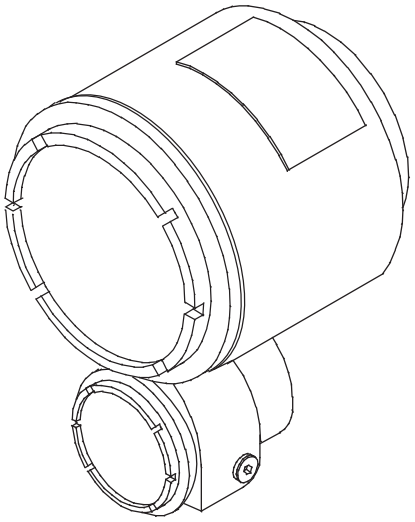
4110 HART® Level Encoder

Precision measuring instrument for transmission of level measurement from mechanical float gauges

Varec®

Installation and Operations Manual



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Read this manual carefully and make sure you understand its contents before using this product. Follow all instructions and safety guidelines presented in this manual when using this product. If the user does not follow these instructions properly, Varec cannot guarantee the safety of the system.

Note! Comply with all applicable regulations, codes, and standards. For safety precautions, the user should refer to the appropriate industry or military standards.

Caution! **Electrical Hazard!** Read and understand static and lightning electrical protection and grounding described in API 2003. Make certain that the tank installation, operation, and maintenance conforms with the practice set forth therein.

Warning! **Striking the instrument with a metal object could cause a spark to occur.** When removing or replacing the instrument in flammable or hazardous liquid storage areas, take necessary measures to protect it from impact.

Warning! **Volatile fumes may be present!** Make certain that the tank is empty and not in service. Ensure that the tank has been leak and pressure tested as appropriate for the liquid to be stored. Observe appropriate safety precautions in flammable or hazardous liquid storage areas. Do not enter a tank that has contained hydrocarbons, vapors, or toxic materials, until a gas-free environment is certified. Carry breathing equipment when entering a tank where oxygen may be displaced by carbon dioxide, nitrogen, or other gases. Wear safety glasses as appropriate. Use a hard hat.

Warning! **Sparks or static charge could cause fire or explosion!** The mechanical connections between equipment may provide a resistance to ground that is adequate for the safe electrical drain of electrostatic charges that may accumulate in the tank and the product. Worker activity and worker clothing may accumulate electrostatic charges on the body of a worker. Care should be used in flammable environments to avoid the hazard.

Contents

1 Introduction

1.1 Using This Manual

This manual is designed to assist the user with the installation, configuration, operation, maintenance, and troubleshooting of the 4110 HART® Level Encoder (4110 HLE).

1.2 Getting Acquainted with the HART® Level Encoder (4110 HLE)

The 4110 HLE, in conjunction with a HART host such as the 4100 Multifunction Transmitter (MFT), represents a data acquisition and communications system for use in liquid level measurement and/or other measurement applications. Liquid level measurement is provided by the 4110 HLE coupled to a 2500 Automatic Tank Gauge (ATG) or other level gauge. Calculations and communications are performed by a HART host such as the 4100 MFT.

1.3 Operation

The 4110 HLE uses an incremental counting technique for determining liquid level. An initial level is identified as part of the calibration procedure. Changes to that level are determined through incremental increases or decreases as detected by the 4110 HLE.

The HART host collects measurement information by polling the 4110 HLE over the 2-wire intrinsically safe HART bus. The HART host provides power and can communicate with up to eight HART devices. When a 4100 MFT is used as the HART host, it processes and transmits this information to a host computer, MODBUS master, or intermediary device over a field communications bus.

1.4 Configuration

The 1200 or 268 Handheld Terminal (HHT) is used to configure the 4110 HLE and connects to the same HART bus used to interconnect the other HART devices. There is a special connection located in the junction box for the 1200/268 HHT.

1.5 Construction

The 4110 HLE is housed within an aluminum enclosure. The enclosure and assembly meet all intrinsic safety and explosion proof requirements and are environmentally sealed to prevent internal exposure to contamination.

2 Installation

2.1 Overview

This section contains instructions for unpacking, mounting, grounding, and wiring the 4110 HLE assembly. An installation checklist is also included.

