter or change parameter values. When changing or entering a value for a given menu item, the associated values must also be changed or input (for example, the required tank dimensions are dependent on the tank shape selected when setting up a volume measurement). The menus provide a step-by step process to ensure that all required parameter values are entered. When using direct entry, the user must know which associated values must also be modified or set.

To use direct entry, you must know the item identifier, also called the keyboard code. You can find the keyboard code for a particular menu item while using the menus as follows:

1. Scroll to the menu item of interest.
2. For all menu items except decimal number entries (floating point entries such as 0.000), simply press the period, “.”, key.
3. For decimal or floating point number entries, press the period, “.”, key followed by the ↑ key. (The ↑ key indicates that you are not entering a decimal number, rather you want to see the direct entry code.)

Items with 6–digit identifiers are data entry values. Items with 1, 2, or 3 digit identifiers are commands or action items (see Chapter 7).

Example: Finding a Keyboard Code

While you are setting up the primary measurement, (as discussed in Chapter 3), when you reach the following menu item, press the period “.” key.

```
Allow display of ALL
units. Change to:
Metric or English→
NEXT↓
```

The information screen shown below will be displayed. Since the “Allow display of All/Metric/English units” item is not a decimal entry, it is not necessary to press the ↑ following the period “.” key.

```
value is 0
Item is data entry
Keyboard code 151002
{HEX = 970C} Press ↓
```

Note: The HEX number is used by the serial port in the “blind computer” mode. You must use the decimal keyboard code to use direct entry via the keypad.

The keyboard code, 151002, is the number used for direct entry. Press ↓ to return to the “Allow display of All/Metric/English units” menu item.

The following menu item is the first decimal (floating point) data entry item in the “Set up level,...” menus.

```
Distance REF LINE to
zero level point.
0.000 ft
      NEXT↓ HELP→
```

Since this is a floating point data entry item, it is necessary to press the period “.” key followed by the ↑ key to see the keyboard code. In this case the keyboard code display shows the following information.

```
value is 0.000
Item is data entry
Keyboard code 015003
{HEX = 0F0F} Press ↓
```

Example: Using Direct Entry

You set up the primary measurement and have returned to the measurement display, but you think you entered an incorrect value for the distance from the reference line to the maximum distance to be measured. (Refer to Chapter 3 for a description of the setup procedure and related menu items.) Using direct entry, you can access the appropriate menu item without having to scroll through the menus.

1. With the transmitter in the measurement display, press the EXIT SETUP key. The following item is displayed:

```
Key in entry ID or
command code then ↓
Press ↑ to exit.
```

2. Enter the entry ID code 013003, then press the ↓ key. The following menu item is displayed. (The actual distance shown is dependent on your gauge setup.)

```
REF LINE to maximum
distance to be
measured 50.00 ft
```

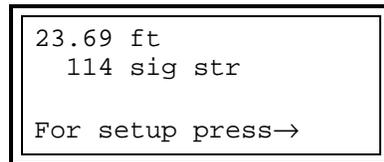
3. If the distance shown (50.0 ft) is correct, press the EXIT SETUP key to keep the current value and to return to the measurement display.
4. If the distance shown is not correct, enter the correct value, and press the ↓ key. Verify the distance shown is now correct (re-enter the number if incorrect), and then press the EXIT SETUP key. You will see a brief message, “Processing and storing data wait” before the measurement display returns. The new distance value will now be used by the Accu-Wave software.

Chapter 3 Set up Level, Level Alarms, and Volume

When power is first applied, the Accu-Wave gauge will be configured to measure distance with a maximum range of 112 ft (34.1 m). Until configured otherwise, the gauge continuously measures and displays distance and signal strength, except when you are in a menu.

Note: Allow 2 minutes after start up for the readings to stabilize.

The measurement display, shown in Figure 3.1, shows the distance to the strongest echo in feet and the amplitude or signal strength (sig str) of the echo.



```
23.69 ft
114 sig str
For setup press->
```

Figure 3.1 Measurement Display

Press → to begin setting up the primary measurement. The gauge continuously makes measurements, even while in the menu display. The primary measurement is distance by default, but you can use the “Set up Level,...” menu to change to level, as described later in this chapter.

Note: The appearance of the menu items as described in this manual will often vary slightly from the actual menu item displayed on your gauge. The appearance of many menu items (words and numbers) varies dynamically with context and will depend on the parameter values and selections you enter during setup.

Note: After you have configured the gauge and the configuration settings have been saved, the gauge retains the configuration settings even when power is turned off.

Typically the displayed distance will correspond to the echo from the surface of the process material as desired, but in some cases the strongest echo will be from another cause, such as:

- a multiple bounce from the process material and the top of the vessel. This multiple bounce might cause a warning message, such as “signal saturated.”
- a multiple bounce from a nozzle obstruction.
- an echo from an obstruction within the vessel.

If it appears that the distance displayed on your gauge is incorrect, you can later use the radar fine tuning tools (described in Chapter 5) to reduce the amplitude of the unwanted echoes so that the system locks onto the correct echo. Before using these tools, you must complete the setup for the primary measurement and define the correct range of interest, as described in the next section.

Set up Primary Measurement (Distance or Level)

During the initial setup, you will be asked to enter the distances to the highest and lowest points on the tank that you need the gauge to “see.” Thus, you need to measure these distances on your tank relative to the reference line marked on the sensor. Note the high and low measurement points do not have to be the top and bottom of the tank. These points are used to establish the range of interest (ROI) as shown in Figure 3.2. The ROI defines the range over which the gauge looks for the echo from the process material surface. The ROI may be overridden in the “Radar fine tuning” menu (refer to Chapter 5).

You must set up either distance or level as the primary measurement before setting up other measurements. The Accu-Wave software numbers the measurements with measurement #1 being the primary measurement. It is good practice to make a list of how you set up each measurement and its measurement number, and to have this list available for future reference.

Select distance as the primary measurement if you are interested in the distance from the zero distance point to the surface of the process material as shown on the right-hand side of Figure 3.2. Select level as the primary measurement, if you are interested in the distance from the zero level point to the current level of the surface of the process material as shown on the left-hand side of Figure 3.2.

The Zero Distance, Maximum Distance, and Zero Level points are all measured from the reference line (inscribed in the sensor housing) downward to the appropriate point on the tank. The Maximum Level point is measured from the Zero Level point upward.

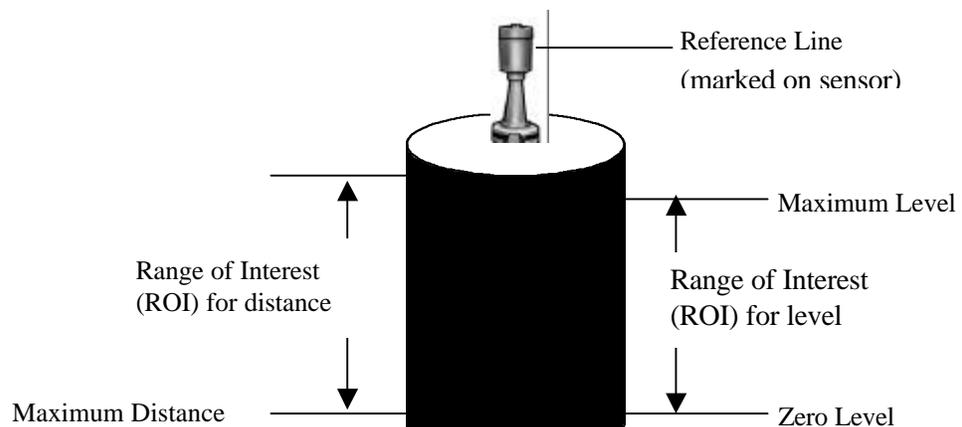


Figure 3.2 Primary Measurement – Distance or Level

After setting up the required entries for the primary measurement, you can set up additional measurements (for example, volume, percent full and percent empty) using the “Set Up Additional Measurements” menu discussed in Chapter 4.

“Set up Level” Menu

The “Set up Level” portion of the “Set up Level, Level Alarms, and Volume” Menu is used to set up the primary measurement, either level or distance, for your gauge. These menu items are given in the table below in the order they appear as you scroll through the

“Set up Level” menu. The “Comments” column of the table describes the purpose of each menu item. An example showing the specific entries required to set up level as the primary measurement is provided immediately following this table.

“Set up Level” Menu	
Display	Comments
Set up level, level alarms & volume ←Exit Setup. Other functions→	From the measurement display, press → to move to the “Set up level,...” menu shown at the left. Press ↓ to access the “Set up level,...” menu items. Note: The software detects whether output relays are installed. If no relays are present, the menu will display “Set up level & volume.”
General HELP text.→ Information on how to set up this gauge NEXT↓	We strongly suggest you read the HELP screens, especially when you are first learning to set up the gauge. Press ↓ to proceed to the next menu item.
primary measurement: Distance Change to Level→ NEXT↓	The primary measurement can be either distance or level. Distance is the default.
Allow display of ALL units. Change to Metric or English→ NEXT↓	Select the desired set of units for the primary measurement using the → key. The default is ALL which includes both English and Metric units. English units are - in, ft, and yd. Metric units are - mm, cm, and M.
Distance units = ft To change to yd, M, cm, mm, or in press→ NEXT↓	Scroll through and select desired measurement units using the → key. The available units depend on previous menu item selection of ALL, English, or Metric units.
Note: The next two menu items define the Range of Interest, the range over which the gauge looks for the echo from the process material surface. The values to be entered depend on whether distance or level is selected as the primary measurement.	

“Set up Level” Menu (continued)	
Display	Comments
If the primary measurement is distance, the following two menu items are shown.	
Distance REF LINE to zero distance point 0.000 ft {.6910} MIN NEXT↓ HELP→	Enter the distance from the reference line on the sensor housing to the zero distance point, the closest point to the sensor to be measured. In most cases the zero distance point is the top of the tank. The readout will be zero at the zero distance point. Above this point, the readout will be negative.
REF LINE to maximum distance to be measured 0.000 ft NEXT↓ HELP→	Enter the distance from the reference line on the sensor housing to the maximum distance point, the farthest point from the sensor, to be measured.
If the primary measurement is level, the following two menu items are shown.	
Distance REF LINE to zero level point 0.000 ft {115.1 MAX} NEXT↓ HELP→	Enter the distance from the reference line on the sensor housing to the point on the tank where the level measurement readout should display zero. The zero level point does not have to be at the bottom of the tank. Below the zero level point, the readout will be negative.
Maximum level to be measured 0.000 ft {x.xxx MAX} NEXT↓ HELP→	Enter the highest possible level to be measured relative to the zero level point. The value displayed as {x.xxx MAX} is calculated based on the entry for the zero level point. The gauge will not measure reliably above this level.
Position of decimal in readout 1 000.0 {ft level} NEXT↓ ←CHANGE→	Press ← or → to move decimal point to the desired position in the display readout for the primary measurement (level or distance).
Note: The next two menu items define the levels (or distances) corresponding to the maximum and minimum current outputs. The default range for the current output is 4.0 mA to 20.0 mA. To change the max or min current output, use the “Modify or reassign current output” menu (see Chapter 6.)	
Meas #1 reading for 20.00 mA output: 0.000 ft level xx.xx assume NEXT↓	Enter level or distance which corresponds to the maximum current output. For level, “Maximum level” is the default (assumed) value. For distance, the value (Maximum Distance – Zero Distance Point) is the default. If the entry is exactly zero, the default (assumed) value is used.
Meas #1 reading for 4.000 mA output: 0.000 ft level NEXT↓	Enter level or distance which corresponds to the minimum current output. The default value is 0.0. For level, this is the “Zero Level Point,” and for distance, this is the “Zero Distance Point.”

Example: Set up Level

Set up level as the primary measurement for a tank. Before beginning the gauge setup, you need to measure the distance from the Reference Line on the sensor housing to the desired Zero Level point on the tank and the distance from the Zero Level point to the desired Maximum Level to be measured. See Figure 3.3.

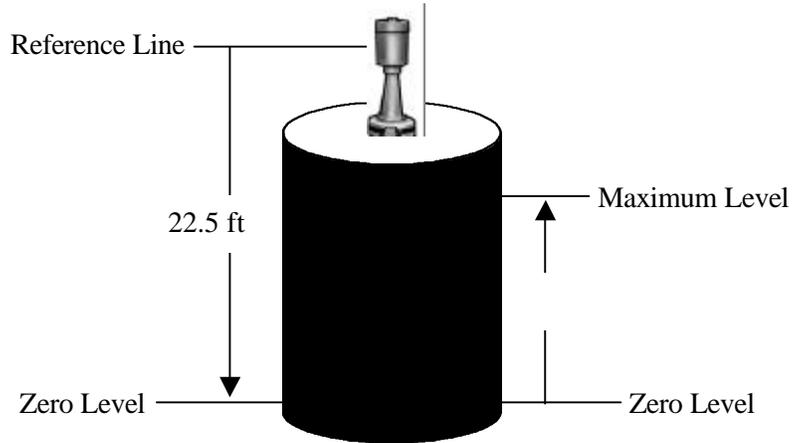


Figure 3.3 Entries Required to Set up Level as Primary Measurement

Follow the steps in the table below to set up level as the primary measurement using the example measurements shown in Figure 3.3.

Example: Set up Level as Primary Measurement	
Menu Display	User Action
Set up level, level alarms, & volume.↓ ←Exit Setup. Other functions→	From the measurement display, press → to move to the “Set up level,...” menu shown at the left. Then, press ↓ to access the “Set up level,...” menu items.
General HELP text.→ Information on how to set up this gauge NEXT↓	General HELP text for setting up the gauge. Press → to read the help text, press ↓ to proceed to the next menu item.
primary measurement: Distance Change to Level→ NEXT↓	The default primary measurement is “distance.” Press the → key to change to “level.” Then press ↓ to proceed to the next menu item.

Example: Set up Level as Primary Measurement (cont.)	
Menu Display	User Action
Allow display of ALL units. Change to Metric or English→ NEXT↓	Select the desired set of measurement units using the → key. The default is ALL which includes both English and Metric units. Then press ↓.
Distance units = ft To change to yd, M, cm, mm, or in press→ NEXT↓	Use the → key to scroll through and select the desired measurement units. We are using “ft” in this example.
Distance REF LINE to zero level point 22.50 ft {115.1 MAX} NEXT↓ HELP→	Enter the distance from the reference line on the sensor housing to the zero level point (the farthest point from the sensor to be measured). In this example the value is 22.5 ft. Enter 22.5 followed by the ↓ key. Press ↓ again to move to the next item.
maximum level to be measured. 18.00 ft (21.74 MAX) NEXT↓ HELP→	Enter the maximum level to be measured relative to the zero level point, 18.0 ft, in this example. Enter 18.0 followed by the ↓ key. Press ↓ again to move to the next menu item.
Position of decimal in readout 1 00.00 {ft level} NEXT↓ ←CHANGE→	Press ← or → to select the desired position for the decimal point.
9.91 ft level 63 sig str For setup, press →	Press “Exit Setup” to save entries and return to the measurement display.

How to Set up Alarms

After setting up distance or level as the primary measurement, the next item in the “Set up Level,...” menu is the “Set up alarm 1” selection. These menu items allow you to set up an alarm for measurement # 1, the primary measurement (level or distance).

Note: If no relays are installed, the “Setup alarm” menu item is not displayed. You can still set up a display alarm that causes the appropriate line in the display to flash off and on, or to perform some other function. Refer to Chapter 8 for details on enabling these alternate alarms.

Alarms for measurements other than the primary measurement (measurement 1) are set up using the “Set up Additional measurements” menu (Chapter 4). The procedure for entering the alarm parameters is the same as described in this section.

Alarms: Set Point, Clear Point, and Dead Band

An alarm is defined with either a set point - clear point configuration, as shown in Figure 3.4, or a set point - dead band configuration, as shown in Figure 3.5.

The set point defines the measurement value, either level or distance for the primary measurement, at which the alarm is activated. The clear point or the dead band defines the measurement value at which the alarm is cleared (alarm ceases).

A clear point sets a fixed measurement value at which the alarm clears. The position of the clear point is independent of the set point and remains the same even if the set point is moved. As illustrated in Figure 3.4, changing the set point from 3.0 m to 3.5 m has no effect on the clear point which remains at 2.0 m.

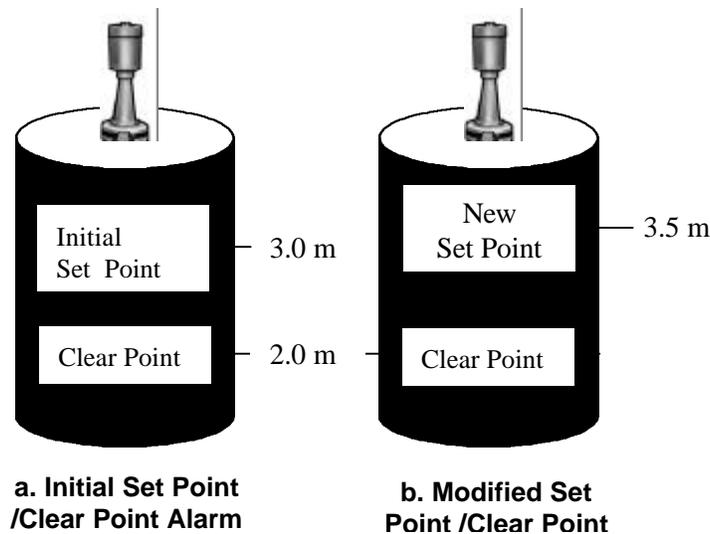


Figure 3.4 Set Point / Clear Point Alarm

A dead band defines a fixed distance between the set point and an implicit clear point. If the set point is moved, the implicit clear point moves also, maintaining the distance from the set point specified by the dead band. As illustrated in Figure 3.5, changing the set point from 2 m to 3 m moves the implied clear point from 4 m to 5 m. The relative distance between the implied clear point and the set point remains fixed at 2 m, the dead band value.

If you may want to later change the alarm set point without affecting the point where the alarm is cleared, use a clear point configuration. Alternately, if you want the alarm clear point to be defined at a fixed distance relative to the set point, use a dead band configuration.

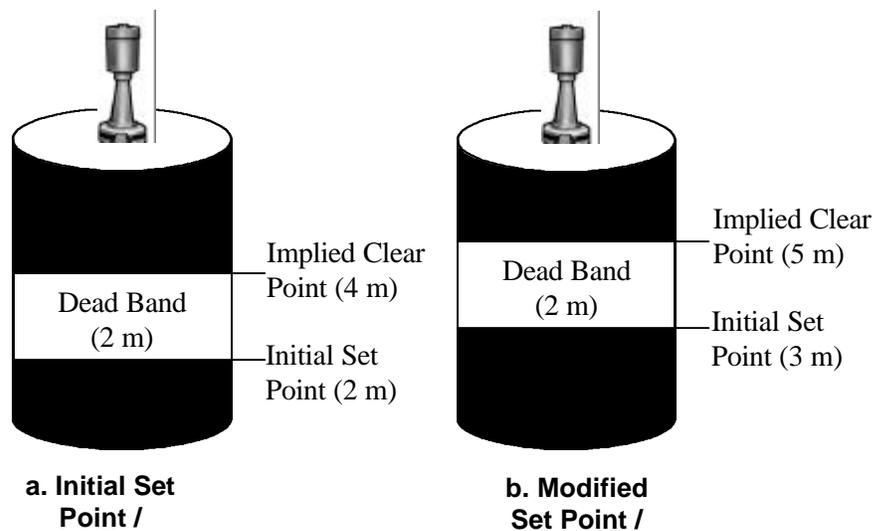


Figure 3.5 Set Point / Clear Point Alarm

High Limit and Low Limit Alarms

An alarm is activated when the measurement value reaches the specified set point. The relative values assigned to the set point and the clear point determine whether the alarm is a *low limit* alarm or a *high limit* alarm.

If the set point value is less than the clear point (or the dead band value is positive), the alarm is a *low limit* alarm. In this case, the alarm is activated as the measurement value decreases below the set point value. The alarm stays active until the measurement value again increases to the clear point value.

Similarly, if the set point value is greater than the clear point (or the dead band value is negative), the alarm is a *high limit* alarm. In this case, the alarm is activated when the measurement value increases beyond the set point value. The alarm stays active until the measurement value again decreases to the clear point value.

The terms low limit and high limit refer to the relative magnitude of the set point and the clear point, not necessarily to a high or low level. The behavior of the alarm depends on the measurement associated with the alarm. Thus, a low limit alarm (set point < clear point) for a distance measurement is in fact a high level alarm. A low limit distance alarm would be triggered when the distance to the process surface decreases below the clear point distance and reaches the set point distance value. Since the distance between the material surface and the sensor is decreasing the level is actually increasing. Specific examples of high limit and low limit alarms are provided later in this chapter.

“Set Up Alarm 1” Menu (Primary Measurement)

This table describes the menu items in the “Set up Alarm” menu group.

“Set up Alarm” Menu	
Display	Comments
Set up alarm 1 (Alarm point, etc.)→ NEXT↓	Menu is normally available only if relays are installed. Press → to access alarm menu or ↓ to skip alarm set up. After alarm 1 is set up, menu to set up alarm 2 will be available, and so on.
<p>Note: The appearance of the following menu items depends on whether distance or level has been selected as the primary measurement. Menu items are shown for distance. Differences are noted in the Comments.</p> <p>You must enter a set point to activate the rest of the Set up Alarm menu.</p>	
←Exit alarm 1 setup Alarm 1 set point 0.000 ft dist NEXT↓ HELP→	Enter the distance (or level) from the zero distance (or zero level) point to the set point; the point at which the alarm is activated. The zero point value was entered during the primary measurement set up.
Alarm 1 clear based on clr point Chng to “dead band”→ Continue as is.↓	Select a clear point or dead band configuration. A clear point is the exact measurement value at which the alarm is cleared. A dead band specifies the span between the set point and the implicit clear point.
Alarm 1 clear point 0.000 ft dist {Makes alarm “Low” limit} NEXT↓ HELP→	Enter desired clear point value: the distance (or level) relative to the zero distance (or zero level) point. If dead band is selected, enter the dead band span relative to the set point. A negative dead band makes the alarm high (set pt > clear pt. A positive dead band makes the alarm low (set pt < clear pt).
Alarm 1: ft dist is indicated by controlling relay 1 NEXT↓ CHANGE→	Select the action used to indicate that alarm 1 has been triggered. The default is “controlling relay 1,” if relays are installed. Other selections are: controlling relay 2 (or 3 or 4 if installed) measurement #1 display flash measurement #2 display flash (or meas #3, #4, etc., if measurements have been set up) Zero current output 1 (or 2 if installed)
<p>Note: Additional menu items related to controlling relays are shown in following table. Other menu items may appear depending on entries you made elsewhere in the menus.</p>	
Set up dist alarm 2 (Alarm point, etc.)→ NEXT↓	After you set up an alarm, the option to set up the next alarm will be presented. If you don’t want to define another alarm, scroll past this screen.

The next table presents those menu items specifically related to controlling a relay as an alarm indicator. As noted in the Comments column, several of the menu items are only displayed if options have been enabled in the “Special functions” menu, see “Special Functions” on page 8-19.

“Set up Alarm” Menu (continued) Relay Indicator Related Items	
Display	Comments
alarm relay 1 set delay 0 seconds (0-255 s after alarm) NEXT↓	Only displayed if “alarm relay delay times” have been enabled in “Special functions” menu (see page 8-19). Alarm condition must persist for the time entered for alarm to be activated.
alarm relay 1 clear delay 0 seconds (0-255 s after alarm has cleared) NEXT↓	Only displayed if “alarm relay delay times” have been enabled in “Special functions” menu (see page 8-19). Alarm clear condition must persist for the time entered for alarm to be cleared.
Do not use latching mode with relay 1. Change to “Do”→ Continue as is.↓	Only displayed if relay latching has been enabled in “Special functions” menu (see see page 8-19). When latch mode is enabled for a relay, the relay remains in alarm state even after the actual alarm is clear. The relay is cleared by a “Clear alarms” command (see page 7-3) or when system has been powered off.
Relay 1 turns on when alarm occurs. Change to “off”→ ←Exit alarm 1 setup.	Only displayed if a relay alarm indicator is selected as the alarm indicator. Non-relay indicators include zeroing current output, flashing display, or activating commands.

After each alarm is set up, you will have the opportunity to set up another alarm, up to 16 alarms. Always keep a written record of how each alarm is set up. You can add a relay board at any time. You can set up more alarms later using the “Set up additional measurements” menu, see Chapter 4.

Example: High Limit Level Alarm

This example illustrates how to set up a high limit level alarm using a Set Point/Clear Point alarm configuration. The primary measurement has been set up as level with the “Distance REF LINE to zero level point” set at 22.5 ft and the “maximum level to be measured” set at 18.0 ft. It is desired to activate a process alarm when the process material level increases to 15.0 ft (relative to the zero level point) and to clear the alarm when the process material level decreases to 13.0 ft. This configuration is illustrated in Figure 3.6.

Since the measurement value for the set point (18.0 ft) is greater than the value of the clear point (15.0 ft), this is a high limit alarm. The required steps to implement this alarm are listed in the table following Figure 3.6.