Warning! To avoid electric shock and possible injury, do not perform any service procedures other than those specified in this manual. These installation instructions are for use by qualified service technicians.

2.1.1 Unpacking

Remove the 4110 HLE from the shipping container and inspect it for evidence of shipping or handling damage. Report any shipping damage to the carrier. Verify that the contents of the shipping container agrees with the packing list.

2.1.2 Storage Prior to Installation

If the 4110 HLE is to be stored prior to installation, it should be repackaged in its shipping container and stored in a temperature and humidity controlled environment.

2.1.3 Becoming Familiar with the 4110 HLE

The 4110 HLE is housed within an explosion proof enclosure. A cover is provided to permit access to both the electronics and a backup battery.

¾-and 2 ½-inch NPT plugs are provided for wiring access. Wiring to the 4110 HLE consists of the HART bus and an optional ground connection.

2.1.4 Hardware Configuration

All configuration is performed using the 268 HHT or a download from a HART host computer.

2.2 4110 HLE Dimensions

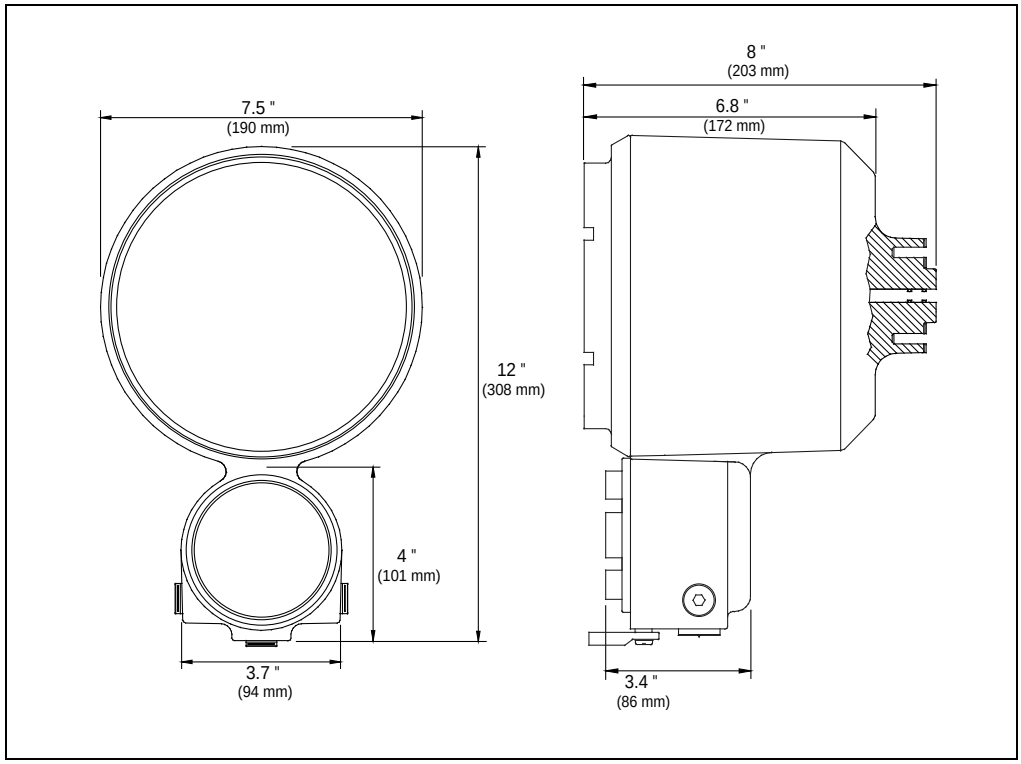

Figure 2-1: 4110 HLE Dimensions

2.3 Mounting the 4110 HART® LE

The 4110 HLE is bolted to the 2500 Series Automatic Tank Gauge head as illustrated in Figure 2-2. It may also be mounted to the Whessoe, Sakura, Tokyo-Keiso, Shand & Jurs, and Gauging Systems, Inc. float and tape gauges with the Varec adapter shown in the following table.