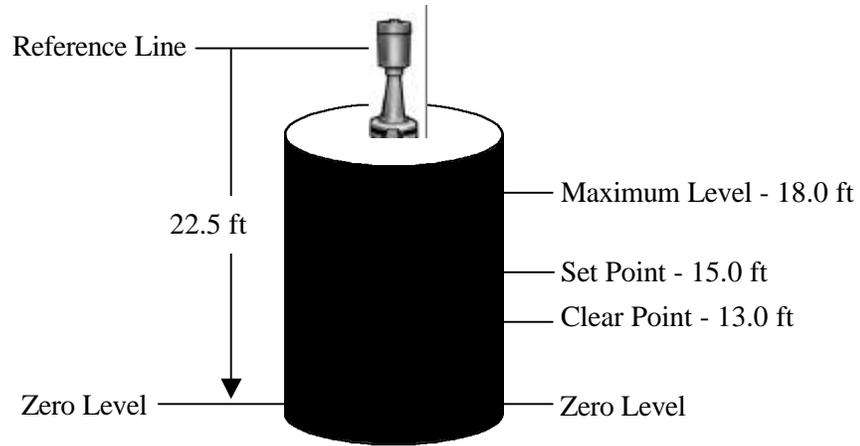


Figure 3.6 High Limit Level Alarm Using Set Point and Clear Point

Example: Set up High Limit Level Alarm	
Display	Comments
Set up alarm 1 (Alarm point, etc.)→ NEXT↓	Set up alarm 1 to be a high limit level alarm as illustrated in Figure 3.6. Press → to access the “Set up alarm” menu items.
←Exit alarm 1 setup Alarm 1 set point 15.00 ft level NEXT↓ HELP→	Enter 15.0 followed by ↓ to enter the desired level for the set point relative to the zero level point. The zero level point was entered during the primary measurement setup. Press ↓ again to continue.
Alarm 1 clear based on clr point Chng to “dead band”→ Continue as is.↓	Press the → to select a clear point configuration as shown here. Then press ↓ to continue.
Alarm 1 clr point 13.00 ft level {Makes alarm “Hi” limit} NEXT↓ HELP→	Enter 13.0 followed by ↓ to enter the desired level for the clear point relative to the zero point level. The display will indicate that this is a “Hi limit” alarm. Press ↓ again to continue.
Alarm 1: ft level is indicated by controlling relay 1 NEXT↓ CHANGE→	Select indicator for alarm 1. If relays are installed, the default is “controlling relay 1,”. Other selections are: controlling relay 2 (or 3 or 4 if installed) measurement #1 display flash Zero current output 1 (or 2 if installed)

Example: Low Limit Distance Alarm

This example illustrates how to set up a low limit distance alarm using a Set Point/Dead Band alarm configuration. The primary measurement has been set up as distance with the “Distance REF LINE to zero distance point” set to 4.5 ft and the “Distance REF LINE to maximum distance point” set to 22.5 ft as illustrated in Figure 3.7.

It is desired to activate a process alarm when the distance of the process material surface decreases to 3.0 ft (relative to the zero distance point) and to have the alarm clear when the distance again increases to 5.0 ft. In addition, it is desired that the alarm clear point remain a fixed distance from the set point if the set point value is later changed.

This is accomplished using a set point – dead band alarm configuration, with the set point distance of 3.0 ft and with a dead band of 2.0 ft. This defines an “implicit clear point” at a distance of 2.0 ft relative to the set point (or at a distance of 5.0 ft relative to the zero distance point). If the set point is later changed, the implicit clear point will also change, but will remain at a distance of 2.0 ft from the set point.

This is a low limit distance alarm since the set point distance is less than the clear point distance. Note that this low limit distance alarm configuration is equivalent to the high limit level alarm in the previous example. However, if the set points were changed, the clear points would behave differently since a dead band configuration is used in this example.

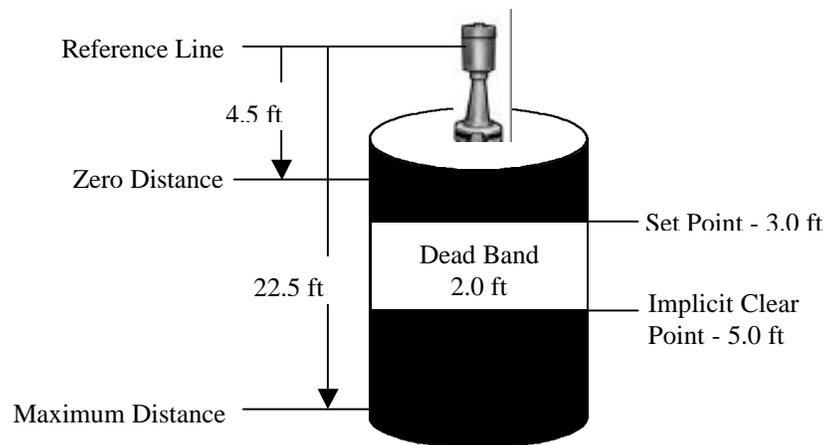


Figure 3.7 Low Limit Distance Alarm Using Set Point and Dead Band

Example: Set up Low Limit Distance Alarm	
Display	Comments
Set up alarm 1 (Alarm point, etc.)→ NEXT↓	Set up alarm 1 to be a high limit level alarm as illustrated in Figure 3.5. Press → to access the “Set up alarm” menu items.
←Exit alarm 1 setup Alarm 1 set point 3.00 ft dist NEXT↓ HELP→	Enter 3.0 followed by ↓ to enter the desired level for the set point relative to the zero distance level. The zero distance point was entered during setup of the primary measurement. Press ↓ again to continue.
Alarm 1 clear based on dead band Chng to “clr point”→ Continue as is.↓	Press → to select a dead band point configuration as shown here. Then press ↓ to continue.
Alarm 1 dead band 2.0 ft dist {Makes alarm “Low” limit} NEXT↓ HELP→	Enter 2.0 followed by ↓ to enter the desired level for the clear point relative to the zero distance point. The display indicates that this is a “Low” limit alarm. Press ↓ again to continue
Alarm 1: ft dist is indicated by controlling relay 1 NEXT↓ CHANGE→	Select indicator for alarm 1. If relays are installed, the default is “controlling relay 1.” Other selections are: controlling relay 2 (or 3 or 4 if installed) measurement #1 display flash Zero current output 1 (or 2 if installed)

How to Set up Volume

The “Tank Volume Setup” portion of the “Set up Level, Level Alarms, and Volume” menu defines how the gauge will calculate volume. Volume setup is optional. If you do not want the gauge to calculate and display volume, simply scroll past the “tank volume setup” menu.

The procedure for setting up tank volume depends on the shape of your tank. With the “Volume setup” menu you can describe your tank by:

- selecting a tank shape from a list of pre-defined shapes,
- describing your tank as a combination of pre-defined shapes,
- setting up a “break” table for volume, a table which defines volume as a function of the height (level of the process material) for up to 16 values of height, or
- defining volume as a polynomial (up to 6th order) expression of height.

The “Set up Volume” menu allows you to select the measurement units for reporting the volume as well as the units for the tank dimensions. The units for the tank dimensions can be different from the units selected for the primary measurement (level or distance).

Note: Once you have set up the tank volume, volume is set as a default measurement and is shown on the measurement display. To use volume to drive a current output or an alarm, you must use the “Set up additional measurements” menu (see Chapter 4) to assign volume to a specific measurement number and to set up the parameters for the current output or alarm.

Tank Shapes

The first step in setting up the tank volume is to define the tank shape. If your tank is one of the six shapes listed in the table below, simply select the tank shape, select the units, and then enter the dimensions of your tank. The required dimensions depend on the selected shape as shown in the table. The tank shapes and dimensions are illustrated in , at the end of this chapter.

Basic Tank Shapes	
Tank Shape	Required Dimensions
vertical cylinder (type 1)	diameter
vertical rectangle (type 2)	width, length
vertical cone (type 3)	top diameter, bottom diameter
horizontal cylinder/flat ends (type 11)	length, diameter
horizontal cylinder/domed ends (type 12)	length (not including domed ends), total length, diameter
sphere (type 18)	diameter

Note: After you select a tank shape, the gauge will compute and display a value for the volume. The indicated volume will be correct only if you have entered all required dimensions.

If you did not set up level as the primary measurement, you will be asked to enter the “Distance from the reference line to the zero-level” and the “maximum level to be measured” in the “Set up Volume” menu.

If your tank does not fit any of these shapes, select “For other shapes or compound shapes.” Additional menu items will be displayed allowing you to select other shapes, define the tank as a combination of shapes, or to define volume as a table of volume vs. height (level) data pairs, or as a polynomial expression of height.

Tank Volume Units

Select the units for the volume display. Select measurement units in which to report volume. The following units are available for volume. If you previously selected “English” or “Metric” units for display, rather than “All,” the appropriate subset of the units listed below will be available.

- *ml* *milliliters or cubic centimeters*
- *cu Meter* *1 cubic meter = 1000 liters*
- *cu inch* *1 cubic inch = 16.39 ml*
- *cu foot* *1 cubic foot = 28.32 liters*
- *cu yard* *1 cubic yard = 764.6 liters*
- *US Gallon* *3.785 liters*
- *UK Gallon* *4.546 liters, 1.2 US liquid gallons*
- *Mega Gallon* *1,000,000 US gallons*
- *Beer Gallon* *4.620 liters*
- *liter* *1 liter = 1000 milliliters*
- *acre foot* *43560 cubic feet*
- *pint (US)* *473.2 ml, 1/2 US quart*
- *quart (US)* *946.3 ml, 1/4 US liquid gallon*
- *oz (US)* *29.57 ml, 1/16 US pint*
- *Acre inch* *3630 cubic feet*
- *K Gallon* *1000 US liquid gallons*
- *UK quart* *1137 ml, 1/4 UK gallon*
- *UK pint* *568.3 ml, 1/2 UK quart*
- *UK oz* *28.41 ml, 1/20 UK pint*
- *Oil Barrel* *159 liters, 42 US liquid gallons*
- *Beer Barrel* *136.3 liters, 36 US liquid gallons*
- *US Barrel* *119.2 liters, 31.5 US liquid gallons*
- *UK Barrel* *163.7 liters, 36 UK gallons*

Note: The abbreviations for the volume units displayed by the gauge may differ slightly from those listed above due to display space constraints.

Tank Dimensions

If you selected one of the six basic shapes for your tank, you will be prompted to select units for the tank dimensions and to enter the dimensions for your tank. The number and specific dimensions required depend on the tank shape selected.

Volume in Tank... (Zero Level Volume)

This menu item allows you to specify the actual volume in the tank when the gauge measures zero level (at the zero level point specified previously during the setup). If the

actual volume is not zero at the zero level point, enter the correct value here. This menu item is only displayed when you select the “other tank shapes or compound shapes” option for the tank shape.

If you have selected one of the six basic shapes, but need to specify a non-zero volume for the zero level point there are two options. If your tank shape is not a sphere, you can specify “other tank shapes or compound shapes” and then specify the tank shape and dimensions using the “Assign & setup tank segment” menu item described below.

Alternately you can enter a value for the “volume in tank when level reading = zero” parameter via direct entry. The direct entry keyboard code for this menu item is 061003.

Assign & setup tank segment...

If you selected the “other tank shapes or compound shapes” option for the tank shape, additional menu items will be displayed allowing you to “Assign & setup tank segment #.” You may select from a larger set of pre-defined shapes, define the tank volume as a table of volume and height (level) values, or define the tank volume as a polynomial expression of height. You can define the tank using up to 8 segments where each segment can be assigned a different shape.

The available tank shapes and associated dimensions are listed in the table below. Except for the sphere (type 18) shape, the “Other Tank Shapes” include the “Basic Tank Shapes” along with additional shapes. The tank shapes and associated dimensions are illustrated in Figure 3.8 at the end of this chapter.

Other Tank Shapes	
Tank Shape	Required Dimensions
vertical cylinder (type 1)	diameter
vertical rectangle (type 2)	width, length
vertical conical (type 3)	top diameter, bottom diameter
vertical spherical (type 4)	top diameter, bottom diameter
vertical parabolic (type 5)	top diameter, bottom diameter
rectangular top and bottom (type 7)	width and length of top and bottom
slope bottom vert. cylinder (type 9)	diameter, dimension C
any shape w/ vert. sides (type 10)	area of shape
horizontal cylinder/flat ends (type 11)	length, diameter
horiz. cylinder/domed ends (type 12)	length (not including domed ends), total length, diameter
domed end (type 14)	width, diameter, bottom offset
pair of domed ends (type 15)	width, diameter, bottom offset

Up to eight segments can be defined to describe the tank shape. After you set up segment #1, the menu will prompt you to “Assign & setup segment #2,” and so on. If you do not need to specify another segment, simply scroll past the “Assign & setup segment” menu item.

For each segment, you select a segment type (shape), specify the corresponding dimensions, the starting level (level at the bottom of the segment), and the ending level (level at the top of the segment). Two or more segments can be assigned the same type (shape). In addition, the segments may overlap, that is, the top and bottom of one segment may be located between the top and bottom of any other segment. This can be useful in setting up compound shapes, for example, a vertical cylinder with a rectangular appendage. Another example is two vertical cylinders that are connected so the level is the same in both. The Accu-Wave gauge can be set up to measure the level in one cylinder, but to compute the combined volume of both cylinders.

Once you have set up the tank segments, you can later modify the parameters for any of the segments you have defined, changing the segment type (shape), dimensions, starting level, or ending level of any of the segments.

Polynomial Expression for Volume

In addition to the pre-defined shapes in the above table, you can define the volume in a segment using a sixth order polynomial expression of the height (level) in the segment. The following formula is used to calculate the volume, V , in the segment:

$$V = A H + B H^2 + C H^3 + D H^4 + E H^5 + F H^6,$$

where:

H = height of material in the segment, and
 A, B, \dots, F = polynomial coefficients (may be positive or negative).

When the “type 20, Vol = polynomial of height in seg” option is selected for the segment type, the user is prompted to enter values for the six polynomial coefficients, A through F . No constant term (zero order coefficient) is included in the polynomial expression for volume. However, the “volume in tank when level reading is zero” menu item allows you to specify a non-zero volume at the “zero level” point.

The value computed by the polynomial expression depends on the volume and height units specified by the user. You must select the coefficients to give the proper value for volume as a function of the height (level) in the segment for the specified units. For many applications, a second order expression (specify A and B coefficients and leave other coefficients set to zero) provides sufficient accuracy.

Volume Break Table (1st or 2nd Order)

The final option for specifying the volume in a segment is to define a volume break point table. A volume break point table contains up to 16 volume/height data pairs which define the tank volume as a function of height within the segment.

Note: Only one volume break table can be defined. The same volume break table can be applied to more than one segment.

For heights which fall between the values entered in the break table, the gauge interpolates between the table values to compute the volume. The more points you enter, up to the maximum of 16, the more accurate your volume reading will be.

There are two types of break point tables, a first order break table (Vol = 1st order break tab of height) and a second order break table (Vol = 2nd order break tab of height). The first order break table uses linear interpolation between the points in the table to determine the volume, while the second order break table uses a second order (non-linear) interpolation method.

If the sides of the tank are curved and the surface area of the process material increases or decreases smoothly as level increases, then a second order break table can provide more accurate volume readings. If the tank shape is complex, a first order break table will often provide better results. In any case, the accuracy of the volume readout will depend on the accuracy of the volume vs. height values entered by the user in the break table.

Tank Volume Set up Menus

The tables in this section show the “tank volume setup” menu items in the order they are presented to the user.

Note: The appearance of each screen in the following table is just an example. The actual appearance (words and numbers) will vary with context and user selections/entries.

The first table shows the “tank volume setup” menu items when one of the basic tank shapes is selected. The next table show the menu items which are displayed when “other shapes or compound shapes” is selected.

“Tank Volume Set up” Menu for “Basic” Tank shapes	
Display	Comments
tank volume setup→ NEXT→	Press → to access the tank volume setup menu items.
←Exit volume setup. Set up tank volume↓ Volume setup HELP→	Press → to access HELP screens for volume setup. Press ↓ to continue with volume setup. Press ← to exit from volume setup.
tank shape is vertical cylinder. Press ↓ to continue. Change tank shape→	Initially tank shape is “none.” If no tank shape is selected, the rest of the “Tank Volume Setup” menu items will not be displayed. When a tank shape is selected, volume will be displayed on the measurement display. The volume readout will be correct only if all of the required dimensions are entered.
Note: Volume is computed as a function of the level of the process material relative to the zero level point. If distance has been set up as the primary measurement, the next two menu items (zero level point and maximum level) are displayed to obtain the required level values.	
Distance REF LINE to zero level point. 0.000 ft NEXT↓	Menu item appears if primary measurement is distance (level information has not been entered). Enter the distance from the reference line on the sensor to the zero level point on the tank.
Maximum level to be measured. 0.000 ft NEXT↓	Menu item appears if primary measurement is distance. Enter the maximum level to be measured relative to the zero level point.
tank volume units: cu ft NEXT↓ CHANGE→	Press → to select the desired units for volume.
Position of decimal in readout 000.0 (volume) NEXT↓ ←CHANGE→	Use the ← and → keys to select the position of the decimal point in the volume readout.
Tank dimension: ft To change to yd, M, cm, mm, or in press→ NEXT↓	Select the units for displaying the tank dimensions. Available units depend on the selection of “All, Metric, or English” set of units.
tank’s diameter 0.000 ft NEXT↓	Enter the requested dimensions. The number and type of dimensions depend on the tank shape selected. Figure 3.8 shows the complete set of shapes and the associated dimensions.

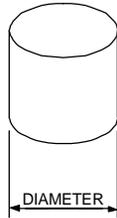
“Tank Volume Set up” Menu for “Compound” Tank Shapes	
Display	Comments
For other shapes or compound shapes.↓ Change tank shape→	Press → to change the tank shape. Press ↓ to set up the tank volume using “compound” shapes.
tank volume units: litre NEXT↓ CHANGE→	Select the units for displaying volume. See page 3-15 for a complete list of the available units.
Tank dimensions: M To change to cm, mm, in, ft, yd press→ NEXT↓	Select the units for the tank dimensions. Choices are ft, yd, M, cm, mm, and in.
volume in tank when level reading = zero 15.00 litre NEXT↓	Enter volume in tank corresponding to the zero level point.
Modify segment 1 vertical cylinder→ NEXT↓	Press → and follow menu directions to set up volume for segment 1. If segment has not been set up, this item will read “Assign & set up tank segment 1.” Specify (or change) segment shape, dimensions, starting level, and ending level of segment 1.
Complete specification of segment 1, then specify other segments as desired.	
Modify segment 2 vertical conical→ NEXT↓	Change type shape, dimensions, starting level, or ending level of segment 2. Shown here with “vertical conical” shape selected.
Modify segment 3 Vol = 1st order break tab of height→ NEXT↓	Example of menu item when volume break table is selected. See the following table for a description of the break table related menu items.
Assign & set up tank segment 4→ NEXT↓	Press → to set up a fourth segment. As each segment is assigned, the “Assign & set up tank shape” menu item will be displayed for an additional segment up to a maximum of 8 segments. Press ↓ to continue without defining a fourth segment.

“Break Point Table” Menu	
Display	Comments
Modify segment 3 Vol = 1st order break tab of height→ NEXT↓	Press → to modify setup. Segment 3 is currently set up as a 1 st order volume break table.
segment 3 is type 21 Vol = 1st order break tab of height→ Continue↓ Change→	Press → to setup parameters for volume break table.
Level at bottom of Segment 3, (type 21) 3.000 M NEXT↓	Specify level at bottom of segment.
Level at top of Segment 3, (type 21) 4.200 M NEXT↓	Specify level at top of segment.
Enter data table for this segment→ NEXT↓	Press → to enter/modify table values. Only one volume break table may be defined, however, the same break point table may be used for several segments if desired.
number of points in volume table 3 NEXT↓	Specify number of volume/height data pairs to be entered.
height from bottom of segment to point 1 = 0.500 M NEXT↓	Enter height for the first point. This menu item is repeated for the number of points specified in the item above (points 2 and 3 in this example).
Vol in segment 30.00 litre @ point 1 (0.5000 M up in segment) NEXT↓	After entering table height values, menus prompt you to enter the corresponding volume values. Again, this item is repeated for each point in the table. When complete, follow menu instructions or press “Exit Setup” to exit the menus and save entries.

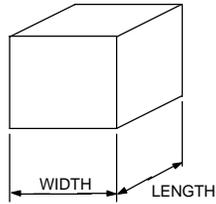
Tank Shapes

The illustrations on the next two pages, Figure 3.8, show the available predefined tank shapes and the required dimensions for each of the shapes.

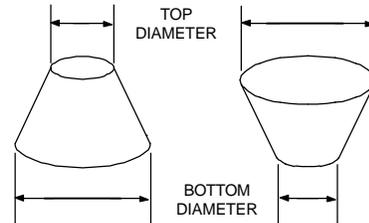
VERTICAL CYLINDER
TYPE 1



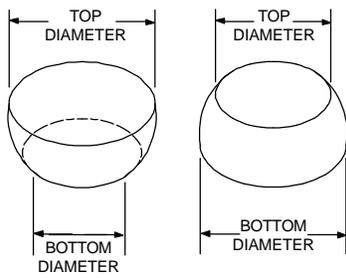
VERTICAL RECTANGLE
TYPE 2



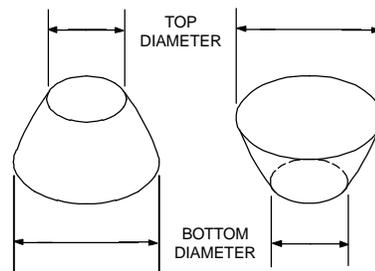
VERTICAL CONICAL
TYPE 3



VERTICAL SPHERICAL
TYPE 4



VERTICAL PARABOLIC
TYPE 5



RECTANGULAR TOP AND BOTTOM
TYPE 7

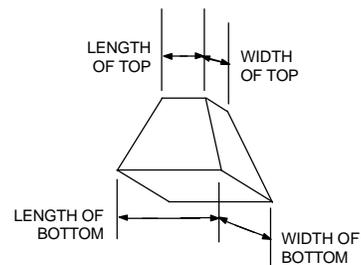
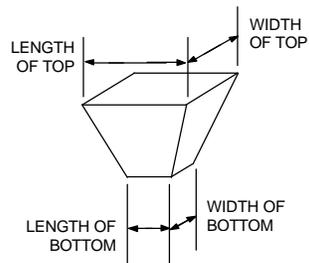
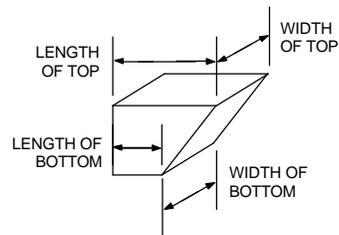
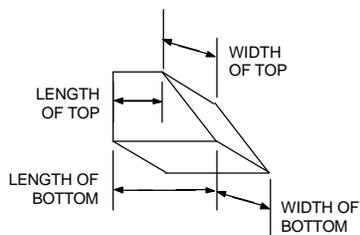
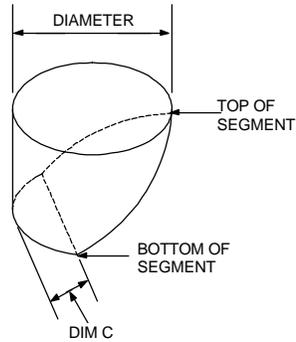
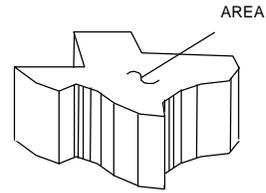


Figure 3.8 Pre-Defined Tank Shapes and Dimensions

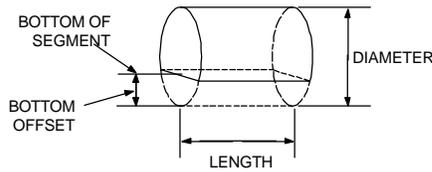
**SLOPED BOTTOM
VERTICAL CYLINDER
TYPE 9**



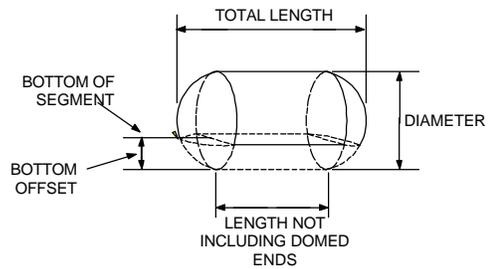
**ANY SHAPE WITH VERTICAL
SIDES (EXAMPLE)
TYPE 10**



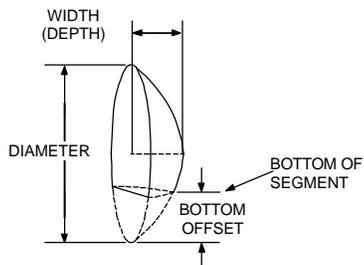
**HORIZONTAL CYLINDER
WITH FLAT ENDS
TYPE 11**



**HORIZONTAL CYLINDER
WITH DOMED ENDS
TYPE 12**



**DOMED END
TYPE 14**



**SPHERE
TYPE 18**

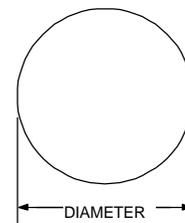


Figure 3.8 Pre-Defined Tank Shapes and Dimensions (cont.)

Chapter 4 Set up Additional Measurements

As described in Chapter 3, the primary measurement (measurement #1) is set up as either level or distance using the “Set up level,...” menu. Up to seven additional measurements can be set up using the “Set up additional measurements” menu. You can use these measurements to drive a variety of alarms and current outputs to meet the needs of your processing procedures.

To reach the “Set up additional measurements” menu from the measurement display, press → twice. Then press ↓ to enter the menu.

The first time you access the “Set up Additional Measurements” menu, the “Assign & set up measurement 2” menu will appear. Measurement 1 is assigned to the primary measurement (distance or level) by default. After measurement 2 is set up, the next time you scroll through this menu item, it will read “Modify setup of measurement 2.” You will then be able to “Assign & setup measurement 3,” and so on, up to a maximum of eight measurements.

The following sections describe the “Set up additional measurements” menu items. The tables at the end of this Chapter show the individual menu items and the sequence in which they are displayed.

Selecting Measurement Type

The “Reading presented by measurement # is” menu item allows you to specify the desired measurement type. Available measurements include:

- distance (outage)
- level
- volume
- ullage (empty volume)
- percent full
- percent empty
- percent distance
- per cent level
- signal strength (sig str)
- mass
- rate
- special measurements, for service diagnostics

Note: Volume related measurements (volume, ullage, % full, % empty, and mass) are not available for selection until “Tank volume setup” has been completed under the “Set up Level, Level Alarms, and Volume” menus.

Special measurements are only available when “Service only items” are enabled (see “Special Functions” on page 8-19).

It is good practice to make a list of all the measurements you set up and keep the list for future reference.

Select Measurement Menus

“Set up Additional Measurements” Menu (Specify Measurement Type)	
Display	Comments
Set up additional measurements (readouts).↓ Other functions→	You can assign up to 7 measurements in addition to the primary measurement. (Primary measurement setup is described in Chapter 3.) Press ↓ to set up additional measurements.
NOTE: Meas. #1 is the primary measurement See “level setup” to modify. NEXT↓	Measurement #1 is assigned to the primary measurement by default. (Use the “Set up level,...” menu to change the primary measurement setup as described in Chapter 3.)
Assign & set up measurement 2→ NEXT↓	Press → to assign a readout to measurement 2. After a readout is assigned to measurement 2, this menu item will read “Modify setup of measurement 2” and show the readout assigned, e.g., “cu ft” indicating volume is assigned to measurement 2.
←Exit measurement 2 Set up for level, dist, %lev, %dist, etc. NEXT↓	Info message only. Press ↓ to set up measurement, or ← to exit measurement 2 setup. After measurement 2 is set up, this menu item will read “Change or disable measurement setup.”
Reading represented by measurement 2 is (inactive) NEXT↓ CHANGE→	Press → to select the readout for measurement 2. Select from Distance, Level, volume, ullage, % full, % empty, % distance, % level, sig str, mass, and rate. You must select a measurement before other setup menu items will be displayed. Select inactive to skip or to deactivate a measurement.

Measurement Specific Parameters and Units

Depending on the measurement type selected you will be prompted to enter units and certain parameters to complete the measurement setup.

Mass Measurement

If mass is selected as the measurement type, you are prompted to select the units from among the following:

- gram grams
- kgram kilograms

- pound pounds
- metric ton 1000 kg
- short ton 2000 lbs
- long ton 2240 lbs
- oz avoirdupois ounces

After specifying the mass units, you next enter the density of your material. (Mass is computed as the specified density times the volume measurement.) The value entered for the density must be in the same units (mass/volume) as specified for the mass and volume measurements. For example, if you select “pounds” for the mass units and “cu ft” for the volume units, the density must be entered in units of pounds/cu ft.

Rate Measurement

The rate measurement computes the time rate of change for the selected measurement. The rate can be computed for any measurement assigned to a measurement number. The rate can always be computed for the primary measurement (measurement 1). Other measurements must be set up using the “Assign and set up measurement” menu before the measurement rate can be computed.

Note: The rate measurement should be set up after setting up the measurement for which you wish to compute the rate. That is, the number of the rate measurement should be larger than the number of the base measurement.

The “smallest change for rate” menu item sets a threshold for the change required in the measurement before the gauge computes a rate value. No rate is computed until the magnitude of the change in the measurement value exceeds the threshold. Once a rate value has been computed (i.e., the change in the measurement exceeds the threshold), a new rate is computed when the threshold is again exceeded, or at the time when the change in the measurement *should* have exceeded the threshold based on the last computed rate estimate. This allows the estimated rate to settle back towards zero if the change in the process measurement stops.

The “rate smooth factor” menu item determines the degree of smoothing applied to reduce fluctuations in the rate measurement via exponential averaging. A factor of 1.0 corresponds to no smoothing (estimated rate equals the last computed rate). Use a smaller rate smooth factor if the measurement tends to fluctuate rapidly, resulting in noisy rate readouts. The minimum factor is 0.01 and corresponds to the greatest amount of smoothing.

The “rate time code” lets you select the time interval associated with the rate measurement. For example, you can measure the change in level per second, per minute, etc. Select from the following set of time intervals:

- s seconds
- m minutes
- h hours
- d days
- w weeks

- M months
- y years

Measurement Parameter and Units Menus

“Set up Additional Measurements” Menu (Measurement Specific Parameters and Units)	
Display	Comments
Note: After selecting a measurement type, menu item(s) prompt for the required parameters to finish setting up the measurement, as shown below.	
If “Distance” or “% distance” are selected, the following menu items are displayed.	
Distance units = ft To change to yd, M, cm, mm, or in press→ NEXT↓	Available units depend on selection of “All,” “English,” or “Metric” units under “Set up Level,...” menus. It is possible (perhaps not often useful) to set up distance as the primary measurement and as another measurement number using different units. No units are required for “% distance.”
Distance REF LINE to zero distance point 0.000 ft NEXT↓ HELP→	Appears if distance is <i>not</i> the primary measurement. Enter the distance from the reference line marked on the sensor to the desired zero distance point on the tank.
REF LINE to maximum distance to be measured 0.000 ft NEXT→ HELP→	Appears if distance is <i>not</i> the primary measurement. Enter the distance from the reference line marked on the sensor to the desired maximum distance point on the tank.
If “Level” or “% lev” are selected, the following menu items are displayed.	
Level units = ft To change to yd, M, cm, mm, or in press→ NEXT↓	Available units depends on selection of “All,” “English,” or “Metric” units under “Set up Level,...” menus. It is possible (although perhaps not often useful) to set up level as the primary measurement and as another measurement number using different units. No units are required for “% lev.”
Distance REF LINE to zero level point 0.000 ft NEXT↓	Appears if level is <i>not</i> the primary measurement. Enter the distance from the reference line marked on the sensor to the desired zero level point on the tank.
Maximum level to be measured. 0.000 ft NEXT↓	Appears if level is <i>not</i> the primary measurement. Enter the maximum level to be measured relative to the zero level point.
If “Volume” or “sig str” are selected, no additional setup items are displayed. Use the “tank volume setup” menus under “Set up level,...” to change the volume parameters.	
If “Ullage,” “% full,” or “% empty” are selected, the following additional menu item is displayed. The units for ullage will be the same as specified for the volume.	
100% Volume =	Enter the tank volume when full. The volume of the

0.000 cu ft NEXT↓	material is computed based on the tank volume setup and the level measurement. The volume of the tank when full is required to compute the ullage (empty volume), the % full and the % empty values.
--------------------------	--

“Set up Additional Measurements” Menu (Measurement Specific Parameters and Units) (cont.)	
Display	Comments
If “mass” is selected, the following menu items are displayed.	
Mass units: Kgram NEXT↓ CHANGE→	Select the units for the mass measurement. Available units are: gram, kgram, pound, metric ton, short ton, long ton, and oz.
material density 0.000 Kgram/cu ft NEXT↓	Enter the material density value. The density value (mass / volume) must be specified in the same units selected for mass and volume. Density values < 0.1 are displayed in scientific notation and the units are not displayed due to display space constraints.
If “rate” is selected the following menu items are displayed.	
rate readout will be rate of: Distance/time NEXT↓ CHANGE→	Select a (previously setup) measurement (distance in this example) for which to compute the rate of change. Measurement number for rate should be greater than the number of the base measurement.
Smallest change for rate compute 0.000 ft dist 2.022E-2 assum NEXT↓	Rate will not be computed until the change in the measurement exceeds the value entered here. Once rate has been computed, it is recomputed when the change threshold is exceeded or when the expected time for the change threshold to be exceeded has elapsed.
rate smoothing factor 1.000 {0.01=smoothest} {0.01 to 1.0} NEXT↓	Smoothing factor for rate measurement. A value of 1.0 corresponds to no smoothing (current estimate is displayed), a value of 0.01 corresponds to the most smoothing (longest effective averaging time).
rate time code ft dist/d Continue↓ Change→	Select the reference time interval for the rate measurement. Choices are: s (seconds), m (minutes), h (hours), d (days), w (weeks), M(months), and y (years).
The next menu item is displayed only if “Service Only Items” are enabled.	
special code for measurement 2 0 see manual NEXT↓	Enter special measurement code. Typically used only for diagnostic purposes.

Measurement Display Setup

In the default configuration, the 4-line display can show 3 measurements readouts (or up to 6 measurements by alternately displaying 3 readouts at a time). The fourth line displays the instruction “For setup, press →.”

Like the primary measurement, the signal strength (sig str) measurement is displayed by default. If the tank volume setup has been completed, the tank volume is also displayed by default. For example if you have set up volume, the measurement display would be similar to the display shown in Figure 4.1 below.

```

10.5 ft level
78.5 cu ft
 114 sig str
For setup press→

```

Figure 4.1 Measurement Display (level, volume, signal strength)

The primary measurement is shown on the first line, the volume is shown on the second line, and the signal strength is shown on the third line. Any additional measurements, up to six total, would be displayed in alternation with the current measurement readouts. For example, if measurement 2 is now set up as “%full,” the measurement display would alternate approximately every 3 seconds between the displays shown in Figure 4.2a and in Figure 4.2b.

```

10.5 ft level
64.5 % full
78.5 cu ft
For setup press→

```

a. Display 1 (level, % full, volume)

```

10.5 ft level
64.5 % full
 114 sig str
For setup press→

```

b. Display 2 (level, % full, sig str)

Figure 4.2 Measurement Display (level, volume, signal strength, % full)

To make room for displaying other measurements or to eliminate the need for the display to alternate between measurement screens, you can disable the display of the “For setup, press →” instruction on the fourth line of the measurement display. The display of this line is disabled using a menu item under the “Special functions” menu, see page 8-19.

Note: Pressing the → key from the measurement display will access the setup menus even if the display of the “For setup” instruction is disabled.

If you do not want signal strength to appear on the measurement display, it can also be disabled using a menu item under the “Special functions” menu, see page 8-19.

You can also disable the display of the primary measurement (measurement 1) as follows. Use the “Special functions” menu (see page 8-19) to enable the service only items. This adds a “Modify measurement 1” menu under the “Additional measurements” menu which includes the “Do / Do not display” option for primary measurement readout.

Do or Do Not Display

Use this menu item to select whether to display the measurement. Normally, any measurement you set up is automatically displayed. If you select “Do not display,” the measurement is not displayed, but you can still use the measurement to drive alarms or current output.

For example, if the volume measurement has been set up, the volume readout will be displayed by default. It is possible to disable the display of the volume readout, but to still have the volume measurement enabled to drive an alarm. Use the “Assign & set up / Modify measurement #” menus to assign volume to a measurement number, and set up the alarm as described above. Then set the “Do / Do not display measurement #” menu item to “Do not” to disable the display of the volume measurement. (The signal strength measurement display can be disabled in a similar manner.)

Display Scaling

A maximum of 4 numeric digits and a decimal point (5 characters total) are available on the 4-line, 20 character/line measurement readout display. The menu items described in this section allow you to scale the displayed readout values, so that values greater than 9999 or less than -9999 can be accurately displayed.

As an example, if you set up a volume measurement and expect readings between 30,000 and 40,000 liters, you can use the display scaling menu items to scale the displayed volume to read in the range 30.00 to 40.00. In this example, the displayed value equals the measured value (liters) divided by 1000. Thus, the units of the displayed value would be kiloliters. Display scaling does *not* affect the units displayed for the readout; however, you can set up a custom units message.

Note: The following menu items are displayed unless the measurement has been assigned to a current output (see Current Outputs on page 6-1). If a current output has been assigned, the “Meas # reading for 20.00 mA output” and “Meas # reading for 4.000 mA output” menu items for setting up the current output are displayed. (The “Meas # reading” menu items are displayed by default for the primary measurement, see page 3-2).

Expected reading values and display scaling only affect the readout. They do not affect the measurement itself. The actual unscaled measurement values are used for any alarms you assign to this measurement.

Highest Expected Reading

If you expect the maximum measurement readout to exceed four digits (value greater than 9999), enter an estimate of the maximum measurement value in the “Highest expected reading” menu item. If you set a highest expected reading value of 10,000 or greater (more than four digits), three additional menu items will be displayed allowing you to set up *display scaling* so the gauge’s display will be meaningful throughout the expected range.

The value for the highest expected reading is not critical, just pick a convenient number with the correct order of magnitude. If the actual measurement happens to exceed the range

you expect, the readout will still display the correct, scaled measurement value, as long as the scaled value can be displayed in four digits. In our example where 40,000 liters is scaled to read 40.00 on the display, if the gauge measures 43,875 liters, the displayed value would be 43.88. Any value up to 99,999 would be displayed correctly, rounded to four significant digits.

Lowest Expected Reading

This menu item is displayed if you set a highest expected reading value greater than 9999 for a measurement. Use this item to enter the lowest expected measurement value (before display scaling).

Scale Actual (highest expected reading) to High End Readout

This menu item is displayed if you set a highest expected reading value greater than 9999 for a measurement. Enter the desired readout value to be displayed for the highest expected reading.

For example, to scale a highest expected reading value of 40,000 to a display value of 40.00, enter 40.00 for the high-end readout value.

Scale Actual (lowest expected reading) to Low End Readout

This menu item is displayed if you set a highest expected reading value greater than 9999 for a measurement. Enter the desired readout value to be displayed for the lowest expected reading.

For example, to scale a lowest expected reading value of 30,000 to a display value of 30.00, enter 30.00 for the low-end readout value.

Set up custom units messages

This menu item is displayed if you set a highest expected reading value greater than 9999 for a measurement. By default, the original volume units will be displayed for the scaled value on the measurement display. The “Set up custom units messages” menu items allow you to set up a user-defined units message up to 10 characters long.

In the above example, the volume measurement with units of liters was scaled by a factor of 1/1000 (40,000 is displayed as 40.00), so the displayed value has units of kiloliters. Thus, you might want to set up a custom units message to read “kiloliter.” Up to 8 custom messages can be defined using any combination of ASCII characters up to 10 characters in length. Refer to “Setting up Custom Units Messages” on page 8-20 for details.

Position of Decimal

Press the ← and → keys to select the position of the decimal point in the display readout. This is the last setting that is required for setting up the measurement. You can press ↓ followed by ← to return to the “additional measurements” menu, or press EXIT SETUP to save changes and return to the normal measurement display.

Set Up Alarm...

The primary measurement is automatically assigned to measurement 1; however, signal strength, volume, and other measurements are not assigned a measurement number by default. Therefore, volume, signal strength, and other measurements are not available to drive the current output, alarms, or relays until you assign them to a measurement number using the “Set up additional measurements” menu.

Setting up an alarm for a measurement other than the primary measurement is a three step process. First, set up the measurement using the “Assign and set up measurement #” menus. Second, assign an alarm to the measurement using the “Assign alarms to measurements” menu items as described in “Set Up Fault Alarms or Change Process Alarm” on page 6-3. By default, all alarms are assigned to measurement 1, the primary measurement. Third, return to the measurement setup menu which will now read “Modify set up of measurement #,” to set up the alarm.

After assigning one or more alarms to a measurement, the “Set up Alarm” menu items will be displayed under the appropriate “Modify setup of measurement #” menu under the “Set up additional measurements” menu, allowing you to set up or modify the alarms. For example, if you assign alarms 5 and 6 to measurement 3, setup menu items for those alarms will be displayed when you set up or modify measurement 3.

For details on setting up alarms and a description of the alarm parameters (set point, clear point, dead band, etc.), refer to “How to Set up Alarms” on page 3-6 which describes alarm setup for the primary measurement. The alarm setup procedure for other measurements is the same as for the primary measurement.

Set up Alarm Menu

Note: If relays are installed, the default indicator for alarm *N* is “controlling relay *N*,” even if *N* exceeds the number of relays. Press → to change the alarm indicator, and the “controlling relay #” options will then correctly reflect the number of installed relays.

“Set up Alarm” Menu	
Display	Comments
Set up alarm 3 (Alarm point, etc.)→ NEXT↓	This item only shows up if an alarm (e.g., alarm 3) has been assigned to the measurement in the “Assign alarms to measurement” item of the “Set up fault alarms...” menu (see “Set Up Fault Alarms or Change Process Alarm” on page 6-3). The alarm number and the measurement number can be different.
Note: The appearance of the following menu items depends on the selected measurement type. You must enter a set point to activate the rest of the Set up Alarm menu. Example displays show volume (cu ft) measurement.	
←Exit alarm 3 setup Alarm 3 set point 40.00 cu ft NEXT↓ HELP→	Enter the measurement value for the alarm set point; the value at which the alarm is activated.
Alarm 3 clear based on clr point Chng to “dead band”→ Continue as is.↓	Select a clear point or dead band configuration. A clear point is the exact measurement value at which the alarm is cleared. A dead band specifies the span between the set point and the implicit clear point.
Alarm 3 clear point 30.00 cu ft {Makes alarm “Hi” limit} NEXT↓ HELP→	Enter desired clear point (or dead band) value, the measurement value at which the alarm is cleared (turned off). If dead band selected, enter the width of the dead band relative to the set point.
Alm 3: cu ft is indicated by controlling relay 2 NEXT↓ CHANGE→	Select action used to indicate that alarm 3 has been triggered. The default for alarm <i>N</i> is “controlling relay <i>N</i> ,” if relays are installed. Other selections are: controlling relay 2 (3, 4 if installed) Meas #1 dispy flash (#2, #3, etc., if measurements have been setup) Zero current output 1 (or 2 if installed)
Note: Additional menu items related to controlling relays are shown in the next table. Other menu items may appear depending on entries you made elsewhere in the menus.	
Set up alarm 4 (Alarm point, etc.)→ NEXT↓	If you assigned more than one alarm (e.g., alarm 4) to the measurement, menu items will be displayed allowing the option to set up these other alarms. If you don’t want to set up another alarm, scroll past this screen.

The next table presents those menu items specifically related to controlling a relay as an alarm indicator. As noted in the Comments column, several of the menu items are only displayed if options have been enabled in the “Special functions” menu. The Special Functions Menu is described on page 8-19.

“Set up Alarm” Menu (continued) Relay Indicator Related Items	
Display	Comments
alarm relay 2 set delay 0 seconds (0-255 s after alarm) NEXT↓	Only displayed if “alarm relay delay times” have been enabled in “Special functions” menu (see page 8-19). Alarm condition must persist for the time entered for alarm to be activated.
alarm relay 2 clear delay 0 seconds (0-255 s after alarm has cleared) NEXT↓	Only displayed if “alarm relay delay times” have been enabled in “Special functions” menu (see page 8-19). Alarm clear condition must persist for the time entered for alarm to be cleared.
Do not use latching mode with relay 2. Change to “Do”→ Continue as is.↓	Only displayed if relay latching has been enabled in “Special functions” menu (see page 8-19). When latch mode is enabled for a relay, the relay remains in alarm state even after the actual alarm is clear. The relay is cleared by a “Clear alarms” command (see page 7-3) or when system has been powered off.
Relay 2 turns on when alarm occurs. Change to “off”→ ←Exit alarm 1 setup.	Only displayed if a relay alarm indicator is selected as the alarm indicator. Non-relay indicators include zeroing current output, flashing display, or activating commands.

Chapter 5 Radar Fine Tuning

The basic setup parameters entered via the “Set up Level,…” menu items (see Chapter 3) establish the measurement range, or the region of interest, along with echo qualification criteria. The measurement range defines the region over which the Accu-Wave gauge looks for echoes. The qualification criteria are applied to the received echoes that fall within the range of interest to identify the “most likely” echo from the surface of the process material. In many applications, the measurement range and qualification criteria derived from the basic setup parameters work fine and no further adjustments are required.

In more challenging applications, additional fine tuning may be required for the Accu-Wave gauge to lock onto the correct echo from the surface of the material. This chapter describes the tools available in the Accu-Wave gauge designed to help deal with these more difficult situations. In addition, this chapter describes how to override the default measurement range (based on the basic setup parameters) and how to change the measurement calibration.

Note: The Radar Fine Tuning menu structure has two layers of menu items, the user layer and the service layer. The default user layer is adequate for many applications.

The service layer provides several additional tools/menu items (tank mapping, region weighting, and dynamic tracking) for handling particularly difficult conditions. These additional tools are not supported in software versions prior to Version 4.31. The service layer of tools is intended to be used by an advanced user or by TN’s service personnel.

If you have difficulty configuring your gauge, contact the TN Technical Support office for assistance.

The Radar Fine Tuning section has four major menus groups.

1. Material Type and Measurement Head Setup
This menu allows you to enter information on the type of material the radar is reflecting and on the measurement head mounting details. The assumed values for these parameters will serve in most applications. However, if your unit is not performing properly, you should enter the actual values for the parameters in this menu.
2. Modify Range of Measurement
This menu allows you to override the measurement range. These entries will not change the zero level, maximum level, or zero distance values you may have already entered. You will be able to extend or constrain the measurement range to something other than that implied by the basic entries.
3. Response Time, Lost Echo & Agitator Reject Setup
This menu deals with dynamic or time related issues. It provides entries to control the response time (damping), the action taken when the signal (echo) is lost, and the response to a temporary loss or change in the echo.

4. False Echo Management

There can be several sources of radar echoes other than the material surface. If the automatic echo selection criteria are adequate for identifying the echo from the surface in your application, this menu provides tools to help the system select the proper echo.

From the measurement display, use the → key to scroll to the “Radar fine tuning” menus. Press ↓ to enter this menu group and to scroll to the four menu groups listed above. Each of these four menu groups is discussed in more detail in the following sections.

Material Type and Measurement Head Setup

The “Material type and measurement head setup” menus allow you to enter information regarding the characteristics of your process material, the process seal, the system to determine the expected signal strength and any distance offset which might be caused by your specific process seal. Unless material information is entered, the system uses low initial amplification to prevent saturation. This configuration will serve in most applications due to the system’s very broad dynamic range.

If the return signal is weak due to a combination of factors such as a low dielectric process material plus agitation, the situation may be improved by entering information about the material. If you select “is not” water based material, the system will increase the initial amplification to a moderate level. Entering the dielectric constant for your particular material will allow the system to optimize the initial amplification.

If there are features in your tank that produce a stronger echo than the surface of the process material, you may see saturation warnings during operation. In this case, you will need to change the dielectric entry to a higher value. (The gain or amplification setting for the microwave signal is determined based on the value of the dielectric constant, as the value of the dielectric constant is increased, the amplification level is decreased.) Even though such offending signals may be stronger than the proper signal, the system can still be tuned to select the proper echo. It is important, however, that the initial amplification be set so that the strongest echo does not cause saturation.

The “spectrum count to average” entry allows the system to enhance weak echoes by averaging several samples. An entry greater than 8 can slow the response to level changes. The spectrum averaging is performed prior to performing the echo limiting and echo rejection tests. Typically, this entry should be left at 1.0 (the default value).

The “Material Type and Measurement Head Setup” menu items are summarized in the following table.

“Material Type and Measurement Head Setup” Menu	
Display	Comments
material type and measurement head setup→ NEXT↓	Menu entry point for the “Material Type and Measurement Head Setup” menu group. Press → to access these menu items, press ↓ to continue to the next “Radar fine tuning” menu group.
←Exit from: material type and measurement head setup→ NEXT↓	Press ← to exit this menu group or press ↓ to proceed.
Set gain = 0.000 (1.0 - 40, overrides automatic value) {2.711 in use} NEXT↓ [Service only item]	If this variable is set to zero (default), the gauge will adjust the voltage gain of the I.F. (audio) signal automatically based on the ROI, and dielectric constant of the process material. If it is set to a non-zero value, this value is used to override the calculated gain setting. Direct Entry Code: ‘029003’
Material in tank is water based Change to “is not”→ NEXT↓	This entry selects one of two default (assumed) values for the dielectric constant of the process material, which in turn sets the initial gain for the microwave signal. In most applications, selecting “water based” or “not water based” is adequate to set the gain. If you know the dielectric constant for your process material, you can enter it in the next menu item. Note: If your application involves more than one process material with different dielectric constants, enter the highest dielectric constant. Direct Entry Code: ‘025010’
Dielectric constant of process 0.000 (presently 80.00) NEXT↓	The “presently” assumed value is used for the dielectric constant of the process material unless you enter a non-zero value here. The assumed value is 80.00 if you selected “is water based” in the previous menu item, or 4.704 if you selected “is not water based.” Direct Entry Code: ‘028003’
measurement geometry 4 in antenna without flange mounted seal NEXT↓ CHANGE→	Select “antenna without flange mounted seal” for an intrusive sensor mounting configuration or change to “antenna with flange mounted seal” for the isolation sensor configuration. Direct Entry Code: ‘005002’

“Material Type and Measurement Head Setup” Menu (continued)	
Display	Comments
<pre>flange mounted seal velocity correction value = 0.000 NEXT↓ HELP→</pre>	<p>Displayed if “antenna with flange mounted seal” is selected above. Enter velocity correction value (in cm) to correct for the reduced propagation velocity of the process seal(s). See Error! Reference source not found. If this value is left at zero, the process seal will induce a small offset error.</p> <p>Direct Entry Code: ‘086003’</p>
<pre>spectrum count to average 1 (1 - 64) NEXT↓ HELP→</pre>	<p>Increase number of averages to improve measurement on non-agitated low dielectric materials such as light hydrocarbons. Values over 8 can slow the response of the gauge. Do not use values > 1 on agitated to turbulent surfaces.</p> <p>Direct Entry Code: ‘022004’</p>
<pre>Optimize system for best Accuracy Chg to “Resolution”→ Continue as is.↓ [Service only item]</pre>	<p>Use default value for best accuracy. Changing to “Resolution” can somewhat improve ability to resolve closely spaced echoes at the cost of a slight decrease in the accuracy of the distance/level measurement.</p>

Modify Range of Measurement

To maximize resolution and minimize false echoes, the system establishes a Range of Interest (ROI) over which it looks at candidate echoes. The default ROI is based on values entered during the primary measurement setup (see page 3-2). If the primary measurement is level, the ROI extends from the zero level point to the maximum level point. If distance is the primary measurement, the ROI extends from the zero distance point to the maximum distance point.

Using the “Modify Range of Measurement” menu items, the ROI can be modified to allow measurements below the zero level (readout will show a negative level) or above the “maximum” level. Alternately, the ROI can be set to exclude the zero level point.