Part Number	Gauge Adapter Kit
13-05956-102	Shand & Jurs or Endress+Hauser 92513, 92514, 92020, and 92030 gauges
13-05956-202	Shand & Jurs or Endress+Hauser 92006,2006
13-07231	Sakura LT-1110 (Metric only)
13-09009	Tokyo-Keiso FT-1201 gauge

Mounting the 4110 HLE to the Level Gauge is accomplished in the following manner (see Figure 2-3).

1. Remove the back cover of the Level Gauge.
2. Remove the access cap from the back cover of the Level Gauge.
3. Mount the 4110 HLE in place of the access cap, making certain that the word "TOP" cast into the housing lines up with the top of the Level Gauge back cover.
4. Install the Level Gauge back cover with the transmitter in the Level Gauge. Make certain that the slot in the 4110 HLE drive coupling engages with the pin on the tape sheave of the Level Gauge.
5. Proceed with field wiring.

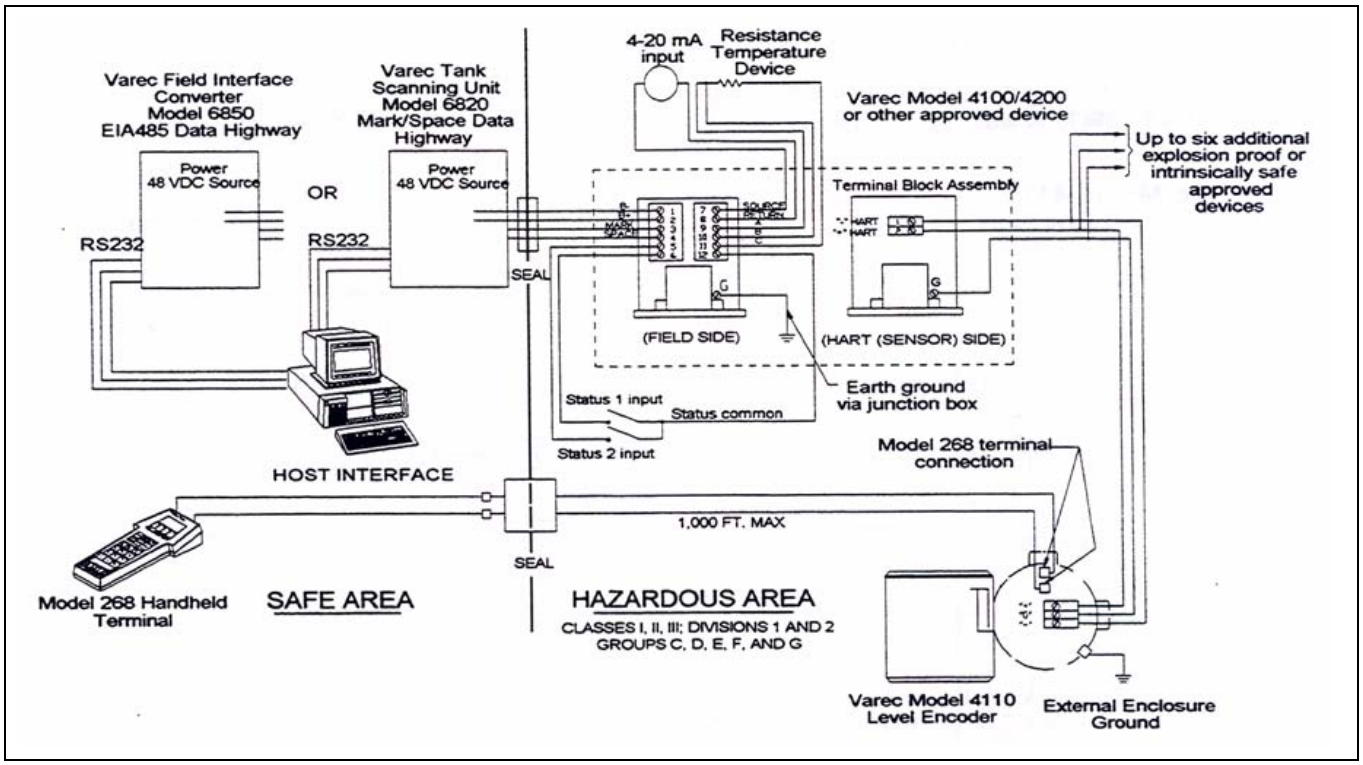

Figure 2-2: Typical System Installation

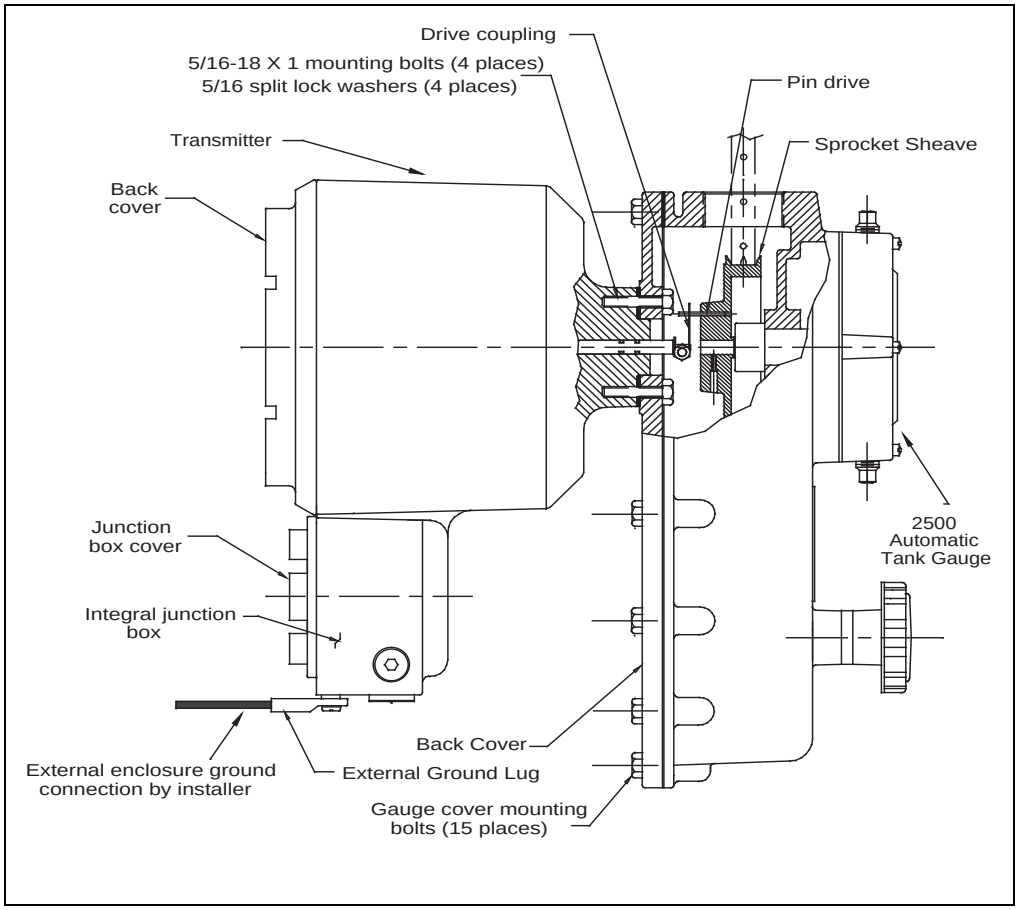

Figure 2-3: 4110 HLE Mounting

2.4 4110 HLE Wiring

Remove a plug from the desired conduit entry. Remove the front cover from the integral junction box. Connections should be made in a conventional manner according to the local plant electric codes.

2.5 HART Bus Wiring

The HART bus connection to the 4110 HLE is accomplished in the following manner (see Figure 2-4).

1. Run the two HART bus wires into the 4110 HLE through the conduit entry at the top.
2. Connect the minus side (-) wire to terminal 1 of the intrinsically safe (IS) terminal block assembly.
3. Connect the plus side (+) wire to terminal 2 of the IS terminal block assembly.
4. For IS installations, connect the chassis ground of the 4110 HLE to the G terminal of the 4100 MFT.