The slope correction and distance offset correction entries allow you to fine tune the gauge’s distance measurement to correct for any variations due to the gauge installation or to adjust the gauge’s readout to match the distance / level readings from another level measuring device.

“Modify Range of Measurement” Menu	
Display	Comments
Distance REF LINE to highest possible level 0.000 ft NEXT↓ HELP→	Defines top of the ROI. If this entry is 0.0, the top of the ROI is set by the maximum level (or zero distance point) entry for the primary measurement. A non-zero entry here overrides the default value for the top of the ROI, and defines the closest echo processed. The gauge will not correctly measure above this level. Minimum value is 2.12 m (0.691 ft).
REF LINE to maximum distance to be measured 0.000 ft NEXT↓ HELP→	Defines bottom of the ROI. If entry is 0.0, the bottom of the ROI is set by the zero level (or maximum distance point) entry for the primary measurement. A non-zero entry here overrides the default value for the bottom of the ROI, and defines the farthest echo processed. The gauge will not measure correctly below this level. Maximum value is 34 m (112 ft).
Slope correction factor 1.000 NEXT↓ HELP→	Adjust gauge readout using following equations: Distance = slope factor x (meas. value + offset). Level = zero level point – distance Limit slope factor value to range of 0.995 and 1.005. Consult TN if this value needs to be changed. Direct Entry Code: ‘049003’
Distance offset correction 0.000 ft NEXT↓ HELP→	Offset value for gauge readout adjustment equations (see entry above). Mounting imperfections can cause up to 0.10 ft offset error. Limit offset value to range of 0.0 to 0.16 ft (0.05m). Consult TN if this value needs to be changed. Direct Entry Code: ‘031003’

Response Time, Lost Echo, and Agitator Reject Setup

The “Response Time, Lost Echo, and Agitator Reject Setup” menus provide entries to control the system response time, what action to take when the signal (echo) is lost, and the response to a temporary loss or change in the echo.

When the Accu-Wave gauge is first turned on, the system begins processing the echoes received from the microwave transmission to identify the true echo from the material surface. Each time the gauge transmits a microwave signal, multiple echoes are received by the sensor. The source of these echoes can include reflections from:

- the surface of the material (the proper or true echo)
- layers within the process material such as foam or oil–water interface
- streams of liquid filling the tank
- the tank bottom as seen through the process material
- agitator blades
- structural features in the tank
- multiple bounces from the various internal surfaces of the tank
- structures relating to the entry of the microwave signal into the tank

Echoes which fall within the range of interest (minimum to maximum distance) defined by your setup entries for the primary measurement are included in the group of candidate echoes, which are analyzed to select the “best” candidate for the echo from the surface.

If the location of the best candidate echo remains consistent (falls within a range gate) over several transmissions, the system locks onto this echo as being the “true” echo from the material surface. Echoes from subsequent transmissions are then analyzed. If the location of the best candidate echo falls within a range gate centered on the average location of the current, true echo (the present distance readout), the echo is considered valid, and the distance measurement of this echo is used to update the measurement readout. If the echo does not satisfy the range criteria, the group of echoes from a new transmission is processed and a new echo report is generated. This process is repeated until the best candidate echo passes the range gate criterion, or until a new “true” echo is confirmed at a new location through its persistence.

Range Gate

The range gate defines the acceptance window which moves with the level (or distance) readout. When the gauge is powered up or when the system switches to the “echo is lost” mode, the range gate is in the *not captured* mode. After a certain number of “hits” (best echo candidates which fall inside the range gate), the range gate switches to the *captured* mode, that is, the gauge locks on to an echo as the true echo. When the range gate is in the *not captured* mode, all “best candidate” echoes from successive transmissions are used to update the measurement readout.

Once the range gate is in the *captured* mode, a “best candidate” echo is only used if:

- The echo distance falls within the range gate

- “Do bypass range gate for near echoes” has been selected and the echo falls short of the range gate
- “Do bypass range gate for far echoes” has been selected and the echo falls beyond the range gate
- Past echoes have fallen outside of the range gate for a period equal to the “agitator reject time” (range gate delay time)

If none of the above conditions are met, the next transmission is processed, a new echo report is generated, and the entire process is repeated until one of the above conditions is met. If no echo meets the above conditions for a specified period of time (the range gate delay time), the echo is considered lost and the gauge will be in the “waiting for echo” state. A second time parameter (time after echo loss before lost echo mode) defines the time between the initial loss of the echo and when the gauge enters the lost echo mode, that is, the range gate reverts to the *not captured* mode.

The optional selections to by-pass the range gate for near echoes, far echoes, or all echoes are typically not required. The “by-pass near” selection can be used to provide a fast response to rising level, while delaying response to echoes which appear to be beyond (below) the material level. Similarly, the “by-pass far” selection can be used to provide a fast response to decreasing level, while delaying response to echoes which appear to be above the material level. This is one of several tools which may be used in combination to reject multi-bounce echoes or echoes from the bottom of the tank as seen through a low dielectric material.

Agitator Reject Time

The persistence (time) required to accept a new “true” echo, which falls outside the range gate of the current true echo, is determined by the “Agitator reject time” (range gate delay) entry.

As implied by its name, a primary purpose of the “agitator reject time” is to reject false echoes due to an agitator that may have blades above the material surface or to delay loss of echo. The reject time should be set to the time required for the blade to pass through the microwave beam. The beam diameter increases by about one foot for each four foot increase in distance from the top of the tank. For example, if the agitator blade is 20 feet from the top of the tank, the beam can be considered to be about 5 feet wide. Based on this beam width and the agitator speed, you can determine an appropriate entry for the agitator reject time.

The range gate feature can also provide cleaner operation with agitated surfaces. In such applications, momentary loss of the proper echo can cause the system to use a false echo from some structure in the tank. Setting an agitator reject time of a few seconds will cause the system to make many tries to get an echo close to the previous surface position before accepting other echoes.

If a long agitator reject time is entered, the response of the system to fast changes in level may be delayed. In some cases, this delay can be dealt with by selecting “Do” by-pass range gate for far echoes. In this configuration, the system will perform range gate processing on echoes which are closer to the measurement head than the measured level,

but will allow any echoes beyond the level (lower) to be accepted without considering the range gate.

Note: If you want to use an agitator reject time entry of “forever,” enter 65535 seconds.

Range Gate Weighting Factor (GWF)

A range gate weighting factor (GWF) can be applied to echoes that fall within the range gate. A GWF value greater than 1 gives additional preference to echoes within the range gate during the processing to select the best candidate. A GWF value less than 1 reduces the preference given to echoes within the range gate.

You may also affect the system response by changing the height (span) of the range gate. The default value for the range gate height is 25 cm (~10 in). Entering a larger value for the range gate height would increase the number of echoes considered valid and which could be used to update the current measurement values.

Using a larger range gate height and a short time constant value would allow the range gate to move quickly as the actual material level moves and would give the system a good chance of getting usable echoes from the material before it moves out of the range gate. Using a smaller range gate height can improve accuracy in turbulent applications but can also slow response depending on the range gate delay used.

The “long” range gate delay configuration would be used to deal with extended process changes such as a filling stream or the actual level going outside the range of interest. In such cases, the range gate delay should be set to the longest expected duration of the “unusual” process condition. A greater time-out should only result from a lost level condition.

Response Time, Lost Echo and Agitator Reject Setup Menus

The following table describes the individual menu items available under the Response Time, Lost Echo and Agitator Reject Setup menu group. Menu items that require the “Service only items” to be enabled include the notation [Service only item].

“Response Time, Lost Echo and Agitator Reject Setup” Menu	
Display	Comments
Level signal time constant 4 seconds NEXT↓ HELP→	Time constant for smoothing filter applied to the primary measurement (level or distance). Range of time constant value is from 1 to 1000 seconds. The longer the time constant, the greater the smoothing, and the slower the response of the system. Default value is 4 seconds. Direct Entry Code: ‘007004’
echo loss mode is hold last value NEXT↓ CHANGE→	When in “lost echo” mode (when gauge loses the return signal), display reports: “Echo lost.” Select one of the following actions: hold last value go to hold value (enter value in next menu item) go to maximum possible distance go to zero distance point Direct Entry Code: ‘142002’
Level hold mode & lost echo value 0.000 ft level NEXT↓	Only displayed when “go to hold value” is selected for the echo loss mode in the previous menu item Direct Entry Code: ‘037003’
time after echo loss before going to lost echo mode 4 seconds NEXT↓	Delay time between echo loss and switch to “lost echo” mode. During this period display will report: “Waiting for echo.” Enter the length of time the gauge waits before going to the signal loss mode selected above. The default is 4 seconds. Direct Entry Code: ‘029004’
Agitator reject time 1.000 sec (range gate delay) NEXT↓ HELP→	Agitator reject time is the delay time before accepting an echo outside the range gate. The range gate is a window that moves with the “measured” level. During this period display reports: “Waiting good echo.” Used to reject false echoes caused by an agitator blade passing through the signal. Direct Entry Code: ‘044003’
height of range gate (moving window) 0.000 ft NEXT↓ HELP→	Enter height of range gate which is centered on the distance measurement readout. A larger window will admit a larger number of signals as possibly valid. If this variable is set to 0.0, the gauge will use the default value of 25cm (± 12.5cm) range window. Direct Entry Code: ‘019003’

“Response Time, Lost Echo and Agitator Reject Setup” Menu (continued)	
Display	Comments
Increase range gate height by 0.000% of distance to surface NEXT↓ [Service only item]	This variable can be used to increase the range gate height by a percent of the distance to the surface. Direct Entry Code: ‘043003’
weighting factor (GWF) for echoes inside range gate. 0.000 NEXT↓ [Service only item]	During the echo selection process, echoes within the range are weighted by the preference factor. If this variable is set to 0.000 (default), no additional preference is given to echoes within the range gate. Entering a value greater than 1.0 will help the gauge track the process material. Direct Entry Code: ‘064003’
Capture range gate after 0 “hits” {128 assumed} NEXT↓ [Service only item]	This is the number of hits within the range gate window before the gauge would enter capture mode. If this variable is set to 0.000 (default), the gauge will use a default value of 32 times the value set for the time constant. Direct Entry Code: ‘011004’
Do un-capture range gate @ timeout Change to “Do not” NEXT↓ [Service only item]	If gauge does accept an echo within the range gate within the agitator reject time, the variable instructs either “Do” or “Do not” remain in capture mode. “Do not” would mean the range gate window would not be used until capture mode is re-established. Direct Entry Code: ‘040050’
disable range gate until re-capture ←Exit this menu NEXT↓ EXECUTE CMD→ [Service only item]	Executing this command will disable the range gate until capture mode is re-established. This command is useful if a large Preference Factor or a long Agitator Reject Time is preventing the gauge from requiring the correct echo (process material). Direct Entry Code: ‘37’ (Command)
Do not bypass range gate for near echoes. Change to “Do”→ Continue as is.↓	Open the range gate to closer echoes. Direct Entry Code: ‘029040’
Do not bypass range gate for far echoes. Change to “Do”→ Continue as is.↓	Open the range gate to farther echoes. Direct Entry Code: ‘029050’
Do not bypass range gate for all echoes. Change to “Do”→ Continue as is.↓	Open the range gate to all echoes. Direct Entry Code: ‘029080’

False Echo Management

Use the “False echo management” menu to correct false readings caused by unwanted echoes.

False echo management has three primary approaches to eliminating false echoes. The first is to constrain the set of candidate echoes to the smallest group that will reliably include the desired echo. The second applies test criteria that can reject some of the unwanted echoes. The third is to apply weighting factors to the remaining candidate echoes to enhance the echo from the material while suppressing all other echoes.

Note: A good understanding of the echo report is necessary before using the Radar Fine Tuning tools to deal with a difficult application.

Echo Report (View Echoes Being Processed)

The first item in the “False echo management” menu is the “view echoes being processed” menu. Each screen in this menu describes one echo in the candidate set.

You should be able to correlate the echoes in the echo report with the physical layout of your tank. First, identify which echo is from the material surface (based on its distance). Echoes at distances greater than the echo from the surface of the material are normally the result of multiple reflections or bounces. If the material is a low dielectric, such as hydrocarbon, one of the more distant echoes may be from the bottom of the tank.

Echoes that appear at distances closer than the material surface are typically from pipes or baffles. If you cannot associate echoes near the top of the tank with physical features, they may be “phantom” echoes from multiple bounces in the entry nozzle or mounting structure. The tools described in this chapter can be used to reject echoes caused by mounting structures. The best approach is to minimize the number and signal strength of these reflections by carefully mounting the Accu-Wave Sensor following the guidelines in the Accu-Wave Installation and Maintenance Manual provided with your gauge.

A typical display from the echo report is shown below:

```
echo 2 of 6 (#4)
Q1 = 180: 33.75 ft
Q2 = 45 : 22.11
SigStr
SWF = 0.500    NEXT↓
```

The first line of the display indicates that this echo report is for echo number 2 out of a total of 6 candidate echoes. The “(#4)” notation indicates that echo number 4 has been selected as the “best” echo. Note the echoes are numbered with echo 1 being the farthest from the sensor, echo 2 being the next farthest, and so on. In this example, echo 6 would be the closest echo to the sensor (among the set of candidate echoes that fall within the range of interest).

The second line shows that the Q1 echo quality factor for echo 2 is 180 (larger values indicate better quality). The distance of echo 2 relative to the reference line on the sensor is 33.75 ft.

The third line shows that the Q2 echo quality factor for echo 2 is 45 (again larger values indicate better quality). The signal strength of echo 2 is 22.11, before any weighting factors or other selection modifiers are applied.

Finally, the fourth line of the display shows the value of the Successive Weighting Factor (SWF).

Limiting the Number of Echoes to Process

The system only analyzes echoes that fall in the range of interest (ROI) and that are stronger than the minimum signal strength. The ROI is initially defined by the primary measurement setup entries. To limit the number of echoes processed, you can modify the range of interest. You can also modify the values for the “maximum number of echoes to be processed” (default value is 8) and/or the “minimum allowable signal strength” (default value is 3). Using the default values, the strongest echoes (up to 8) with signal strength > 3 are considered as the candidate echoes. The “Clutter Data Management” menu items can be used to remove “phantom” echoes which fall within the ROI. To optimize Accu-Wave performance, you should constrain the set of candidate echoes to the smallest group that will reliably include the desired echo (echo from process material).

Note: Only a few of the Radar Fine Tuning tools actually alter the echo report - the minimum allowable signal strength, the maximum echo count to process, the clutter data management, and modifying the range of interest (ROI).

None of the other Radar Fine Tuning tools alter the echo report. These other tools and weighting factors are applied to the signal strength in the echo report to select the best echo from the set of echo candidates.

Echo Rejection

Several of the menu items under the “False Echo Management” menu are used to reject unwanted echoes. These items do not alter the echo report, but do modify the echo selection process. The three tools used to eliminate echoes from being considered as candidate echoes are:

1. The “maximum desired signal strength” can be used to reject echoes that are stronger than the desired echo. This capability may be used to reject very strong false echoes while allowing the weighting factor to be set to deal with other situations.
2. “Q1 and Q2 quality factor rejection” criteria can be used to reject any echo which has a low Q1 and/or Q2 quality factor value.
3. “Tank mapping” can be used to specify the location of physical targets within an empty tank and have the gauge ignore echoes from these targets. (See “Tank Map Setup” on page 5-21.)

Warning: If the desired echo's signal strength exceeds the "maximum desired signal strength," the desired echo will be rejected, unless it is the only candidate echo.

If the quality factor of the desired echo does not exceed the quality factor rejection threshold, the desired echo will be rejected.

Echo Weighting Factors

There are four echo weighting tools available for difficult applications.

1. Successive Weighting Factor (SWF) - Factor applied to the signal strength of an echo before comparing it to the next closer echo to determine which is the most likely candidate (default value is 0.5).
2. Range Gate Weighting Factor (GWF) - Increases the weight of the echoes within the Range Gate. See "Response Time, Lost Echo and Agitator Reject" on page 5-6.
3. Region Weighting Factors - Tank is divided into regions (2 to 8) and an additional custom weighting factor is assigned to each of the regions. See "Region Weighting Setup" on page 5-24.
4. Map Echo Weighting Factor - Applied if tank mapping is set to derate (rather than ignore) mapped echoes. See "Tank Map Setup" on page 5-21.

The successive weighting is the most commonly used tool for adjusting echo selection and is the only echo weighting factor used by default. When activated, the other three echo weighting factors are used to weight the signal strength of the echoes in the echo report prior to parsing the report using the factor SWF.

The SWF is applied as follows:

1. The echo report is parsed from the farthest echo (echo #1 in the echo report) to the closest echo (last echo in the echo report) based on weighted signal strength.
2. The SWF is applied to echo #1 (farthest from the gauge). For example, if the signal strength of echo #1 was 1000, after applying the SWF (default value = 0.5), the weighted signal strength of this echo would be 500.
3. The weighted signal strength of echo #1 is compared sequentially to the non-weighted signal strength of echoes 2 through N. Echo #1 would be replaced as the "best" candidate by the next closer echo with a signal strength greater than the weighted signal strength of echo #1.
4. This process continues until a final "best candidate echo is chosen, that is, an echo with a weighted signal strength which exceeds the non-weighted signal strengths of the remaining, closer, candidate echoes.

A smaller Successive Weighting Factor helps suppress more distant echoes which might be from multiple reflections. This situation can occur with high dielectric materials such as water. A larger weighting factor helps suppress closer echoes that might be from structural features. This situation can occur with low dielectric materials such as hydrocarbons, where the good echo can be weaker relative to closer, spurious echoes.

Example: Locking on to False Target Closer (higher) than Material Surface

When the process material has a low dielectric constant, the return signal from the material surface can be weaker than the echoes from false targets. If there is a pipe or other artifact (false target) in the tank above the surface level of the process material, the gauge may lock on to the echo from the false target with the strongest signal rather than locking on to the proper echo from the material surface.

Note: If the dielectric constant of the process material is below two, call TN Technologies and speak with a Microwave Applications Specialist.

To make the system favor the more distant (proper) target, enter a larger value for the successive weight factor. Use a weighting factor large enough so that the signal strength of the proper target multiplied by the weighting factor is at least twice as large as the signal strength of any of the closer, false echoes.

In some instances, using a large weighting factor (to deal with close echoes) can cause the system to lock on to bottom of tank. Use the ‘bottom echo signal strength factor’ and ‘Distance REF LINE to tank bottom’ menu items to mask the tank bottom.

Example: Locking on to False Target Farther (lower) than Material Surface

With high dielectric materials, such as water, multiple reflections can occur depending on the shape of the tank. Use a smaller successive weighting factor to exclude these relatively strong, more distant echoes. Select a weighting factor small enough so that the signal strength of any false echo multiplied by the weighting factor is less than half as large as the signal strength from the closer, proper target.

The use of a very small weighting factor to favor close echoes can cause the system can lock on to relatively weak, close artifacts instead of the proper target. This complication can often be handled by limiting the number of echoes processed. Be careful to ensure that the number of echoes processed is large enough to always include the echo from the actual material surface.

“False Echo Management” Menu	
Display	Comments
View echoes being processed→ NEXT↓	Allows you to examine the echo report for each echo within the range of interest. Press → to access the echo reports, then press ↓ to scroll through the echo reports. The echo report is described on page 5-11.
echo amplitude successive weighting factor(SWF)=.5000 NEXT↓ HELP→	The successive weighting factor is applied to the signal strength of each echo before it is compared to the next closer echo. The same weighting factor is used for each echo. This is part of the process of selecting the “best candidate.” Direct Entry Code: ‘007003’
Minimum allowable signal strength 3.000 NEXT↓ HELP→	Only echoes with a signal strength equal or greater than this value will be reported as a possible candidate. Direct Entry Code: ‘108003’
maximum desirable signal strength 0.000 NEXT↓ HELP→	If this variable is set to 0.000 (default), the gauge will not use this function to reject echoes. If this variable is set to a non-zero value, the gauge will reject any echo greater than this value unless there are no other candidates. Used to reject strong unwanted echoes. Warning: If the desired echo exceeds this setting, the desired echo will be rejected unless it is the only candidate echo. Direct Entry Code: ‘104003’
maximum echo count to be processed 8 NEXT↓ HELP→	This item limits the number of echoes which the gauge will process. Enter a value between 1 and 24. For the default value of 8, the strongest echoes (up to 8 maximum) which exceed the minimum allowable signal strength and which fall within the ROI are reported as candidate echoes. Direct Entry Code: ‘025004’
Reject echoes with Q1 below 0 NEXT↓ [Service only item]	Enter minimum value for quality factor Q1 (0 - 255). If a non-zero value is entered, any candidate echo with a Q1 value less than this minimum value will be rejected. A 0 entry (default) disables the rejection of candidate echoes based on the Q1 value. Direct Entry Code: ‘043004’
Reject echoes with Q2 below 0 NEXT↓ [Service only item]	Enter minimum value for quality factor Q2 (0 - 255). If a non-zero value is entered, any candidate echo with a Q2 value less than this minimum value will be rejected. A 0 entry (default) disables the rejection of candidate echoes based on the Q2 value. Direct Entry Code: ‘044004’

“False Echo Management” (continued)	
Display	Comments
bottom echo signal strength factor 0.000 NEXT↓ [Service only item]	When set to 0.0 (default), this factor is not used in the echo selection process. When a non-zero value is entered, this weighting factor is applied to echoes at the “distance (from the) REF LINE to tank bottom” (next menu item) and beyond in the echo selection process. Note: Limit setting between 0.05 to 1.0. If this setting needs to be changed, consult TN. Direct Entry Code: ‘121003’
Distance REF LINE to tank bottom 0.000 ft NEXT↓ [Service only item]	This item works in combination with the previous item. Direct Entry Code: ‘054003’
spectrum cutoff point 91.00 % NEXT↓ [Service only item]	Do <i>not</i> modify this value.
Clutter data management→ NEXT↓	Press → to enter the “Clutter data management” submenu. See the next section for details.
tank map setup→ NEXT↓ [Service only item]	Press → to enter the “tank map setup” submenu. This submenu is used to map and reject false echoes in an empty tank. See page 5-21 for details.
region weighting setup→ NEXT↓ [Service only item]	Press → to enter the “region weighting setup” submenu. This submenu lets you divide the tank into regions (up to 8) and assign a different weighting factor to each region. See page 5-24 for details.
Minimum allowable post weighting signal strength 0.000 NEXT↓ [Service only item]	Enter desired threshold value. Default value of 0.0 disables this threshold test. When a non-zero value is entered, only echoes with a weighted signal strength greater than or equal to this value are reported as candidate echoes.
dynamic threshold setup→ NEXT↓ [Service only item]	Press → to enter the “dynamic threshold setup” submenu. This submenu defines parameters which help track a turbulent process while still providing a quick and reliable update response. See page 5-26 for details.

Clutter Data Management

Imperfections in the transition from the microwave head to the tank can cause microwave energy to be reflected. These imperfections can be due to poor alignment of the nozzle pipe during welding, pipe size mismatch, joints, valves, pipe liner, or material buildup. Although the physical source of these reflections is normally outside the range of interest (at or above the top of the tank), multiple bounces can cause these “phantom” echoes to appear to be in the range of interest. These echoes will persist even when the actual material level rises above the apparent distance to the phantom targets. These phantom targets are referred to as clutter.

Erase Clutter

Even if these phantom echoes are not strong enough to confuse the system in the selection of the proper echo, this clutter can cause errors when the distance to the material surface is close to the distance associated with a phantom target. The effects of phantom targets can be reduced by the use of clutter erase.

The gauge “learns” the phantom signals and mathematically removes them from consideration. During the learn clutter (“Get clutter data”) operation, the system stores all of the apparent target information over the maximum possible clutter zone, ~ 7.4 ft (2.25 m) or 25% of the maximum measurement distance, whichever is greater.

User Considerations

The gauge always measures the clutter data out to a fixed, maximum clutter distance. You then specify the distance from the reference line for which the actual clutter removal is performed. The clutter data will include any real (physical) targets located between the reference line and the maximum clutter distance. It is essential that the specified clutter removal distance *not* include any actual physical targets which might be covered by the material surface during normal operation. (See the “Tank map setup” or “Regional weighting setup” section in the chapter for information on how to mitigate the effect of these reflections.)

The user-entered clutter distance must be at least 30 cm (~12 in) above the level of the process material when the clutter data is taken. Otherwise, part of the real target’s echo data will be considered to be clutter.

The measurement range can be essentially anything up to the maximum system capability. However, the internal range is normally from about 8 m (27 ft) to the maximum system capability. For user-entered ranges below the internal minimum, the system ignores targets between the top of the range of interest and the internal minimum. The range of interest is established by the “zero level point” entry, if the primary measurement is level. The ROI can be overridden by the “maximum distance to be measured” entry.

If anything in the setup entries causes the internal range or the initial amplification to change after clutter data has been taken, clutter erase will be disabled and the “bad entry” message will be displayed. Initial amplification is normally a function of the dielectric constant and the range of interest-related entries. The bad data message can be suppressed

by taking new clutter data, selecting “Do” disable clutter erase, or entering a clutter distance of zero (which disables the clutter erase feature).

The need for clutter erase can be established by viewing the echo report. Look for echoes within a few feet (up to 7 ft or 2 m). If the signal strength associated with these echoes is more than 5% of the signal strength from the material surface, you should consider doing clutter erase. If the signal strength associated with these echoes is more than 50% of the signal strength from the material surface, you should verify the sensor mounting.

The clutter distance may be entered or changed before or after clutter data is taken. However, the clutter distance must always be at least 30 cm (1 ft) less than the distance to the material surface when clutter data was taken. In addition, the clutter distance must not be extended to include any true physical sources of echoes (such as pipes) that might be covered during normal operations.

Automatic Clutter Update

In most applications which require clutter erase, the clutter data is only taken once. However, in applications where the clutter echoes are strong and the clutter can change due to buildup or ambient temperature extremes, automatic timed clutter data may be employed.

Timed clutter data is activated by entering a clutter update time from a minimum of 1 minute to a maximum value of 45 days (65000 minutes). At the end of each clutter update interval, the system activates the clutter update process. The system waits to measure the clutter data until the measured level is at least 30 cm (1 ft) beyond the value entered for the clutter distance.

“Clutter Data Management” Menu	
Display	Comments
Clutter distance {from REF LINE} 0.000 ft {7.826 MAX} NEXT↓	If this entry is 0.0, the Clutter Data Mgmt menu items will not be displayed. Maximum allowable clutter distance is 7.147 feet or 25% of the maximum measurement range, whichever is greater. When a clutter erase command is executed, clutter data is collected to the maximum clutter distance. The “Clutter distance” defines which portion (or all) of the clutter data will be removed from the spectrum.
Do not disable Erase clutter Change to “Do”→ Continue as is.↓	May be used to disable clutter erase for diagnostic purposes. Direct Entry Code: ‘041080’
Get clutter data & save result. ←Exit this menu. NEXT↓ EXECUTE CMD→	Press → to execute the “Get clutter data” command. The distance to the material surface must be greater than the clutter distance value, or the valid echo will be removed as clutter. The actual level can reach the clutter area during operation, but can not rise above any physical features associated with the clutter. Note: Clutter Erase is best performed when the tank level is low (but not empty) and the surface of the process material is being agitated. If the measurement range is over 27 ft (8m), you must redo the learn (get) clutter if you change measurement range. Direct Entry Code: ‘104’
service clutter items→ NEXT↓ [Service only item]	Provides an additional set of diagnostic tools, if service only items are enabled. See “Service Clutter Items” table below.
Automatic clutter data update time 0 min NEXT↓ HELP→	Automatic update of clutter data is activated by entering a non-zero time. If this entry is zero, clutter data update is performed by manual command only. When active, new clutter data is taken at the interval entered. The latest clutter data is saved to non-volatile memory every 4 hours or at the update interval, whichever is the longest. Note: Use auto update only when clutter can change over time due to buildup on the seal or nozzle. You should do a manual clutter data update before entering an auto update time.

“Service Clutter Items” Menu [“Service Only Items” must be enabled]	
Display	Comments
←Exit from: service clutter items NEXT↓ HELP→	Provides an additional set of diagnostic tools, if “service only items” are enabled.
clutter spectrum count to average 8 {1 - 64} NEXT↓	Number of clutter spectrum values to average. Default value is 8.
Gain: now 1.252 clutter 1.252 stored 1.252 (read only) NEXT↓	gain: Preamp gain in use now. clutter: Preamp gain in use when clutter data now in use was taken. stored: Preamp gain stored in NVRAM.
cm/tic: now 1.488E-2 clutter 1.488E-2 stored 1.488E-2 (read only) NEXT↓	now: Range slope (cm/tic) factor in use now. clutter: Range slope factor in use when clutter data now in use was taken. stored: Range slope factor stored in NVRAM.
temp disable Erase clutter ←Exit this menu. NEXT↓ EXECUTE CMD→	Will not show up if “disable” clutter erase has been selected in the main clutter management menu. This is a toggle HOLD command which disables clutter erase. If hold mode is “disable” clutter erase, this command will show up as “enable.”
Get clutter data when dist > 6.984 ft ←Exit this menu. NEXT↓ EXECUTE CMD→	Arms system to get clutter data when level goes below clutter distance.
Get clutter data do not save result. ←Exit this menu. NEXT↓ EXECUTE CMD→	Collects clutter data for current use but does not write over stored data.
Load & use stored clutter data ←Exit this menu. NEXT↓ EXECUTE CMD→	Puts stored clutter data into use (instead of that collected above).
Save clutter data ←Exit this menu. NEXT↓ EXECUTE CMD→	Stores clutter data collected above.
saved clutter data→ NEXT↓	View saved clutter data values, real and imaginary clutter values.

Tank Map Setup

Tank mapping is used to map an empty tank for the physical targets such as ladders, beams, baffles, etc. Use Region Weighting Setup if the reflections from an agitator blade need to be mitigated. When tank map data is collected, the gauge can map up to 12 echoes.

Note: When the map empty tank command is executed, the number of mapped echoes will be limited to the echo candidates (echo report) which have a reported echo distance less than the mapped distance.

The gauge collects the following parameters for each of the mapped echoes:

- distance from REF LINE to echo
- signal strength
- quality factor (Q1)

If tank mapping is enabled, the gauge will compare the echo report to the mapped echoes for a possible “hit(s).” To be considered a “hit,” the candidate echo must meet the following three criteria.

5. The distance to the echo must be within a user-entered window of one of the mapped echoes (default is 1% of maximum distance).

Note: The distance comparison is performed less significantly than the values displayed in the echo reports meaning this tolerance window is an approximate window size.

6. If an echo meets the first criteria, the quality factor of the echo candidate is compared to the quality factor of the corresponding mapped echo. The quality factors must be within a user-entered tolerance (default is a tolerance of 32).
7. If an echo meets the first criteria, the signal strength of the echo candidate is compared to the signal strength of the corresponding mapped echo. The signal strength readings must be within a factor of 2 (0.5 to 2.0). The user cannot modify this tolerance.

An echo that is considered a hit (meaning the report echo met all three of the ‘hit’ criteria) can either be ignored or derated by a weighting factor. The default is to ignore all hits. If you choose to derate all hits, you can enter a “map echo weighting” factor. The default value for this weighting factor is 0.05.

The user has one additional option, “Do” or “Do not” allow echoes shorter than the farthest mapped hit. The default is “Do not” meaning any echo candidate closer than the farthest mapped hit will not be chosen unless there are no other possible candidates.

User Considerations

If the tank is not quite empty or you do not want to map the tank bottom, it is essential that the user-entered map distance be at least 30 cm (1 ft) above the level of the process material (or tank bottom) while the tank map data is taken. If both the tank mapping and clutter erase tools are being utilized, the clutter erase data must be acquired prior to tank mapping.

Note: The “Tank Map Setup” menu structure appears only if “Service Only Items” are enabled. Direct Entry Code 025020.

The direct entry codes were intentionally omitted from this table. Use the “Tank Map Setup” menu to set up this tool.

“Tank Map Setup” Menu [“Service Only Items” must be enabled]	
Display	Comments
Do not enable tank mapping Change to “Do”→ Continue as is.↓	When set to the default value of “Do not enable tank mapping,” the menu items below are not displayed. Change to “Do” to enable tank mapping. Reset to “Do not” at any time to disable tank mapping. Direct Entry Code: ‘026040’
maximum distance to map for false echoes 0.000 ft 25.25 assume NEXT↓	Set maximum distance to be mapped. Default or assumed value is ~7.5 cm (0.25 ft) past the maximum distance to be measured. If the tank is not completely empty, the map distance must be less than the distance from the REF LINE to the process material surface.
Map empty tank for false echoes ←Exit this menu. NEXT↓ EXECUTE CMD→	This command maps the tank for false echoes such as ladders, beams, baffles, etc. (not agitator blades).
false echo window 1% of max distance NEXT↓	Set “false echo window” value, the first of three criteria used to determine if an echo is a hit (corresponds to a mapped echo). The default value is 1% of maximum distance.
map Q1 tol 32 NEXT↓	Set tolerance of the Q1 quality factor, the second of three criteria used to determine if an echo is a hit (corresponds to a mapped echoes). The default is 32, meaning the Q1 value of the report echo must be within 32 of the Q1 value of the corresponding mapped echo to be considered a possible hit. Note: The third criteria is the signal strength, which must be within a factor of 2 of the signal strength of the mapped echo.

“Tank Map Setup” Menu (cont.) [“Service Only Items” must be enabled]	
Display	Comments
ignore mapped echoes Change to “derate”→ Continue as is↓	Echoes corresponding to a mapped echo (echoes that meet all three “hit” criteria) can either be ignored or “derated” by a weighting factor. The default is to ignore all hits.
Map echo weighting factor (MWF) 5.000e-2 NEXT↓	This menu item is only displayed if the above item was changed from “ignore to “derate.”
Do not allow echoes shorter than map hit Change to “Do”→ Continue as is.↓	The default is “Do not.” This means the gauge will not consider any reported echoes closer than the farthest map hit to be a possible candidate echo.
Note: After executing the “Map empty tank for false echoes” command, a series of menu item will be displayed describing the mapped echoes.	
map echo #1 of 5 17.77 ft distance signal str=5.781 Q1=129 NEXT↓	Information for each mapped echo is displayed: distance from REF LINE to echo, signal strength, and quality factor (Q1)

Region Weighting Setup

This menu allows the user to divide the tank into regions (2 to 8) and assign a custom weighting factor to each of the regions. The user enters the distances at which the adjacent regions intersect. The first region starts at the REF LINE, and the last region ends pass the maximum distance point. These custom weighting factors work in combination with the other echo weighting or preference factors. The region weighting factors do *not* parse the echoes within the region; instead all of the echoes within the region are simply weighted by its regional weighting factor. The regional weighting factors are applied to the echo candidates prior to parsing with the default echo weighting factor.

Note: The weighted echo values can be monitored by assigning special code ‘1062’ as an additional measurement.

The region weighting factors do not alter the echo report.

The “Region Weighting Setup” menu structure only appears if “Service Only Items” are enabled- Direct Entry Code 025020.

The direct entry codes were intentionally omitted from this Table. Use the “Region Weighting Setup” menu structure to set up this set of tools.

“Region Weighting Setup” Menu [“Service Only Items” must be enabled]	
Display	Comments
Do not enable region weighting Change to “Do”→ Continue as is.↓	When set to default value of “Do not enable region weighting,” the menu items below are not displayed. Change to “Do” to enable region weighting. Reset to “Do not” at any time to disable region weighting. Direct Entry Code: ‘026050’.
number of weighted regions 3 {2 to 8} NEXT↓	The default is 2 regions, meaning the tank will be divided into 2 regions. A maximum of 8 regions is allowed.
Note: A separate menu item will be displayed to define the extent of each region, except the last region. The first region always begins at the REF LINE (0.000). The boundaries of the last region are defined by the farther boundary of the next-to-last region and the maximum distance point.	
region 1 Distance 0.000 to 10.00 ft NEXT↓	Enter far boundary for region 1 (10.00 ft in this example). The next region begins at the far boundary of the previous region and ends at the user-entered value. The accuracy of the regional boundary entries are the greater of the max_distance/256 or 1.5 inches.
region 2 Distance 10.00 to 15.00 ft NEXT↓	Enter far boundary for region 2 (15.00 ft in this example), and so on. Only 3 regions were specified in this example. The boundary of the third (last) region is defined by farther boundary of region 2 and the maximum distance point.
Note: Following menu items prompt for the desired weighting factor for each region. The region weighting factors (RWFs) work in combination with the other echo weighting factors. The RWFs do not alter the echo report.	
region 1 {RWF(1) 0.000 to 10.00 ft} factor 1.000 NEXT↓	A separate weighting factor can be assigned to each of the regions.
region 2 {RWF(2) 10.00 to 15.00 ft} factor 1.000 NEXT↓	Enter region 2 weighting factor.
region 3 {RWF(3) 15.00 to 20.71 ft} factor 1.000 NEXT↓	Enter weighting factor for region 3 (the last region in this example).

Dynamic Threshold Setup

Note: The “Dynamic Threshold Setup” menu items are only displayed when the “Service Only Items” are enabled. Direct Entry Code 025020.

If the dynamic threshold setup is required, the Agitator Reject Time (Direct Entry Code 044003) should be increased to 8 seconds or longer.

Setting a dynamic threshold is intended to help track a turbulent process. When the surface of the process material is turbulent or agitated, the amplitude of the echo from the process material will fluctuate randomly. Setting a dynamic threshold will assist the gauge in accepting a reliable (strong) return, while still providing a quick and reliable update of the material surface level (or distance) measurement.

The amplitude of the previously accepted echo and two user-entered parameters are used to dynamically set the minimum amplitude (signal strength) of the next acceptable echo. The two parameters are:

- Dynamic Threshold Base - A constant (K), which is used to set the base value of the dynamic threshold using the equation
$$\text{dynamic threshold} = \text{amplitude of the last accepted echo} / 2^K .$$
- Change Dynamic Threshold Factor - Each second that the gauge operates without getting an acceptable echo, the dynamic threshold is multiplied by this factor.

These two parameters decrease the level of the dynamic threshold since the multiplication factor is less than 1. After the gauge acquires an acceptable echo, the dynamic threshold process starts over with the initial or baseline dynamic threshold value being set based on the amplitude of the last accepted echo and the dynamic threshold base factor.

The rate at which the Dynamic Threshold changes can be smoothed by changing one or both of the dynamic threshold smoothing factors. The “increase smoothing factor” (ISF) is applied if the new base threshold value is greater than the old threshold. In this case the dynamic threshold will be computed as:

$$\text{threshold}_{\text{old}} + [\text{ISF} \times (\text{threshold}_{\text{new}} - \text{threshold}_{\text{old}})].$$

The “decrease smoothing factor” (DSF) is applied if the new base threshold value is less than the old threshold. In this case the dynamic threshold will be computed as:

$$\text{threshold}_{\text{old}} + [\text{DSF} \times (\text{threshold}_{\text{new}} - \text{threshold}_{\text{old}})].$$

“Dynamic Threshold Setup” Menu [“Service Only Items” must be enabled]	
Display	Comments
Do not enable dynamic threshold Change to “Do”→ Continue as is.↓	When set to default value of “Do not enable dynamic threshold,” the menu items below are not displayed. Change to “Do” to enable dynamic threshold. Reset to “Do not” at any time to disable dynamic threshold. Direct Entry Code: ‘026060’
Change dynamic threshold by .8000 each sec NEXT↓	If there is no acceptable echo with an amplitude greater than the present value of the dynamic threshold, the dynamic threshold is decreased by the factor entered here (value must be less than 1.0). Direct Entry Code: ‘010003’
dynamic threshold base= signal str/2 ^k NEXT↓	The initial baseline value of the dynamic threshold is set at the amplitude of the previously accepted echo divided by 2 ^k . Enter the value of the exponent K. For example, if 3 is entered, the initial baseline value will be 1/8 (1/2 ³) of the amplitude of the previously accepted echo. Direct Entry Code: ‘058004’
Dynamic threshold increase smoothing factor 1.000 {0.001 to 1.0} NEXT↓	Enter value for the “increase smoothing factor” (ISF). Default value is 1.0 or no smoothing. If the new base threshold value is greater than the old threshold, the base value of the dynamic threshold will be equal to: $\text{threshold}_{\text{old}} + [\text{ISF} \times (\text{threshold}_{\text{new}} - \text{threshold}_{\text{old}})]$ Direct Entry Code: ‘149013’
Dynamic threshold decrease smoothing factor 1.000 {0.001 to 1.0} NEXT↓	Enter value for the “decrease smoothing factor” (DSF). Default value is 0.1. If the new base threshold value is less than the old threshold, the base value of the dynamic threshold will be equal to: $[\text{threshold}_{\text{old}} + [\text{DSF} \times (\text{threshold}_{\text{new}} - \text{threshold}_{\text{old}})]$ Direct Entry Code: ‘149023’

Overall echo selection process

Note: The following example illustrates how the Radar Fine Tuning tools work in combination with one another. It is not intended to reflect the setup of a typical application.

Range of Interest (ROI) Setup:

- Primary Measurement: Level
- Distance REF LINE to zero level point: 25.00 ft

- Maximum level to be measured: 24.00 ft
- False Echo Management menu:
 - Successive weighting factor (SWF): 0.5 (default)
 - Bottom echo signal strength factor: 0.25
 - Distance REF LINE to tank bottom: 24.00 ft
- Response Time, Lost Echo and Agitator Reject menu:
 - range gate weighting factor (GWF): 5

Region Weighting Setup:

Region Number	Region Boundary	Weighting Factor
1	REF LINE – 11.00 ft	1.5
2	11.00 – 13.00 ft	2.0
3	13.00 ft – max distance	1.1

Tank Mapping Setup:

- Set to derate mapped echoes: 0.05 derating factor

Echo Report

echo number	distance (ft)	sig str	Comment	Combined wtg factor	modified sig str*
1	24.75	1000		1.1 x 0.25	275
2	22.00	200		1.1	220
3	17.00	300		1.1	330
4	12.50	100		2.0	200
5	11.50	50	within range gate	2.0 x 0.5	500
6	9.00	150		1.5	225
7	7.50	1000	mapped	1.5 x 0.05	75
8	5.00	200	mapped	1.5 x 0.05	15

*The sig str reading from the echo report is weighted by the factors in the “Combined wtg factor” column to obtain the “modified sig str” value before applying the 0.5 successive weighting factor to select the “best echo.” In this example, echo number 5 would be selected as the “best” candidate echo. (See “Echo Weighting Factors” on page 5-13.)

Chapter 6 Current Outputs, Relays, and Alarms

This chapter covers the “Modify or reassign current output” menu (the “Current output” menu) and the “Set up fault alarms or change process alarm assignments” menu (the “Alarm” menu).

Current Outputs

Note: If your MeasureTech Accu-Wave does not have an I/O board with a current output installed, the “Modify or reassign current output” menu will not be displayed.

Use the “Current outputs” menu to

- specify which measurement should drive the current output
- implement correction factors on each current output
- define a current output hold value which is different from the default of 50% of scale

Note: Measurements other than the primary measurement (level or distance) must be set up in the “Set up additional measurements” menu (see Chapter 4) before they can control a current output.

You can direct different measurements to the same current output, but one must be assigned in normal output mode and the other must be in alternate output mode. The current output can be switched from normal mode to alternate mode by executing a command to switch when an alarm is triggered (see “Set up for Alarms to Execute Commands” on page 6-4) or you can enter a command to switch modes (see “Common Action Items” on page 7-2).

For example, if you were interested in monitoring a maximum level of 20 ft during one portion of the process and a maximum level of 10 ft during another part of the process, you could set up the measurements and current outputs as follows.

Set up measurement 1 (the primary measurement) as level and assign it to drive the current output in normal mode with the maximum current output corresponding to 20 ft.

Also assign measurement 2 to the level measurement, but assign measurement 2 to drive the current output in alternate mode with the maximum current output corresponding to 10 ft. Recall that the measurement value corresponding to the maximum current output is entered in the measurement setup menus.

Note: It is good practice to make a list of the current output assignments as you set them up, and keep the list available for future reference.

“Modify or Re-assign Current Output” Menu	
Display	Comments
Modify or re-assign current output↓ Other functions→	Press ↓ to access “Current Output” menu items. Press → to scroll to other menus.
maximum current output 20.00 mA (4.000 to 20.00) NEXT↓	The range for the maximum current output is from the minimum current output (currently 4.000mA) to 20.00mA. The default value for the maximum current output is 20.00mA.
minimum current output 4.00 mA (.0001 to 20.00) NEXT↓	The range for the minimum current output is from .0001mA to the maximum current output (currently 20.00mA). The default value for the minimum current output is 4.000 mA. Note: Entering a value of exactly 0.0 causes the default value of 4.000mA to be used for the minimum current output.
Note: If two or more measurements have been set up, the next two menu items will be displayed. If a second current output is also installed, the next two menu items will be repeated for “current out 2.”	
Mea 1: ft level is sent to current out 1 in normal mode. NEXT↓ CHANGE→	Assign desired measurement to current output 1 in the normal mode. Select from the primary measurement and the measurements set up using the “Additional measurements” menus.
Mea 1: ft level is sent to current out 1 in alternate mode. NEXT↓ CHANGE→	Assign a measurement to current output 1 in the alternate mode. If system includes more than one current output, additional entries will show up.
Note: If a second current output is installed, the next two menu items will be displayed first for “current output 1” and then for “current output 2.”	
correction factor for current output at maximum: 1.000 NEXT→	Fine tune the maximum current output value to correct for component and wiring variations. (The maximum current output value is scaled by this value.) This item is repeated for each current output installed.
correction factor for current output at minimum: 1.000 NEXT→	Fine tune the minimum current output value to correct for component and wiring variations. (The minimum current output value is scaled by this value.) This item is repeated for each current output installed.
current output hold mode value 50.00 % of scale NEXT↓	Enter desired value for mid-range hold value for the current output. Value is entered as a percentage of the maximum current output value. The default is 50%.

Set Up Fault Alarms or Change Process Alarm Assignments

Note: If no relays are installed in your gauge, the “Set up fault alarms...” menu will not be displayed initially. Use the “Special functions” menu (page 8-19) to enable alarm related functions so you can set up a non-relay display alarm or other indicator.

The “Set Up Fault Alarms...” menu provides four submenus which allow you to:

- Set up alarms to execute commands
- Assign process alarms to monitor specific measurements
- Assign relays to warning and fault alarms
- Assign relays to mode alarms

Non-relay Alarms

If your gauge does not have relays installed, the various alarm setup options will not be displayed in the menus. To enable display of the alarm setup menu options, you must go to the “Special Functions” menus (page 8-19) and change the item “Do not enable alarm related selections” to “Do enable.” You will then be able to assign any of the alarm indicators with the exception of controlling a relay.

Alarm Types

Process alarms actions occur when a process measurement value (level, volume, etc.) passes either the alarm set point or alarm clear point, that is, when the alarm is activated or when the alarm clears. The default alarm indicator for process alarms is to control relay number N , where N is the alarm number.

Fault and warning alarms alert you to potential problems with the operation of the gauge. The fault and warning alarms are:

- system fault
- radar head fault
- waiting for echo
- echo is lost
- signal saturated warning
- current output maximum or minimum reached

Mode alarms provide information about the status of the gauge.

- holds are active
- alternate output in use
- alternate time constant
- keypad in use
- power has been off

Fault, warning, and mode alarms do not have a default assignment. In some cases, a warning message is displayed. The status and history of alarms can be reviewed using the

“view alarm status” and “view alarm history,” see “Diagnostics: System Test, Related Items” on page 9-2.

Set up for Alarms to Execute Commands

Use the following procedure to set up alarms to execute commands:

1. Use the “Set up Alarms to Execute Commands” menu items (see table below) to define up to 3 sets of alarm actions. Each alarm action set consists of a pair of commands, one to be executed when an alarm is activated and one to be executed when the alarm is cleared. Defining the alarm action set makes the command pair available to assign to an alarm.
2. To assign a command action set to a process measurement alarm, you must have set up the measurement (see Chapter 4) and have assigned an alarm to the measurement (see page 6-5). Then the alarm action set will be added to the list of alarm indicators in the “Set up Alarm” menu items.
3. To assign a command action set to a fault, warning, or mode alarm, use the menu items described in the “Assign Relays to Fault, Warning and Mode Alarms” section on page 6-6.

Note: Write down each of the command action sets as you specify them. Due to the limited display space, the “alarm indicated by” selection in the “Set up alarm” menu item can not display the full command name. The alarm action sets are referred to as “#1 act on ALM action,” and so forth.

“Set up for Alarms to Execute Commands” Menu	
Display	Comments
Set up for alarms to execute commands→ NEXT↓	Menu subgroup heading. Press → to access menu items, press ↓ to scroll to next “Alarms” menu subgroup.
#1 act on ALM SET is “Do nothing” command Continue↓ Change→	Press → to scroll through the list of commands. Select the action (command) to be executed when alarm is activated. Selecting a command other than “Do nothing” makes action set #1 available for assignment to specific alarm conditions.
#1 act on ALM CLR is “Do nothing” command Continue↓ Change→	Select the command to be executed when the alarm clears. Typically a command is selected to undo the effects of the command executed when the alarm is activated.
Note: The above two menu items are repeated for alarm action sets #2 and #3. Once commands have been assigned to alarm action sets, these action sets are available as alarm indicators along with controlling relays (if installed), flashing the display, and zeroing the current output.	

Alarm Commands

The following commands can be assigned as alarm actions:

- do nothing
- hold current output at 50.00% of scale
- hold current output at maximum (normally 20 mA)
- hold current output at minimum (normally 4 mA)
- clear all holds
- disable range gate until re-capture
- stop data stream on port 1
- re-start data stream on port 1
- stop data stream on port 2
- re-start data stream on port 2
- show custom message on line 4
- stop custom message on line 4
- switch current output to alternate mode
- switch current output to normal mode
- switch display to alternate mode
- switch display to normal mode
- hold current output at zero mA
- save relay log data to NVRAM
- update data output to port 1, RS-232
- update data output to port 2, RS-485

Assign Alarms to Measurements

Use the “Assign alarms to measurements” menu to assign alarms to monitor specific measurements. This menu item will only be displayed if you have set up one or more measurements in addition to the primary measurement using the “Additional measurements” menu (Chapter 4).

By default all 16 alarms are assigned to the primary measurement, measurement 1.

“Assign Alarms to Measurements” Menu	
Display	Comments
Assign alarms to measurements→ NEXT↓	Menu subgroup heading. Press → to access menu items, press ↓ to scroll to next “Alarms” menu subgroup. Only displayed if you have set up one or more additional measurements (other than primary).
#1 alarm monitors measurement 1 ft level Continue↓ Change→	Press → to scroll through the list of measurements that have been set up until the one you want appears. Message on third line indicates the measurement type corresponding to the measurement number.
Note: By default configuration, all 16 alarms are assigned to the measurement 1 (the primary measurement). Above menu item is repeated for alarms 2 – 15. Press “EXIT SETUP” to save entries and return to the measurement display if you do not want to assign more alarms.	
#16 alarm monitors measurement 1 ft level Continue↓ Change→	Scroll through the list of measurements that have been set up until the one you want appears.

Assign Relays to Fault, Warning and Mode Alarms

Relays can be assigned to fault alarms, warning alarms and mode alarms using the menu items shown in the table below. The “Assign relays to warning alarms and fault alarms” menu items apply to warning and fault alarms, while the “Assign relays to mode alarms” menu items apply to the mode alarms.

The “Assign relays...” menu headings are somewhat misleading as these menus are used to assign any of the alarm indicators (controlling relays, flashing the measurement display, zeroing current output, or executing a command) to the fault, warning, or mode alarms.

Assign “Relays” to Warning Alarms and Fault Alarms

This menu assigns actions to indicate a warning alarm state, a system fault alarm or a signal loss alarm.

“Assign Relays to Warning and Fault Alarms” Menu	
Display	Comments
Assign “relays” to warning alarms and fault alarms→ NEXT↓	Menu subgroup heading. Press → to access menu items, press ↓ to scroll to next “Alarms” menu subgroup. For each of the following menu items, press → to scroll through and select the desired alarm indicator.
system fault alarm indicated by (Nothing) NEXT↓ CHANGE→	“System fault” can be caused by a radar head fault, a signal processor failure, a write error to non-volatile memory, or a memory checksum error.
Radar head fault alarm indicated by (Nothing) NEXT↓ CHANGE→	Caused by partial or complete loss of control signals from radar head.
Waiting for echo alarm indicated by (Nothing) NEXT↓ CHANGE→	No echo is being received (within the range of interest and above the minimum signal strength) but the “lost echo” delay has not yet timed out. The signal (if any) is outside of the acceptable range gate.
echo is lost alarm indicated by (Nothing) NEXT↓ CHANGE→	No echo is being received (within the range of interest and above the minimum signal strength) and the “lost echo” delay has timed out.
signal saturated alarm indicated by (Nothing) NEXT↓ CHANGE→	The signal strength of the strongest echo has exceeded the maximum allowed level. If this problem continues, increase the dielectric constant (page 5-2) to reduce the gain applied to the microwave signal.
current max or min alarm indicated by (Nothing) NEXT↓ CHANGE→	Current output has reached the maximum or minimum value.
←Exit from: Assign “relays” to warning alarms and fault alarms	Press ← to Exit from this menu subgroup.

Assign “Relays” to Mode Alarms

This menu assigns actions (alarm indicators) to the mode alarms.

“Assign Relays to Mode Alarms” Menu	
Display	Comments
Assign “relays” to mode alarms→ NEXT↓	Menu subgroup heading. Press → to access menu items, press ↓ to scroll to next “Alarms” menu subgroup. For each of the following menu items, press → to scroll through and select the desired alarm indicator.
Hold(s) are active alarm indicated by (Nothing) NEXT↓ CHANGE→	One or more “holds” are active. See “Hold Action Items” on page 7-4.
output on alt meas alarm indicated by (Nothing) NEXT↓ CHANGE→	The current output has switched to the alternate measurement. See “Current Outputs” on page 6-1.
alternate time const alarm indicated by (Nothing) NEXT↓ CHANGE→	
Keypad is in use alarm indicated by (Nothing) NEXT↓ CHANGE→	The transmitter keypad or a serial port is being used to access the gauge’s setup menus. See “Security” on page 9-1.
Power has been off alarm indicated by (Nothing) NEXT↓ CHANGE→	The gauge power has been off. Generally not a concern unless there was an unexpected interruption in power. Once saved, the gauge’s setup parameters are preserved even when power is disconnected.
←Exit from: Assign “relays” to mode alarms	Press ← to Exit from this menu subgroup.

Do / Do Not Show Relay Status

In addition to the four “Set up Fault Alarms...” submenus, there is a menu item that allows you to enable display of the relay status on the measurement display. If you select “Do show relay status,” a message similar to “ 21 RELAY# ON” is displayed, indicating that relay number 1 and number 2 are currently on. Only the number of the relays which are currently on are shown in the relay status message.

Chapter 7 Action Items

The “Action Items” menu contains the most frequently used commands. Commands are grouped by function into four menu subgroups.

- “Common action items” menu: use this menu to restart the system, erase all entries, clear all holds, change mode, and zero relays.
- “Alarm action items” menu: use this menu to clear, acknowledge, disable, erase, show history, end delays, and zero relays for all alarms.
- “Hold action items” menu: use this menu to clear, hold current output, set hold mode value, scale, and set holds for distance, level and volume.
- “Serial port related action items” menu: use this menu to update set up and enable serial ports.

When you execute a command, a message appears telling you that the command is being executed.

Common Action Items

“Common Action Items” Menu	
Display	Comments
Common action items (clear memory, etc)→ NEXT↓	Press → to enter the “Common action items” menu. Press ↓ to continue to next “Action Item” menu subgroup.
System restart. Does not affect user data ←Exit this menu. NEXT↓ EXECUTE CMD→	Restarts system – erases temporary memory, but does not affect user-entered setup data.
Erase all entries!!! (except COMM setup) ←Exit this menu. NEXT↓ EXECUTE CMD→	Erase all previously entered set up data. All settings except for serial communication settings are reset to factory defaults. Gauge will behave just like the first time power was applied.
Clear all holds (some now in effect) ←Exit this menu. NEXT↓ EXECUTE CMD→	This item is only displayed when one or more holds are in effect. See “Hold Action Items” on page 7-4.
Note: If more than three measurements are set up, the system assigns the “extra” readouts to show up in “alternate mode” and the display toggles between “normal” and “alternate” modes. The lowest-numbered measurements are displayed at top of both normal and alternate mode displays depending on available space.	
Switch display to alternate mode ←Exit this menu. NEXT↓ EXECUTE CMD→	Displayed when more measurements are set up than can be displayed at one time. Execute command to stop display alternation, showing only the higher-numbered readouts. Execute “Clear all holds” command to resume display alternation.
Switch display to normal mode ←Exit this menu. NEXT↓ EXECUTE CMD→	Similar to “Switch ... to alternate” item above. Stops display alternation, showing only the lower-numbered readouts. Execute “Clear all holds” command to resume display alternation.
Switch current out to alternate mode ←Exit this menu. NEXT↓ EXECUTE CMD→	Displayed when a measurement has been assigned to a current output in alternate mode, see page 6-1. Execute command to switch to alternate current output mode. Display will then read “Switch ... to normal mode.” Execute command again to switch back to normal current out mode.

Alarm Action Items

“Alarm Action Items” Menu	
Display	Comments
Alarm action items (View, clear, etc)→ NEXT↓	Press → to enter the “Alarm action items” menu. Press ↓ to continue to next “Action Item” menu subgroup
view alarm status→ NEXT↓	Press → to review all alarms currently in effect. Includes process, warning, fault, and mode alarms
view alarm history→ NEXT↓	Press → to review history of all alarms which have occurred since the last “clear all alarms” command. Includes process, warning, fault, and mode alarms.
Clear all alarms ←Exit this menu. NEXT↓ EXECUTE CMD→	Acknowledge, then clear and reset all alarms. All alarm actions are cleared, but the setup of the alarms is not affected. Alarm actions are re-established when the alarm is again activated.
Acknowledge all alarms ←Exit this menu. NEXT↓ EXECUTE CMD→	Acknowledge, but do not clear or reset alarms. All alarm actions (relay, etc.) are cleared, but the actual alarm remains activated. The alarm action is not re-established until the alarm is cleared (by command or change in process) and the alarm is again activated.
Disable all alarms ←Exit this menu. NEXT↓ EXECUTE CMD→	Turns all alarms off until manually turned on. This command causes the system to ignore alarms. After executing this command, the display will read “Enable all alarms.” Executing the command a second time reinstates all alarms.
Erase all alarm action assignments ←Exit this menu. NEXT↓ EXECUTE CMD→	Erases entries for alarm assignments to relays, command execution, display flash, and zeroing current output. Executing this command returns all alarm assignments to their defaults.
Note: The next two menu items are only displayed if “alarm delay times” have been enabled in the “Special Functions” menu (page 8-19) and a delay time for alarm activation or alarm clear has been entered for one or more alarms.	
end alarm delay command ←Exit this menu. NEXT↓ EXECUTE CMD→	If an alarm condition is true but alarm activation is being delayed because the alarm delay time has been set, this command cancels the delay time and the alarm will be activated.
end un-alarm delay command ←Exit this menu. NEXT↓ EXECUTE CMD→	If an alarm clear condition is true but the alarm clear is being delayed because the alarm clear (un-alarm) delay time has been set, this command cancels the delay time and the alarm will be cleared.

Hold Action Items

“Hold Action Items” Menu	
Display	Comments
“Hold” action items (Hold reading, etc)→ NEXT↓	Press → to enter the “Hold action items” menu. Press ↓ to continue to next “Action Item” menu subgroup.
Clear all holds (none now in effect) ←Exit this menu. NEXT↓ EXECUTE CMD→	Execute this command to clear all holds (if any holds are in effect).
Hold current output at max (20.00 mA) ←Exit this menu. NEXT↓ EXECUTE CMD→	Holds all current outputs at the value entered for the maximum current output.
Hold current output at min (4.000 mA) ←Exit this menu. NEXT↓ EXECUTE CMD→	Holds all current outputs at the value entered for the minimum current output.
Hold current output at zero mA ←Exit this menu. NEXT↓ EXECUTE CMD→	Holds all current outputs at 0.0 mA.
Current output hold mode value 50.00% of scale NEXT↓	Enter value in % for the mid-range current output hold value. Default value is 50.00%.
Hold current output at 50.00% of scale ←Exit this menu. NEXT↓ EXECUTE CMD→	Press → to execute command to hold current output at the mid-range value specified in the previous menu item.
Level hold mode value 0.000 ft level NEXT↓	Enter the hold value for the primary measurement (level or distance). This value is also used as the “lost echo value” when “go to hold value” is selected as the “echo loss mode.” See page 5-8.
Hold level at 0.000 ft level ←Exit this menu. NEXT↓ EXECUTE CMD→	Press → to hold primary measurement value at the hold value specified in the previous menu item. After executing command, display changes to read “Clear holds→.” Press → to clear the hold level command.

“Hold Action Items” Menu (cont.)	
Display	Comments
level hold value 0.000 cm {for abs level test} {cmd 154} NEXT↓	Enter hold value for level used to test the absolute level. Execute level hold using the next menu item.
Hold level at 0.000 ft level ←Exit this menu. NEXT↓ EXECUTE CMD→	Press → to execute command to hold primary measurement value at the hold value specified in the previous menu item. Use “Clear all holds” command (first item in this table) to clear.
Volume hold mode value 0.000 cu ft NEXT↓	Only displayed if “tank volume setup” has been completed. Enter the volume hold value.
Hold Volume at 0.000 cu ft ←Exit this menu. NEXT↓ EXECUTE CMD→	Press → to execute command to hold volume measurement value at the hold value specified in the previous menu item.

Serial Port Related Action Items

“Serial Port Related Action Items” Menu	
Display	Comments
<pre>serial port related action items→ NEXT↓</pre>	Press → to enter the “Hold action items” menu. Press ↓ to return to main heading for the “Action Items...” menu group
<pre>update data output to port 1, RS232 ←Exit this menu. NEXT↓ EXECUTE CMD→</pre>	Sends a data set (as defined by serial transmit setup or default) to RS-232 port.
<pre>update data output to port 2, RS485 ←Exit this menu. NEXT↓ EXECUTE CMD→</pre>	Sends a data set (as defined by serial transmit setup or default to RS-485 port.
<pre>clear flgs-buff RS232 ←Exit this menu. NEXT↓ EXECUTE CMD→</pre>	[Service only item.]
<pre>clear flgs-buff RS485 ←Exit this menu. NEXT↓ EXECUTE CMD→</pre>	[Service only item.]
<pre>dump setup data via port 1, RS232 ←Exit this menu. NEXT↓ EXECUTE CMD→</pre>	Available only if “Serial dump items” have been enabled in the “Special Functions” menu. This item allows the gauge’s current setup to be dumped to the RS-232 serial port. Requires special purpose program.
<pre>dump setup data via port 2, RS485 ←Exit this menu. NEXT↓ EXECUTE CMD→</pre>	Same as previous item, except for RS-485 port. Requires TNComm software or other special purpose program.
<pre>retrieve setup data via port 1, RS232 ←Exit this menu. NEXT↓ EXECUTE CMD→</pre>	Available only if “Serial dump items” have been enabled in the “Special Functions” menu. This item retrieves the gauge’s setup data dumped to the RS-232 serial port using the “dump setup data” command. Requires special purpose program.
<pre>retrieve setup data via port 2, RS485 ←Exit this menu. NEXT↓ EXECUTE CMD→</pre>	Same as previous item, except for RS-485 port. Requires TNComm software or other special purpose program.

Chapter 8 Serial Ports, Contact Inputs, and Special Functions

This chapter describes the menu items under the “Set up serial ports, contact INPUT, or Special functions” menu. This menu group includes menu subgroups for the following gauge functions.

Configure the RS-232 (port 1) and RS-485 (port 2) serial ports for communicating with computer terminals and printers and set up the data stream transmission parameters.

Assign commands to execute when the contact closure input(s) are opened or closed.

Set up and control the gauge’s “Special functions” – a variety of useful, but specialized menu items for controlling the operation of relays, specifying what is shown on the measurement displays, and enabling the “service only” menu items.

Serial Ports

The gauge offers both an RS-232 single-drop (port 1) and an RS-485 multi-drop (port 2) serial interface. Each port provides independent access to the gauge’s measurement and software functions, and both ports can be used simultaneously. For example, the system is able to communicate with a host computer on one port, while sending data to a printer on the other port.

The remote device (host computer or terminal) can enter or recall setup data and enter commands. Interactive communications on either port emulate the integral keypad on the transmitter. The gauge interprets the received characters as keypad entries.

By default, the gauge’s serial interface emulates the transmitter’s integral display and keypad when you connect a remote ANSI terminal or a PC with ANSI terminal emulation software to the RS-232 port (or to the RS-485 port using an RS-232 to RS-485 adapter). Alternately, you can connect a TN Model 9733 Hand Held Terminal to the RS-485 port.

The RS-485 port supports multi-unit “party line” communications for a maximum of 32 units. Each unit must be assigned a unique unit identification number so it can be addressed individually. A unit assigned the default unit number of zero will behave as if it is the only unit in use.

TN Technologies offers TNComm software for your PC that lets you set up and monitor daisy-chained RS-485 gauges, download or upload gauge setups, and emulate a Model 9733 Hand-Held Terminal.

Terminal Types

The menus allow you to configure the RS-232 (Port 1) and RS-485 (Port 2) ports to communicate with the following devices.

ANSI terminal: The gauge sends ANSI escape sequences for screen and cursor control which are supported by ANSI terminals and by most PC-based communication packages. This setup allows full access to the gauge menu system from the terminal. The arrow keys on the terminal keypad behave in the same fashion as the integral keypad on the transmitter. The “X” or “x” keys on the remote computer or terminal correspond to the “EXIT SETUP” key on the transmitter’s keypad.

VT100 terminal: This setup supports VT100 terminals and is similar to the ANSI terminal setup.

Hand-Held terminal: This configuration supports the TN Hand Held Terminal (Model 9733) or the TNCOMM software emulation of the the Hand Held terminal.

Printer: This mode supports serial output to most printers. The ANSI screen-control escape sequences are not available because they might be misinterpreted as printer set up commands. Data is transmitted at the update interval you select in the “Set up port...” menu items described below, or whenever you execute the “update data output” action item (see page 7-6). This mode is output only, so the menu system is not available.

Blind mode: This is a special mode which supports access to the gauge via a user-written program or script. The menu system is not available, rather the hexadecimal version of the direct entry keyboard codes are used to set parameters. The gauge unit will echo a “>” character (ASCII code 62) if the code is understood, otherwise it sends a “<” character (ASCII code 60). This mode supports user-written scripts from within a terminal emulation communications package to automate a setup or a data monitoring procedure.

Serial Port Related Menus

There are four menu subgroups used to set up and control the serial ports, two for the RS-232 port and two for the RS-485 port. When you make entries for the parameters, the actual port operation will not change until you save the entries (press “EXIT SETUP” to save entries and return to the measurement display).

The serial port communication settings are configured using the “Modify Port 1 (RS232) Configuration” and the “Modify Port 2 (RS485) Configuration” menus. The “Set up Port 1 (RS232) Data Transmission” and “Set up Port 2 (RS485) Data Transmission” menus control the selection, formatting, and transmission of measurement data to the terminal or printer.

The RS-232 and RS-485 configuration menus are very similar and the menu items described in the following tables apply to both ports, except where noted.

Modify Port 1 RS232 (Port 2 RS485) Configuration Menus

Use this menu to set up the baud rate and other communication parameters for each port. The RS-232 menu items will display “RS232” or “Port 1 RS232” while the RS-485 menu items will display “RS485” or “Port 2 RS485.” The necessary configuration information for your communication device should be found in the user’s manual for the device.

“Modify Port 1 RS232 (Port 2 RS485) Configuration” Menu	
Display	Comments
Modify Port 1 RS232 configuration→ (baud rate, parity) NEXT↓	Press → key to access the “Modify port configuration” setting menus.
Do not disable port 1 RS232 Change to “Do”→ Continue as is.↓	Turns port on or off. Change to “Do” if you need to temporarily disable the RS-232 port.
unit number of this gauge (0 to 32) 0 (Should be 0 if not party line.) NEXT↓	<i>Applies to Port 2 RS-485 only.</i> Default value is 0 for single unit operations. Assign unit id number (1-32) for party line communications. Master gauge (unit) is normally assigned to be unit 1 for party-line comm’s.
interface RS232 with ANCI terminal (or PC emulation) Continue↓ Change→	Interface RS-232 with the following serial devices: ANSI terminal (or PC emulation) VT100 terminal (or PC emulation) Handheld terminal Printer “Blind” mode (no key echo, menu or words)
port 1 RS232 9600 baud Continue↓ Change→	Select baud rate. Valid choices are 1200, 2400, 4800, or 9600 bps.
port 1 RS232 uses 7 bit word Change to “8”→ Continue as is.↓	Select word length - 7 or 8 bit word lengths are supported.
port 1 RS232 uses even parity Change to “none”→ Continue as is.↓	Select parity - even parity or none are supported.
Do send LineFeed with CR for NewLine Change to “Do not”→ ←Exit port 1 setup.	“Do send” causes a LINEFEED (ASCII char 10) to be sent after a CARRIAGE RETURN (ASCII char 13) for NEWLINE. “Do not” suppresses the LINEFEED after a CR. Some serial printers expect CR only while others expect CR + LF.

Data Transmission (Data Streaming)

When a port is set up for data streaming (continuous transmission of readings), the system sends a readout update on a regular basis. This update interval can be varied from 1 second to 9999 seconds between updates. The update data can include the readouts from any or all of the measurements that have been set up (measurements 1 through 8). Data

can be formatted for various terminals (CRTs), printer presentations, or for host computers.

Data streaming on a party-line (RS-485 multiple units) is automatically suspended when you send the "SLEEP" command, and is normally suspended when you "CONNECT" to any unit on the party line. You can tell a unit to "output while in connect" using the "Set up Port ..." menus (described below) so the unit will continue to data stream, except while you are in the menu system. A unit with a unit number of zero will automatically "output while in connect."

A reading is a measurement such as level or volume. A data set is all of the readings being sent by a particular unit. By default, a NEWLINE is sent after each reading. A HOME and a CLEAR are sent after each set. This causes the data to update at the same place on the screen.

Set up Port 1 RS232 (Port 2 RS485) Data Transmission

This menu controls the selection, formatting, and transmission of real-time measurement data to a serial device via the RS-232 (RS-485) ports.

"Modify Port 1 RS232 (Port 2 RS485) Configuration" Menu	
Display	Comments
Set up port 1 RS232 data transmission→ (data streaming) NEXT↓	Press → key to access the "Set up port..." menus to configure data transmission (data streaming).
←Exit from: RS232 data transmit setup. Continue↓ Data Transmit HELP→	Press → to access the "Data Transmit Help" screens. Press ↓ to continue with setup.
Do not inhibit RS232 data streaming. Change to "Do"→ Continue as is.↓	Turns data streaming on or off. If you inhibit data streaming (select "Do"), data transmission stops until you again select "Do not."

“Modify Port 1 RS232 (Port 2 RS485) Configuration” Menu (cont.)	
Display	Comments
The following menu item is repeated for measurement (1-8) which has been set up.	
Do not send meas 1 ft level to RS232 port. NEXT↓ CHANGE→	Similar menu item is displayed for each measurement number you have set up. You can enable or disable the transmission of the data for each measurement individually.
Do not transmit data in “packet” format Change to “Do”→ Continue as is.↓	Select “Do” to enable transmission of data in packets as described on page Error! Bookmark not defined. , or select “Do not” to transmit data in non-packet format as described on page 8-12.
Do not data stream in “connect” mode Change to “Do”→ Continue as is.↓	<i>Applies to RS-485 party-line communications only.</i> Select “Do” to have the gauge continue data streaming while the gauge is in “connect” mode. See “Party-Line Communications” on page 8-15.
This is a slave unit (xmit control). Change to “master”→ Continue as is.↓	<i>Applies to RS-485 party-line communications only.</i> Specify whether this gauge is a slave or the master for party-line communications. See “Party-Line Communications” on page 8-15.
Set up data format.→ NEXT↓	Menu subgroup header. Press → to access data format menu items. Format options depend on selection of packet or non-packet data transmission above. See page Error! Bookmark not defined. for packet data format menu items and see page 8-12 for non-packet data format menu items.
Set up header- Form feed, message, etc {RS232}→ NEXT↓	Menu subgroup header. Only displayed if non-packet data transmission has been selected. See page 8-14 for a description of menu options.
window code, 0 must be >= 33 and must = window code in all other units. NEXT↓	<i>Applies to RS-485 party-line communications only.</i> The value entered must be the same for all units and must be at least as large as the largest “must be >=” value displayed for any unit. See page 8-15.
Highest unit number in group 8 NEXT↓	<i>Applies to RS-485 party-line communications only.</i> Only appears in setup for Master unit. Enter the highest unit number assigned to any gauge on the party-line. Maximum number of units is 32.
port 1 RS232 update time 0 sec NEXT↓	Set the time (seconds) between updates. If zero (0) is entered, the gauge waits for an “update data output” command for the serial port (see “Serial Port Related Action Items” on page 7-6). <i>For RS-485 party-line operations:</i> Set update time to zero (0) for slave units. For the master unit, set time (sec) between update cycles. See page 8-15.

Set Up Data Format (Non-Packet Text Data) Menu

The “Set Up Data Format” menu items for non-packet data are displayed if “Do not transmit data in packet format” is selected in the “Set up port ... transmission data” menu. These menu items establish the formatting used for non-packet text transmission (for example, labeling, tabulation, and pagination) for measurements sent to a terminal or printer.

In the following menu items, a reading refers to a particular measurement such as level or volume. A data set refers to all the readings being transmitted by a particular unit (gauge). By default, a NEWLINE is sent after each reading. A HOME and a CLEAR are sent after each data set. This causes the data to update at the same place on the screen.

The “Set up data format” menus for non-packet data are identical for the RS-232 and the RS-485 ports except for the references to the port number. The table below shows the menu items as they appear for the RS-232 port.

“Set Up Data Format (Non-Packet Data)” Menu	
Display	Comments
Set up data format.→ NEXT↓	The following non-packet format menu items are displayed if “Do not transmit ... packet format” was selected in the “Set up port ... data transmission” menus. The menu items are identical for the RS-232 and RS-485 ports.
Do not put meas num before each reading. Change to “Do”→ Continue as is.↓	Select “Do” to put the measurement number (1 to 8) before each reading.
Do send NEWLINE after each reading. Change to “Do not”→ Continue as is.↓	“Do” sends a logical NEWLINE after each reading. “Do not” suppresses the NEWLINE.
Do send units with each reading. Change to “Do not”→ Continue as is.↓	“Do” sends the measurements unit string (ft level, sig str, cu M, etc). “Do not” suppresses the units string.
Do not put unit num before each reading. Change to “Do”→ Continue as is.↓	<i>Applies to RS-485 party line communications only.</i> Sends the gauge unit number with each reading.
Do not put TAB after each reading. Change to “Do”→ Continue as is.↓	Change to “Do” to append a TAB (ASCII char 9) after each reading. Useful for sending columnar data to a printer.

“Set Up Data Format (Non-Packet Data)” Menu (cont.)	
Display	Comments
Do CLEAR & HOME before each data set. Change to “Do not”→ Continue as is.↓	Sends an ANSI clear/home escape string after data set.
Do not send NEWLINE after each data set. Change to “Do”→ Continue as is.↓	Change to “Do” to send logical NEWLINE after transmission of a gauge’s data set.
Do not send user msg before each data set. Change to “Do”→ Continue as is.↓	Change to “Do” to send a custom (user-defined) message before each dataset.
Do not put unit num before each data set. Change to “Do”→ Continue as is.↓	<i>Applies to RS-485 party line communications only.</i> Change to “Do” to send the gauge unit number before transmission of each gauge’s data set.
Set up custom data set messages {RS232}→ NEXT↓	Displayed if “Do send usr msg” was selected above. Menu is similar to “Setting up Custom Units Messages” on page 8-20 and uses the same message data base.
port 1 (RS232) start readout at screen row 0 NEXT↓	Sends ANSI command to position readout start at a specifed row number. Not available in blind, printer, or hand-held terminal modes.
Port 1 (RS232) start readout at screen column 0 NEXT↓	Sends ANSI command to position readout start at a specifed column number. Not available in blind, printer, or hand-held terminal modes.

Setup Header, Form Feed, and Message

This menu subgroup is only displayed when “Do not transmit data in packet format” is selected in the “Set up port ... data transmission menu.” These menu items allow you to set up formatting information such as headers and form feeds. These items are most often used for formatting data to be sent to a printer.

These menu items are identical for the RS-232 and RS-485 ports, except for references to the specific port. The table below shows the menu items as they are displayed for the RS-232 port.

“Set up Header, Form Feed, Message, etc.” Menu	
Display	Comments
Set up header- Form feed, message etc {RS232}→ NEXT↓	This menu subgroup is available if “Do not transmit ... packet format” was selected in the “Set up port ... data transmission” menus. The menu items are identical for the RS-232 and RS-485 ports
Send header every 0 data sets (0 disables header) (RS232) NEXT↓	Enter integer value “N” to send a header every “N” data set transmissions from a gauge. Enter 0 to disable the header.
Do not form-feed before header, RS232 Change to “Do”→ Continue as is.↓	Change to “Do” to send a form-feed (ASCII char 12) before each header. Useful for grouping datasets on separate pages.
Do not add message to header, RS232 Change to “Do”→ Continue as is.↓	Change to “Do” to add a custom message to header.
Set up serial header message (RS232) NEXT↓	Displayed if “Do send add message to header” was selected above. Menu for setting up header message is similar to “Setting up Custom Units Messages” on page 8-20 and uses the same message data base.

Party-Line Communications

This section describes various aspects of setting up and using party-line communications for multiple gauges.

Setting up a Party-Line

To set up party-line communications from the local keypad and display of each gauge on the party-line, use the following procedure.

1. Wire all units to the RS-485 common lines as per the wiring instructions in the Accu-Wave Installation and Maintenance Manual provided with your gauge.
2. For each unit, ensure the “Modify port ...” menu communication settings is the same (baud rate, parity, and handshake). Assign each gauge a unique non-zero unit number. See page 8-8.
3. In the “Set up port ... data transmission” menu (page 8-10), set up the desired RS-485 measurement selections, data formats, user messages, etc., for each unit.

After completing the data transmission setup, write down the “must be \geq ” value displayed in the “window code” menu item. This is the minimum window code required to transmit the data set for a particular gauge.

4. Using the “Set up port ... data transmission” menu, configure the “master” unit as follows. (The master unit is usually assigned the lowest unit number, typically unit #1.)
 - Specify that this unit is the master unit.
 - Set the window code to be greater than or equal to the largest of the “must be \geq ” window code values found for all of the units in step 3.
 - Specify an appropriate RS-485 update time (see the next section, “Master Update Time.”)
5. Using the “Set up port ... data transmission” menu, configure each of the “slave” units as follows:
 - Specify that the unit is a slave.
 - Specify the same (largest) value for the window code as used for the master unit in step 4.
 - Specify that the RS-485 update time is zero (0).

Master Update Time

Gauges on a party-line transmit their data following the timing diagram shown in Figure 8.1. All of the gauges wait for the master unit to transmit a “sync” character (Ctrl-V, ASCII 22). The master gauge transmits this synch character once per the update time interval which is specified in the “Set up port ... data transmission” menu.

Each gauge (including the master) counts off equally spaced time intervals based on the window code (set identically for all of the gauges). When the current “window” interval corresponds to a gauge’s unit number, that gauge transmits its data.

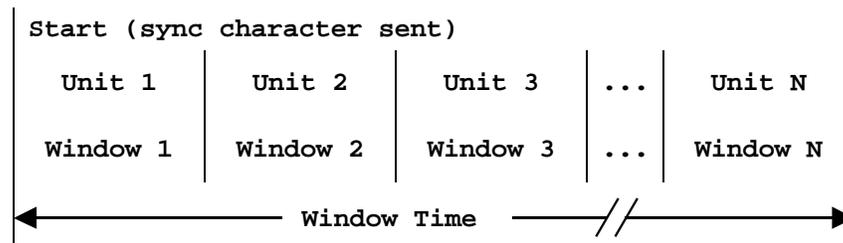


Figure 8.1 Party-Line Transmission Timing (Number of units, $N \leq 32$)

For this data transmission scheme to work, two constraints must hold:

- Each slave unit must be programmed with the same window length, window code, since equal spacing is assumed.
- The update time interval specified in the “Set up port ... data transmission” menu of the master unit must be greater than or equal to the combined transmit time of the network. The minimum update interval required is given by the following formula.

$$\text{Update time} = \text{Largest window code} \times \text{Largest Unit Number} \times 0.06 \text{ sec}$$

Party-Line Modes

The party line has three distinct modes of operation, Unconnected, Connected, and Sleep. Normally, the party line operates in the Unconnected mode.

A unit in Unconnected mode only responds to:

- a connect ESCAPE sequence with the proper unit-number suffix
- a command code with the proper unit-number suffix
- an all units SLEEP Command
- an all units WAKEUP Command
- a data streaming sync character

Otherwise, the unit sends updates at regular intervals as specified in the setup.

When a unit is in “Connect” mode, the unit’s setup menus can be accessed (if not in Blind or Printer mode) and the unit will continue to send updates if “Do data stream in connect mode” has been enabled. Connect mode is exited when a valid DISCONNECT command is received.

A unit in Sleep mode will not respond to anything except a valid WAKEUP Command.

Party-Line Commands

Some useful escape codes are:

ESC [Z# uu CONNECT Command. (uu = unit number, e.g., 01).

ESC O Q DISCONNECT Command

ESC X C SLEEP Command (ANSI)

ESC X D WAKEUP Command

ESC X 1 CONNECT Acknowledge (gauge sends this to acknowledge the CONNECT command)

ESC X 2 Acknowledge DISCONNECT Command

ESC O V ID REQUEST Command

ESC X 4 ID REQUEST TERMINATED Command

ESC [Yuu;cc;vvdd POLLING Command,
where

uu = unit number (in hex) on party line

cc = command (in hex)

vv = unit number + 3 (in hex)

dd = command number +3 (in hex)

Presently, only three “cc” command values are supported:

86 – Single Data Stream Update on RS-485

8B – Download NVRAM contents to PC on RS-485

8D – Upload NVRAM contents to gauge

Example:

ESC [Y01;86;0489 sends the “Single Update” command to Unit 1.

Party-Line Limitations

The RS-485 party-line uses half-duplex communications. That is, only one system can send information at any given time. For instance, if you are entering data during the time window for a gauge to send its output, garbled characters may result. This occurs mainly when the gauge’s menu system is being accessed in Connect mode. In this circumstance, you should verify that the gauge received the correct setup information before continuing.

The party-line also behaves erratically when more than one device issues synch characters. This can happen if there is more than one master on the link, or if synch characters are sent from a terminal or PC.

Data streaming has to be explicitly turned off in the “Set up port 2 RS485 data transmission” menu. Deselecting all measurements from data streaming will not inhibit data streaming. Rather, the gauge will send a default update with all measurements, escape string positioning, and the “For setup, ...” message. This default update is intended to appear after a complete NVRAM erasure (i.e., performing a CMD 74), when data streaming has not yet been configured. Also, the data formatting and update time menus will not be available until at least one measurement is selected.

Contact Inputs

You can assign commands to be executed based on a user-provided contact input open or close. The following menu items are available for each contact closure input installed in your gauge.

Note: If you do not have a current I/O board installed, you will not see the “Contact closure inputs” options.

“Assign Commands to Execute on Contact Open/Close” Menu	
Display	Comments
Do nothing command executed by closing switch 1. Use↓ Chg→	Press → to scroll through the list of commands until the one you want is displayed. Commands include, hold current output at max/min, clear all alarms, clear all holds, etc.
Do nothing command executed by opening switch 1. Use↓ Chg→	Press → to scroll through the list of commands until the one you want is displayed. Typically, select a command to reverse the effect of the contact close command.
Note: These items are repeated for all the contact closure inputs that are installed.	

Special Functions

“Special functions” Menu	
Display	Comments
Do not enable alarm related selections Change to “Do”→ Continue as is.↓	Displayed if no relays are installed. Change to “Do” to enable the alarm-related menu selections throughout the setup menus.
Do not enable alarm relay delay times. Change to “Do”→ Continue as is.↓	Only displayed if relays are installed. Change to “Do” to enable relay alarm delay time entries in menus which set up process limit alarms.
Do not make relay latching available Change to “Do”→ Continue as is.↓	Only displayed if relays are installed. Change to “Do” to enable relay latch mode entries in menus which set up process limit alarms.
Do not disable “For setup”, etc. display Change to “Do”→ Continue as is.↓	Change to “Do” to suppress the message on line 4 (warnings and setup direction) of the normal readout. This allows all four lines to be used for measurement readouts.
Do not show relay status on readout. Change to “Do”→ Continue as is.↓	Change to “Do” to display relay status on measurement display. The numbers of the relays currently turned on are displayed along with the normal measurement readouts.
Do not disable display of fault msg Change to “Do”→ Continue as is.↓	[Service only item.] Change to “Do” to disable display of system fault messages.
Do not disable dynamic tracking Change to “Do”→ Continue as is.↓	Leave this item set to “Do not” so that dynamic tracking remains enabled.
Dynamic tracking threshold 0.000 f (if 0, assumes half range gate) NEXT↓	[Service only item.] Controls dynamic tracking threshold. Typically leave this value set at 0.0, so default threshold (half range gate) is used.
Do not disable “sig str” readout Change to “Do”→ Continue as is.↓	Change to “Do” to disable display of signal strength. This will make display space (one line) available for another readout.

“Special functions” Menu (cont.)	
Display	Comments
Do not enable user defined (UD) units. Change to “Do”→ Continue as is.↓	Change to “Do” to enable user defined units option in the various “Select Units” menu items.
Note: Enabling the “Service only items” causes additional items to show up in various “Radar Fine Tuning” submenus as well as in other setup menus.	
Do not enable service only items. Change to “Do”→ Continue as is.↓	Causes additional “service only” setup items to show up in several areas. Default condition is “do not.”
Do enable serial dump items. Change to “Do not”→ Continue as is.↓	Change to “Do not” to disable commands to dump and retrieve setup data via the serial ports. See “Serial Port Related Action Items” on page 7-6.
Special span entries Level→ NEXT↓	Submenu allowing the current output span for the primary measurement (Meas 1 reading for current output max/min) to be changed, overriding span defined by entries in the primary setup section.
Assign commands to blind keys NEXT↓	Submenu to assign commands to the eight hidden keys on the transmitter keypad and to specify whether command prompt is displayed when hidden key is pressed. Default is no prompt, assigned command is executed when hidden key is pressed.
Set up custom units messages→ NEXT↓	Submenu group to set up custom messages. See the next section for details.

Setting up Custom Units Messages

User entered messages can be used to redefine units and to provide headers for serial data. For example, suppose display scaling has been used to scale the tank volume readout by a factor of 1000, that is, 10,000 cu ft is displayed as 10 cu ft. You could set up a custom message of “K_CU_FT” and then select that message to be displayed for the volume units.

The system supports up to 8 custom (user defined) messages strings of up to 10 characters each. Custom message menus are found in the “Special functions” menu described in the previous section, as well as in the “Set up data format” submenu of the “Set up port ... data transmission” menu, see page 8-12. This menu option is also displayed when you enable display scaling (see page 4-8).

In each case, you can access any of the custom messages which have been entered. You can modify an existing message or add a new message, and then select which message to use for a particular purpose.

You enter message characters by using the right and left arrow keys to scroll through the available character selections or by using the ASCII codes for the characters given in the table below. The entry screen for each character shows the rest of the 10 character message to provide context for your selection.

Note: Enter a value of 0 (zero) for the first character to reset the message to the null string, the default value.

32	SP(ace)	51	3	70	F	89	Y	108	l
33	!	52	4	71	G	90	Z	109	m
34	"	53	5	72	H	91	[	110	n
35	#	54	6	73	I	92	¥	111	o
36	\$	55	7	74	J	93	]	112	p
37	%	56	8	75	K	94	^	113	q
38	&	57	9	76	L	95	_	114	r
39	'	58	:	77	M	96	`	115	s
40	(	59	;	78	N	97	a	116	t
41	)	60	<	79	O	98	b	117	u
42	*	61	=	80	P	99	c	118	v
43	+	62	>	81	Q	100	d	119	w
44	,	63	?	82	R	101	e	120	x
45	-	64	@	83	S	102	f	121	y
46	.	65	A	84	T	103	g	122	z
47	/	66	B	85	U	104	h	123	{
48	0 (zero)	67	C	86	V	105	I	124	|
49	1	68	D	87	W	106	j	125	}
50	2	69	E	88	X	107	k	126	→

“Set up Custom Units Messages” Menu	
Display	Comments
Set up custom units messages→ NEXT↓	Press → to access the custom message setup menu items. There is a maximum of 8 messages, 10 characters per message. The custom units message has no effect on the measurement readout.
character #1 of custom message #1 0 ←→ "" NEXT↓	Enter first character of the first custom message. Use the arrow keys to scroll through the available characters, or enter the ASCII character code from the table above. Enter 0 to reset to default (null) value.
Note: Press ↓ after selecting a character to move to the next character in the message. Pressing ↓ twice moves to the next message.	
character #1 of custom message #2 0 ←→ "" NEXT↓	Enter characters for custom message 2, or press ↓ to continue to the next menu item.
Note: The next menu item is repeated for each measurement which has been set up using the “Set up additional measurements” menu.	
Meas #1 use message #0 for readout units "ft level" Continue↓ Change→	Select message to use with measurement number 1. The default message (#0) is shown – “ft level.” Press → to scroll through and select one of the custom messages. Leave at #0 to use default message.
Volume- use message #0 for readout units "cu ft" Continue↓ Change→	Selecting a custom message for volume here replaces the volume-units message wherever it appears. If an additional measurement (e.g., meas #3) has been assigned to volume, that measurement’s units can be replaced by a custom message, while other references to volume would use the normal units message.

Chapter 9 Security, Service, and Diagnostics

The “Security, service and diagnostic functions” menus is divided into four primary menu subgroups.

- Security Items: (Password, etc.)
- Diagnostics: System Test, Related Items
- User Service & Related Items
- Factory Service & Related Items
(only available if “Service Only Items” are enabled)

These menu groups are described in this chapter.

Security

Password protection is available to prevent unauthorized personnel from making new setup entries or changing existing entries. The password is a numeric entry that can be from 1-8 digits in length and include any combination of the digits 0-9. For example, “056,” “4321,” and “12345678” are all valid passwords. Leading 0’s are part of the password and must be entered.

Once a password has been set, you must enter this password whenever you use the set up menus. To disable the password, enter 0 for the password value.

Caution: Do not forget your password! Once a password is established, you cannot change entries or do fine tuning without the password.

The “entries have been changed xx times” item can be used to check for unauthorized entries. The value in this entry is updated each time a setup entry is changed and saved. After you complete the setup of your gauge, note this value and then periodically check this item to see if the number has changed. If the number has changed, it indicates that one or more menu setup items have been changed and saved.

The “Keypad is in use” item can also help you detect unauthorized changes by activating an alarm when the system is accessed by either the keypad or the serial port.

“Security Items” Menu	
Display	Comments
Security items: Password, etc.) NEXT→	Press → to access the “Security items” menus.
password ***** (Lock out setup) NEXT↓ HELP→	A password can be any combination of numbers up to 8 digits long. Once a password is entered, the first item in SETUP will ask for the password. To disable the password function, enter 0 here.
entries have been changed 184 times (read only) NEXT↓ HELP→	Whenever entries are changed and saved (save is automatic when leaving SETUP), this count is increased by one. This feature can be used to verify that the system has not been changed.
Keypad is in use alarm indicated by (Nothing) NEXT↓ CHANGE→	This alarm indicates that the system setup menus are being accessed either via the keypad or serial port. Use the → key to scroll through the available alarm indicators.

Diagnostics: System Test, Related Items

The Accu-Wave is highly fault tolerant. If you do encounter a problem, this menu offers several helpful tools. Should you need to call or fax TN Technologies about a problem, note the “version number” item to determine the software revision installed in your system. The actual date and time of the software build is also listed here if the “service only items” are enabled.

Execute the “Run self test” command to perform the system diagnostic check. The system performs an automatic test and verification function every 10 minutes. All user-entered data is double stored and periodically cross-checked. Errors are automatically corrected and an alarm is activated when an error is detected.

“Diagnostics: System test, related items” Menu	
Display	Comments
Diagnostics: System test, related items→ NEXT↓	Press → to access the “Diagnostic...” menu items.
Run self test ←Exit this menu. NEXT↓ EXECUTE CMD→	Execute the self-test command to test the various types of memory, the data integrity, and the signal processor.
View alarm status→ NEXT↓	View any alarms resulting from self-test as well as other alarms presently in effect, including process, warning, fault, and mode alarms.
View alarm history→ NEXT↓	Review all alarms which have occurred since the last clear alarms command, including process, warning, fault, and mode alarms.
Serial port error logs→ NEXT↓	Sub menu containing error logs for RS-232 and RS-485 serial ports. See “Serial port error logs” table below.
relay history logs→ NEXT↓	Only displayed if relays are installed. Submenu containing logs of relay activity including cumulative on time and number of times activated. See “relay history logs” table below.
Program rev # 4.31 NEXT↓	Software version number. Note this number when calling TN Service with questions.
Program rev # 4.31 11-MAY-1998 05:33:21 NEXT↓	[Service only item] Software version number and date/time of software build. Note this number when calling TN Service with questions.
Snapshot MENU→ NEXT↓	[Service only item] Show instantaneous value of various dynamic internal parameters. See the “Snapshot” menu table below.
View internal constants→ NEXT↓	[Service only item] Submenu to display values of various internal constants that are computed based on user entries.

Serial Port Error Logs

“Serial Port Error Logs” Menu	
Display	Comments
Serial port error logs→ NEXT↓	Press → to access submenu containing error logs for RS-232 and RS-485 serial ports.
0 frame errors on RS232 port NEXT↓	Number of RS232 port frame errors.
0 parity errors on RS232 port NEXT↓	Number of RS232 port parity errors
0 over run errors on RS232 port NEXT↓	Number of RS232 port overrun errors.
0 frame errors on RS485 port NEXT↓	Number of RS485 port frame errors.
0 parity errors on RS485 port NEXT↓	Number of RS485 port parity errors
0 over run errors on RS232 port NEXT↓	Number of RS485 port overrun errors.
0 bad RS485 cksums NEXT↓	Number of RS485 port checksum errors.
0 bad RS485 commands NEXT↓	Number of RS485 port command errors.

Relay History Logs

“Relay History Logs” Menu	
Display	Comments
relay history logs→ NEXT↓	Only displayed if relays are installed. Press → to access non-volatile logs (saved every hour) of relay activity.
Relay 1 on time 142.1 hours (non-volatile save once per hour) NEXT↓	Cumulative total of “on” time (need not be continuous) for relay 1. This menu item is repeated for each relay installed.
Relay 1 has been on 25 times. (non-volatile save once per hour) NEXT↓	Cumulative number of times relay 1 has been turned on (since last time memory was cleared). This menu item is repeated for each relay installed.

Snapshot Menu

“Snapshot” Menu [Service only item]	
Display	Comments
Snapshot MENU→ NEXT↓	[Service only item] Press → to view instantaneous value of various dynamic internal parameters.
Note: The next menu item is repeated for each measurement which has been setup using the “Set up additional measurements” menu.	
readout from measurement 1 11.07 ft level ←CONT UPDATE→ NEXT↓	Provides snapshot of measurement 1 readout. Press → to update display. Press ← to switch to continuous update mode. Display will then show ←FREEZE. Pressing ← again will switch back to “freeze” or snapshot mode. This has no effect on the measurement display.
readout from measurement 2 150.8 cu ft ←CONT UPDATE→	Displays the present reading from measurement 2, if measurement 2 has been set up.

“Snapshot” Menu (cont.) [Service only item]	
Display	Comments
base signal strength 113.9 NEXT↓	Signal Strength of “best” candidate echo as reported in the echo report.
weighted signal strength 113.9 NEXT↓	Signal strength of “best” candidate echo after weighting factors have been applied.
View echos being processed→ NEXT↓	Allows you to examine the echo report for each echo within the range of interest. Press → to access the echo reports, then press ↓ to scroll through the echo reports. The echo report is described on page 5-11.
View marker report→ NEXT↓	Reports relative control levels at which RF frequency markers occur. See “View Marker Report” menu table below.
DSP restart count 0 NEXT↓	
Internal value of Sensor signal 1.871E4 ←CONT UPDATE→ NEXT↓	Filtered value of echo position after electrical offset is subtracted. Press ← for continuous measurement updates. Press ← again to return to FREEZE mode.
Internal value of distance 441.0 cm ←CONT UPDATE→	Filtered value of echo position (distance) converted to centimeters. Most internal values in the software are stored in CGS units (centimeters, grams, seconds).
Note: The next three menu items will only display meaningful values when a single current output board is installed.	
Internal value of I out % 60.80 % ←CONT UPDATE→	Internal value of current output - % of range.
Internal value of I out flt 5429 (8000=100%) ←CONT UPDATE→	
Internal value of I out fix 5428 (8000=100%) UPDATE→	This is the value actually sent to the current output board.

View marker report

Before viewing any of the marker report items with direct entry, you must enter command 13 to tell the system to prepare the data.

“View Marker Report” Menu [Service only item]	
Display	Comments
View marker report→ NEXT↓	Submenu of “Snapshot” Submenu. Reports relative control levels at which RF frequency markers occur.
Sweep drive range = 2031 (-32.60 to 1999) NEXT↓	
MARKER #0= -32.60 delta to #1 = 104.9 slope delta=98.85% %NonLIN=0.000	The marker values are relative figures which are proportional to the sweep drive voltage at the indicated frequency marker.
MARKER #1 = 72.20 delta to #2 = 208.4 slope delta =-2.591% %NonLIN=2.592	delta = difference between two markers values. slope delta = percent change in slope between one pair of markers and the next. NonLin% = percent difference between the delta of this marker pair and the average delta over the sweep.
MARKER #2 = 280.6 delta to #3 = 203.0 slope delta =-1.923% NonLIN = .9292	
MARKERS #3-10 – above menu items repeated for markers 3-10.	
marker #11 = 1999 delta to #12 = 0.000 slope delta = 0.000% %NonLIN=0.000	Marker #11 is dummy marker covering only part of a frequency sub-range. Thus, the slope delta and %NonLin data relating to this point is not useful.

User Service & Related Items

“User Service & Related Items” Menu	
Display	Comments
System restart. Does not affect user data ←Exit this menu NEXT↓ EXECUTE CMD→	Re-initializes system including the DSP. Erases temporary memory, but does not affect user-entered setup data.
Erase all entries !!! (except COMM setup) ←Exit this menu NEXT↓ EXECUTE CMD→	Erase all previously entered set up data. All settings except for serial communication settings are reset to factory defaults. Gauge will behave just like the first time power was applied.
Clear all holds (none now in effect) ←Exit this menu. NEXT↓ EXECUTE CMD→	Execute this command to clear all holds (if any holds are in effect).
Hold current output at max (20.00 mA) ←Exit this menu. NEXT↓ EXECUTE CMD→	Holds all current outputs at the value entered for the maximum current output.
Hold current output at min (4.000 mA) ←Exit this menu. NEXT↓ EXECUTE CMD→	Holds all current outputs at the value entered for the minimum current output.
Hold current output at zero mA ←Exit this menu. NEXT↓ EXECUTE CMD→	Holds all current outputs at 0.0 mA.
Current output hold mode value 50.00% of scale NEXT↓	Enter value in % for the mid-range current output hold value. Default value is 50.00%.
Hold current output at 50.00% of scale ←Exit this menu. NEXT↓ EXECUTE CMD→	Press → to execute command to hold current output at the mid-range value specified in the previous menu item.

“User Service & Related Items” Menu (cont.)	
Display	Comments
Level hold mode value 15.00 ft level NEXT↓	Enter the hold value for the primary measurement (level or distance). This value is also used as the “lost echo value” when “go to hold value” is selected as the “echo loss mode.” See page 5-8.
Hold level at 15.00 ft level ←Exit this menu. NEXT↓ EXECUTE CMD→	Press → to hold primary measurement value at the hold value specified in the previous menu item. After executing command, display changes to read “Clear holds→.” Press → to clear the hold level command.
level hold value 0.000 cm {for abs level test} {cmd 154} NEXT↓	[Service only item] Enter hold value for level used to test the absolute level. Execute level hold using the next menu item.
hold level at 0.000 cm ←Exit this menu. NEXT↓ EXECUTE CMD→	[Service only item] Press → to execute command to hold primary measurement value at the value specified in previous item. Use “Clear all holds” to clear.
Volume hold mode value 150.0 cu ft NEXT↓	Only displayed if “tank volume” setup has been completed. Enter the volume hold value.
Hold Volume at 150.0 cu ft ←Exit this menu. NEXT↓ EXECUTE CMD→	Press → to execute command to hold volume measurement value at the hold value specified in the previous menu item.
Review measurement assignments 1-8→ NEXT↓	Press → to view current measurements, e.g., Meas #s 1, 2, & 3 Level volume cu ft (inactive) → Press → to view other measurements if setup.
Do enable service only items. Change to “Do”→ Continue as is.↓	Change to “Do not” to disable “service only items.” This will disable a variety of additional menu items throughout the Setup menus. In particular, several of the Radar Fine Tuning tools will be disabled including “Tank Map Setup,” Region Weighting Setup,” and the “Dynamic Threshold Setup.”

Factory Service & Related Items

Factory Service & Related Items” Menu [Service only item]	
Display	Comments
Program rev # 4.31 11-May-1998 05:33:21	The program revision number and the date/time of the software build.
DSP version: REV3.0 13:50:30 18/MAY/96	Before viewing the DSP rev # with direct entry, you must do a command 130 to tell the system to get the data.
hardware diagnostics→ NEXT↓	Menu subgroup header. See “Hardware diagnostics” menu table below.
View error status: Bad NV writes, etc.→ NEXT↓	Menu subgroup header. See “View error status” menu table below.
test relays→ NEXT↓	Menu subgroup header. See “Test Relays” menu table below.
Do not enable RS232 test mode Change to “Do”→ Continue as is.↓	
Do not enable RS485 test mode Change to “Do”→ Continue as is.↓	
Do not disable bad entry testing Change to “Do”→ Continue as is.↓	
Do not disable radar, after restart Change to “Do”→ Continue as is.↓	

Factory Service & Related Items” Menu (cont.) [Service only item]	
Display	Comments
signal diagnostics→	Menu subgroup header. See “Signal diagnostics” menu table below.
Factory test !!! Erases ALL !!! ←Reject command EXECUTE CMD→	Performs an in-depth test of the system. Test takes several minutes to complete and erases all setup data.
View menu, special measurement, alarm & command codes→ NEXT↓	Allows you to scroll through a list of the codes for commands, special measurements (add offset of 1024 to measurement number), and alarms.
Do not use break tab distance correction Change to “Do”→ Continue as is.↓	

Hardware Diagnostics (Factory Service Submenu)

Display	Comments
hardware status: DSP BRD	Indicates DSP board is installed.
hardware status: relays installed	Indicates relays are installed.
Soc 1 board type: current-relay	Board type installed in transmitter PCB slot #1.
Soc 2 board type: none	Board type installed in transmitter PCB slot #2.
Soc 3 board type: DSP	Board type installed in transmitter PCB slot #3.
Soc 4 board type: none	Board type installed in transmitter PCB slot #4.
current outputs = 1	Number of current outputs installed.
relays = 2	Number of relays installed.
Switch INPUTs = 2	Number of contact closure inputs installed.

View Error Status: Bad NV writes, etc. (Factory Service Submenu)

“View Error Status Bad NV writes, etc” Menu	
Display	Comments
address 00h failed to clear (00 is OK) NEXT↓	If non-zero, address could not be erased.
address 00h write failed verify (00 is OK) NEXT↓	If non-zero, address could not be written correctly.
address 00h write to PROM area (00 is OK) NEXT↓	If non-zero, write to PROM address failed.
Any NV error count 0 NEXT↓	Count of Non-Volatile (NV) RAM errors.
primary NV error count 0 NEXT↓	Count of primary NVRAM errors.
Sec NV error count 0 NEXT↓	Count of secondary NVRAM errors.
Prot RAM error count 0 NEXT↓	Count of protected memory errors.
clear DSP status history ←Reject Command EXECUTE CMD→	

Test relays (Factory Service Submenu)

Note: This submenu is not displayed if no relays are installed.

“Test Relays” (Factory Service Submenu) [Service Only Item]	
Display	Comments
commands 88, 89, 153 relay to test = #1 NEXT↓	Enter relay number to test.
test-set relay #1 ←Exit this menu. NEXT↓ EXECUTE CMD→	Test “setting” relay 1 (activate).
test-clr relay #1 ←Exit this menu. NEXT↓ EXECUTE CMD→	Test clearing relay #1.
test all relays on ←Exit this menu. NEXT↓ EXECUTE CMD→	Test turning all relays on.
test all relays off ←Exit this menu. NEXT↓ EXECUTE CMD→	Test clearing all relays.
clear all holds (none now in effect) ←Exit this menu. NEXT↓ EXECUTE CMD→	Clear any holds in effect.
test step relay #1 ←Exit this menu. NEXT↓ EXECUTE CMD→	Press → to test closing each relay in sequence, beginning with relay number entered in first item of this menu.
reset IOUT FPGA ←Exit this menu. NEXT↓ EXECUTE CMD→	Reset I/O board logic – does not reset relays.

Signal Diagnostics (Factory Service Submenu)

“Signal Diagnostics” Menu [Service Only Item]	
Display	Comments
Do not spec to sweep sig for scope Change to “Do”→ Continue as is.↓	Time shares the sweep control line to the head with the frequency spectrum for use with a scope. A low going pulse on the line is provided for scope trigger.
Do not I.F. to sweep sig for scope Change to “Do”→ Continue as is.↓	Time shares the sweep control line to the head with the I.F. (audio) signal date for use with a scope. A low going pulse on the line is provided for scope trigger.
Set gain = 0.000 (1.0 - 40, overrides automatic value) (1.252 in use) NEXT↓	Normally, the preamp gain is adjusted based on the dielectric constant and the measurement range. This selection disables the range determined portion of the gain.
Dielectric constant of process 0.000 (presently 80.00) NEXT↓	If value is 0.00, the “presently” assumed value is used. Enter a non-zero value to change default. Dielectric constant determines gain applied to microwave signal.
Do not disable range-GAIN function. Change to “Do”→ Continue as is.↓	
gain set step 1 set=20.00 gain=1.252 NEXT↓	Gain is a non-linear function of gain setting. Select step number.
+ gain set 1 steps set=20.00 gain=1.252 ←Reject command EXECUTE CMD→	
- gain set 1 steps set=20.00 gain=1.252 ←Reject command EXECUTE CMD→	
track MIN & MAX on measurement 0 none NEXT↓ CHANGE→	Press → to select measurement number. Selecting a non-zero measurement number will cause additional menu items to be displayed allowing you to track the min and max values of the selected measurement.

Appendix A How to Return Equipment for Service

Call the TN Technical Services Department (Factory Service division) before returning equipment for repair. Many problems can be diagnosed and resolved over the phone. For after hours or weekend service, call our 24-hour Service number: 512-388-9320.

With all units returned for repair, please include:

- Specific information about the problem.
- A contact name and phone number, in case we need more information.
- A purchase order authorizing repairs, or a request for a quote.

Ship prepaid to the address below:

Factory Service Department
TN Technologies
2555 North IH 35
Round Rock, Texas 78664

Our Receiving Department will not accept collect shipments.

Do not ship to our P.O. Box.

Appendix B Specifications

Operating Principle

Frequency modulated continuous wave (FMCW) radar signal which measures distance; microprocessor based transmitter computes level, volume and nine other measurements.

Range

Up to 115 ft. (35 m.)

Reference Accuracy

±3 mm (1/8 in.)

Repeatability

±3 mm (1/8 in.)

Input Power

24 Vdc ±25%, 12 W

Serial Outputs & Inputs

RS-485 (Standard): Half duplex partyline communication to a host computer or hand-held terminal.

RS-232 (Optional): Full duplex communication with a remote terminal, printer, PC or host computer.

Current Output

4 to 20 mA, isolated, loop-powered (24 Vdc). Maximum load – 700 ohms. Compliant with NAMUR 43 specification for fault current.

Contact Closure Input

1 contact closure input provided. (User provides switch.)

Circuit Protection

Meets IEC 801-1,-2, and -3
Current output is isolated.

Microwave Emissions

In compliance with ANSI C95.1, “RF Field Exposure Safety Guidelines”

Dimensions

Refer to Dimensional Drawings

Rod Antenna: D868217

Horn Antenna: TBD

Weight

Rod Antenna: ~15 lbs.

Horn Antenna: TBD.

Temperature Range (Electronics)

-40° C to +70° C (-40° F to +158° F)

Pressure

Rod Antenna

PP 600 psig. max.

PTFE 300 psig. max.

Exposed Materials (Process)

Rod Antenna

SS316 and Polypropylene, or
SS316, PTFE, and O-ring material.

Horn Antenna

TBD

Mounting

Rod Antenna

1 inch NPT bushing, or
Welded flange (150/300 lb.; 2, 3, 4, 6 inch)

Horn Antenna

TBD

Hazardous Location Approvals

FM

Class I, II, III, Division 1, Groups B, C, D, E, F, G
Class I, II, III, Division 2, Groups B, C, D, F, G
NEMA 4X

CSA

Class I, II, III, Division 1, Groups B, C, D, E, F, G
Class I, II, III, Division 2, Groups B, C, D, E, F, G
TYPE 4X

CENELEC

EEx d IIB + H₂

Eex n IIB + H₂

Appendix C Menu Flowcharts

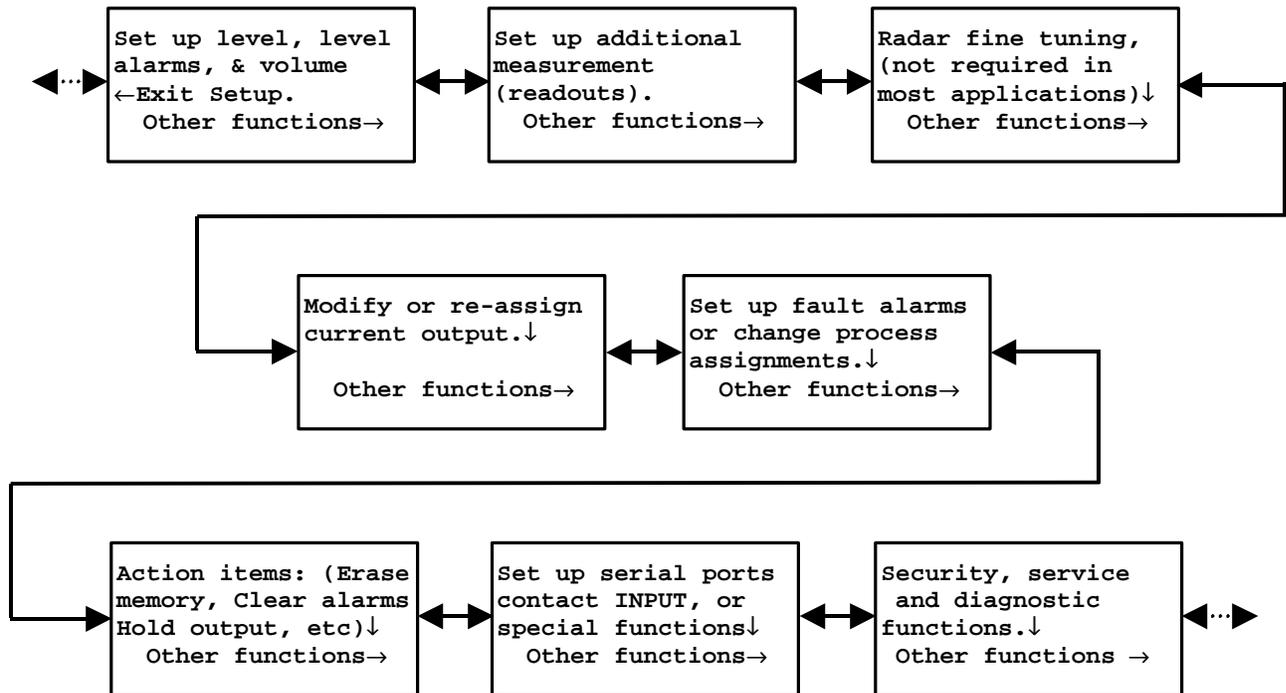
This appendix shows the overall arrangement of the menu groups and the menus contained in each menu group. Use the arrow keys to scroll through the menus. Help texts are available at appropriate points. The dynamic menu system controls the items you see so that only menu selections pertinent to your application are presented.

Note: The actual menu display can vary dynamically with context. Many menus, items, or selections appear only if the proper conditions are met. For instance, current-output related items do not appear if a current I/O board is not installed.

Most items will show a somewhat different message when accessed by direct entry than when seen in the setup menus.

When no entries are made in the setup menus for five minutes, the display times out and returns to the measurement display shown in Figure 2.1. Any changes you made are saved and used by the gauge. See Chapter 2 for a more detailed explanation of how to use the menus.

The diagram below shows an overview of the top-level menu groups. Some items are not always displayed, depending on your application and previous settings. The tables on the following pages explain prerequisite conditions for each conditional menu. The tables also reference the sections / page numbers that describe each menu. Refer to those sections for information about individual setup items and lower-level menus.



Top Level Menu Structure

This table describes the top-level menus and references the appropriate chapter in the manual. Each of these menus is then described in a separate table on the following pages.

Top Level Menu Structure	
Display	Comments
Set up level, level alarms, & volume ←Exit Setup. Other functions→	See Chapter 3. Primary measurement setup – distance or level. Set up alarm(s) (optional) for the primary measurement and set up tank volume (optional).
Set up additional measurement (readouts). Other functions→	See Chapter 4. Define and set up additional measurement readouts. All alarms are assigned to primary measurement by default. To set up an alarm for a “non-primary” measurement, you must first assign an alarm to the measurement using the “Set up fault alarms...” menu below.
Radar fine tuning, (not required in most applications)↓ Other functions→	See Chapter 5. Various tools for fine tuning the radar gauge. Often these tools are not required except in more difficult applications – such as tanks where other structures cause false echoes, where agitator blades cause problems in locking onto the proper echo, or for low dielectric constant process materials.
Modify or re-assign current output.↓ Other functions→	See Chapter 1. Current output related menu items. Only displayed if an I/O board with a current output is installed in the Accu-Wave transmitter.
Set up fault alarms or change process assignments.↓ Other functions→	See Chapter 1. Assign process (measurement) alarms and set up other types (fault, warning, or mode) alarms. This menu is not displayed unless relays are installed, or unless you “enable alarm-related functions” under the “Special Functions” menu (see page 8-19).
Action items: (Erase memory, Clear alarms Hold output, etc)↓ Other functions→	See Chapter 7. Set up and/or execute various action items.
Set up serial ports contact INPUT, or special functions↓ Other functions→	See Chapter 8. Configure the serial ports, the contact closure inputs, and a number of miscellaneous “special” functions.
Security, service and diagnostic functions.↓ Other functions →	See Chapter 9. As the menu title states, security, service, and diagnostic functions and tools are provided.

“Set Up Level, Level Alarms, & Volume” Menu Group

“Set Up Level, Level Alarms, & Volume” Menu	
Display	Comments
(primary measurement setup items)	Page 3-2. Set up the primary measurement.
(current output span / display scaling)	Page 3-2. Set up the current output span relative to the primary measurement. Only displayed if I/O board w/current output is installed.
Set up alarm 1 (alarm 2, etc) →	Page 3-6. Set up alarm(s) for primary measurement. Only displayed if relays are installed or if alarm-related selections are enabled in “Special functions” menu. Menus displayed for alarms 2–16, as needed.
Tank volume setup →	Page 3-13. Set up volume measurement (optional).

“Set Up Additional Measurements” Menu Group

“Set Up Additional Measurements” Menu	
Display	Comments
Modify setup of measurement 1 (units) →	Page 3-2. Modify setup of primary measurement. Only displayed if service-only items are enabled in the “Special functions” menu.
Assign & setup or Modify setup of measurement (number) (units) →	Page 4-1. Set up or modify previously setup additional measurements.
(measurement type and units items)	Page 4-2. Define parameters for next measurement to be set up (measurement number 2 to 8).
(measurement display items)	Page 4-6. Parameters related to measurement readout display.
Set up alarm n →	Page 4-9. Set up alarm(s) for additional measurements. Alarms must first be assigned to measurement (see page 6-3).

“Radar Fine Tuning” Menu Group

“Radar Fine Tuning” Menu	
Display	Comments
material type and measurement head setup→	Page 5-2.
modify range of measurement→	Page 5-4.
Response time, lost echo and agitator reject setup→	Page 5-6.
False echo management→	Page 5-11. Includes several submenus for specialised tools false echo management: Clutter Management, page 5-17, Tank Map Setup, page 5-21, Region Weighting Setup, page 5-24, Dynamic Threshold Setup, page 5-26. The last three tool menus are only displayed if the “service only items” are enabled.

“Modify or Reassign Current Output” Menu Group

“Modify or Reassign Current Output” Menu	
Display	Comments
(Current output range items)	Page 6-1. Set max/min current output values.
(Measurement assignment items)	Page 6-1. Assign measurement to each installed current output in normal and alternate modes.
(Correction factor items)	Page 6-1. Allows fine tuning of current output values.
(Current HOLD value setting)	Page 6-1. Specify current output hold values.

“Set up Fault Alarms or Change Process Alarm Assignments” Menu Group

“Set up Fault Alarms or Change Process Alarm Assignments” Menu	
Display	Comments
Set up for alarms to execute commands →	Page 6-4.
Assign alarms to measurements →	Page 6-5. Available only if additional measurements are set up. Alarms must be assigned to non-primary measurements using this item, before alarms can be set up for “non-primary” measurements.
Assign “relays” to warning alarms and fault alarms →	Page 6-6.
Assign “relays” to mode alarms →	Page 6-8.
(“show relay status” selection item)	Page 6-3.

“Action Items Menu” Group

Contains the most frequently used commands grouped in four submenus.

“Action Items Menu”	
Display	Comments
Common action items (clear memory, etc)→	Page 7-2.
Alarm action items (View, clear, etc)→	Page 7-3. Displayed only if relays are installed or if alarm-related selections are enabled in the “special functions” menu.
“Hold” action items (Hold reading, etc)→	Page 7-4.
Serial port related action items →	Page 7-6.

“Set Up Serial Ports, Contact Input, or Special Functions” Menu Group

“Set Up Serial Ports, Contact Input, or Special Functions” Menu	
Display	Comments
Modify port 1 RS232 configuration →	Page 8-8.
Modify port 2 RS485 configuration →	Page 8-8.
Set up port 1 RS232 data transmission → (data streaming)	Page 8-10.
Set up port 2 RS485 data transmission → (data streaming)	Page 8-10.
Assign commands to execute on contact open/close 1 (2)→	Page 8-18. Available only if a relay I/O board (with or without relays) is installed.
Special Functions →	Page 8-19.

“Security, Service, and Diagnostic Functions” Menu Group

“Security, Service, and Diagnostic Functions” Menu	
Display	Comments
Security items: (password, etc.) →	Page 9-1.
Diagnostics: system test, related items →	Page 9-2.
User service & related items →	Page 9-9.
Factory service & related items →	Page 9-11. Available only if service-only items are enabled in “Special functions” menu.

Glossary

- AC Alternating current.
 - Alarm In this manual, does not necessarily mean an abnormal or dangerous condition exists. Here alarm broadly means that a previously specified condition exists. Alarms can be process, system fault and warning.
 - Alarm clear Condition under which the alarm ceases.
 - Alarm clear point Measurement at which alarm is deactivated or cleared.
 - Alarm set point Level (or distance, volume) at which alarm is triggered. When triggered, user defined alarm action occurs. This can be any of several things such as flash display, activate relay, or execute command.
 - ALM Alarm.
 - ALM CLR Alarm clear.
 - ALM SET Alarm set.
 - Antenna Bottom of sensor. A device for sending or receiving radio waves.
 - Antenna offset Another name for zero distance point.
 - Assign To link or connect. For example, you can “assign” the level measurement to an alarm. Then you can assign an “output” such as flash display or execute command for that alarm.
- The end result is that a level at or above the level you specify will cause the display to flash or will execute a command.
- Assy. Assembly.
 - Attenuate To reduce. For example, to reduce the intensity of microwaves by passing them through an absorbing medium.
 - Baffle A device such as a plate or wall used to deflect, check or regulate flow.
 - Baud rate Any of the standard transmission rates for sending or receiving binary coded data.

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- Beamwidth Out going microwaves spread out approximately 15° wide.
- Board A flat sheet on which integrated circuits are printed.
- Break point table A table of 1-16 points (distance or level) and the corresponding volume of the tank at that point.
- Cal Calibration.
- Cap Top of sensor. Contains transceiver and preamp assembly.
- Clear point The reading at which the alarm ceases.
- Clutter Clutter is one or more false echoes from the following: the sensor itself, the isolation seal (if present), or the tank nozzle.
- Clutter distance Defines the distance out from the reference line over which the gauge should cancel the clutter signal.
- CMD Command.
- Coaxial cable Cable with a center conductor surrounded by a dielectric sheath and an external conductor. Has controlled impedance characteristics that make it valuable for data transmission.
- COMM module Communication module for serial communications with the gauge.
- Command code A numeric code used in direct entry to cause the transmitter to execute a command from the keyboard instead of from the menus.
- Compound shapes Can be described as two or more of the predefined shapes.
- CPU Central processing unit.
- Dead band The range of readings between the set and clear points.
- Decimal Point Position Specifies the position of the decimal point in the measurement readout, for example, 12.34 or 123.4.
- Dielectric A nonconductor of direct electrical current.
- Dielectric constant Determine a material's ability to reflect microwaves.
- Direct entry Use keypad to directly access a menu item or execute a command without scrolling through the menus.
- Display mode The gauge display is in "normal" mode when it is first turned on. It can be set up to display normal mode or alternate mode or to toggle between the two.
- DSP Digital signal processing
- DPT Dynamic process tracking
- Echo Return microwave signal.
- Echo #1 The echo that appears to be reflected from the farthest object.
- Echo qualification When more than one echo is received, the gauge uses this process to determine which one is reflected from the process material.

- **Entry ID** Identifies a menu item for direct entry.
- **Esters** Any of a class of often fragrant compounds that can be represented by the formula RCOOR' and that are usually formed by the reaction between an acid and an alcohol with elimination of water. For example: acetate.
- **False echo** Echo reflected from any surface other than the surface of the process material. For example, echoes reflected off of baffle support brackets or the bottom of the tank.
- **False signal** Any signal (echo) reflected from any surface other than the surface of the process material. For example, microwaves reflected off of baffle support brackets or the bottom of the tank.
- **Fault** A hardware or software condition that causes a device, a component, or an element to fail to perform in a required manner
- **Fault alarm** Notifies you of level signal lost or system fault (others are also available). A line on the display flashes off and on.
- **GA** Gauge, thickness of wire.
- **Gauge** Combined sensor and transmitter.
- **Good echo** Values are inside the signal window.
- **HELP** Information in the menu to explain a particular item.
- **HEX** Hexadecimal.
- **Hidden keys** Unmarked keys located around the keypad on the transmitter which can be programmed by the user. Also called blank keys.
- **High alarm** The clear point is less than the set point.
- **Hz** Hertz (cycles per second)
- **I/O** Input and output
- **Intrusive mounting** The antenna extends downward into the tank nozzle.
- **Isolation mounting** The antenna is mounted outside the tank and separated from the process material by a seal.
- **Item identifier** Identifies an item for direct entry.
- **Keyboard code** A menu item identifier used in direct entry.
- **Keypad** Used to enter commands and data and to scroll through items, options and menus.
- **Linearity** The closeness to which a curve approximates a straight line.
- **Lost signal alarm** For some reason, the sensor is not detecting a strong enough microwave reflection to make a measurement. Minimum acceptable signal strength and action to take if the signal is lost are programmed by the customer.
- **Low alarm** The clear point is greater than the set point.
- **Marker** Indicates an event.

- **MAXECHOS**
Maximum number of echoes to be processed.
- **Meas.** To measure or a measurement.
- **Measurement**
Any parameter which the gauge is programmed to measure or display. For example, level, distance, or volume.
- **Measurement #1**
The primary measurement, either distance or level.
- **Measurement display**
Shows the current values of distance or level, signal strength, and other measurements that have been set up.
- **Measurement head**
The sensor.
- **Measurement head geometry**

Whether the sensor is an isolation mounting or intrusive mounting type.
- **NEC** National Electric Code
- **Outage** Distance from top of tank to material surface.
- **Password** Provides security.
- **PC** Personal computer.
- **PF** Preference factor.
- **Predefined shapes**
The gauge can calculate the volume of the following shapes: vertical cylinder, vertical rectangle, vertical cone, horizontal cylinder with flat ends, horizontal cylinder with domed ends, sphere, sloped bottom cylinder, and parabola.
- **Primary measurement**
Either distance or level. Also referred to as measurement 1. Limited to level or distance. See “Set up level, ...” menu.
- **Process alarm**
High and low alarms. Set point (trigger point) and clear point are entered on the “Set up Level” menu.
- **Process material**
Material, usually liquid, whose level is being measured.
- **Program** In this manual, means using the menus to define the measurements and alarms.
- **Radar** Detects distant objects by means of radio waves reflected from an object; the term is derived from the original term radio detection and ranging.
- **Radar fine tuning**
This menu is used to customize set up for challenging applications. Here you can enter a specific dielectric constant (standard level setup only requires that you specify water or non-water based liquid material). Clutter distance, auto clutter update time, agitator reject time, etc. are also on this menu.
- **Readouts**
Measured parameters which have been set up to display on the gauge screen.
- **REF LINE**
Reference line that is cast in the antenna housing.
- **Reflected wave**
The portion of the microwave reflected from

- the process material back to the gauge sensor.
- Refracted wave
Only of concern when the process material has a low dielectric and the material level in vessel is also low. Wave train produced when microwaves cross boundary between 2 media (for example, air and process material). Refracted portion of wave is that which crosses into second medium and is not reflected back to sensor.
 - Relay A switch used to activate the contact outputs when an alarm occurs.
 - ROI Range of interest.
 - EXIT SETUP key
Saves your entries and returns to the measurement display.
 - Scientific notation
A floating-point system in which numbers are expressed as a product of a number between 1 and 9.999 multiplied by an appropriate power of 10 (3.465E-4).
 - Sensor Contains the microwave circuitry. Includes transceiver and preamp assembly, antenna, adapter flange, seals and gaskets.
 - Serial port
Accommodates serial data transmission, that is, each bit is sent sequentially (one bit at a time).
 - Set point The reading at which the alarm occurs.
 - Set up Verb: To “program” the gauge for your specific application.
- For example, “set up process alarms.”
- Setup Noun: As in “level setup.” A type of configuration, defined by the customer. An arrangement of data or devices to solve a particular problem.
 - Sig Str Signal strength.
 - Signal strength
Represents the amplitude of the signal received by the sensor. This parameter appears when you first power up the gauge. If you want to use it as a “real” system parameter, use the “Set up Additional Measurements” menu. There are no units associated with signal strength. Minimum acceptable signal strength is sometimes used to fine tune a challenging application.
 - Sparge
To agitate a liquid by spraying compressed air or gas through a pipe into the liquid. Can cause foamy surface.
 - Time constant
Sets the signal filter damping. A longer time constant will smooth the output, reducing the effects of turbulence. The default is 4 seconds.
 - Toggle Verb: To switch between 2 selections by pressing a key. First time, selection A appears, second time, selection B, third time, selection A again.
 - Transceiver
Combination of receiving and transmitting equipment located in the sensor.

- Transmitter Does digital processing.
- Ullage Empty volume.
- Units mask Defines which set of measurement units will be displayed. The default is All.
- Volume Amount of process material measured in the vessel. Gauge measures distance, calculates the level, and converts this to volume based upon the vessel shape you selected in “Set up volume menu.”
- Vortices Whirlpools of flowing fluid. Areas of lower pressure with fluid flowing in a circular motion.
- Warning alarm These alarms notify you of system status; for example, keypad in use.
- WF Weighting factor.
- Zero distance point The vertical location on the tank that the user defines as zero for the distance reading. Frequently, top of the tank.
- Zero level Point in tank at which the gauge should report level equal to zero.
- Zero output 1 Sends current output to 0 mA.
-