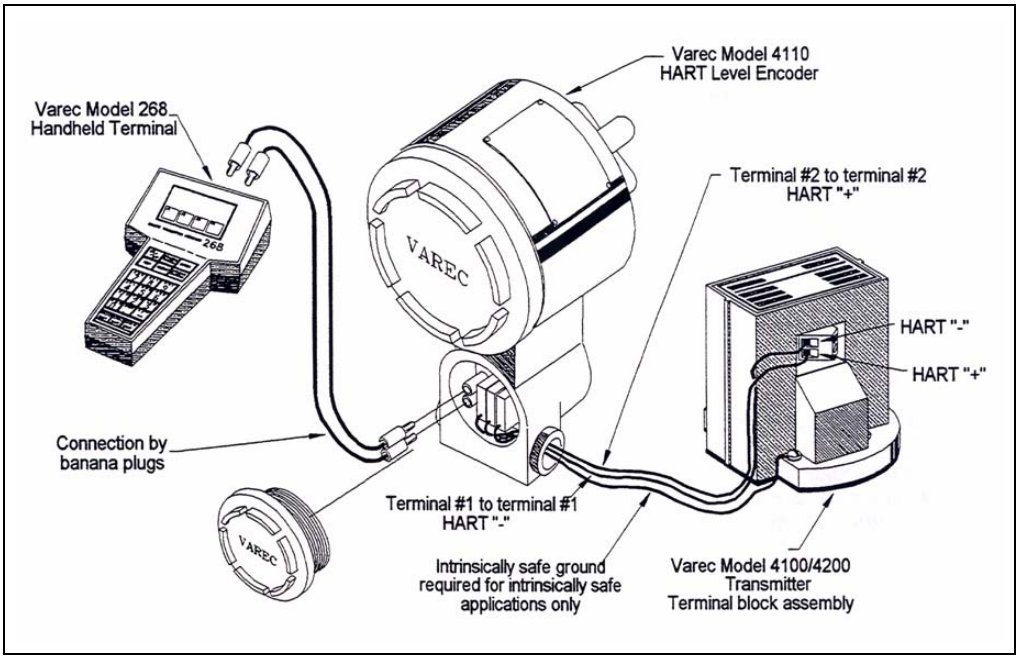

Figure 2-4: 4110 HLE Wiring Connections

2.6 Wiring Completion

Caution! Do not overtighten metal plugs used to seal wiring compartment ports. Overtightening may damage the housing.

Properly seal the conduit entry. Install covers and tighten to ensure that O-ring seals are adequately compressed. Proper sealing of all ports is necessary to prevent moisture or other contamination from entering the wiring compartment.

2.7 Battery Life Preservation

To preserve the life of the battery, the 4110 HLE contains special battery-usage circuit. The circuit will stop using the on-board battery if physically disconnected and then connected to the 4110 HLE electronics. Additionally, the battery can be turned off from the 268 HHT. This is a preferred method, since the 4110 HLE main housing does not have to be opened.

The battery is disconnected when the 4110 HLE is shipped. After field reconnection, the battery-usage circuit is automatically enabled when the 4110 HLE is calibrated.

Warning! There are situations where the 4110 HLE may be calibrated for a quick system checkout and then turned off for quite some time before putting it into service. The battery-usage circuit should be turned off or disconnected to maximize the life of the battery until the 4110 HLE is ready to be put into service.

Warning! The battery may explode if mistreated. Do not recharge, disassemble or dispose of in fire.

Warning! Dispose of used batteries properly and promptly. Keep away from children.

2.8 Installation Checkout

After a thorough check that all connections are properly made, the battery is reconnected, and all covers and plugs are installed, turn on power to the MFT. Proceed to Section 3, 4110 HLE Configuration, for configuration instructions.

2.9 Installation Checklist

The steps required in the installation process are summarized in the following table. Since each step is detailed specifically with accompanying notes, cautions, and warnings, be sure to refer to the sub-sections indicated for further information.

Check	Step	Sub-Section(s) Reference
	Unpack 4110 HLE and check the packing list.	Unpacking
	Verify that the required supply of input power is available.	Mounting the Equipment
	Mount the 4110 HLE	Mounting the Equipment
	Route the conduit between the 4100 MFT and 4110 HLE and seal all ports.	Wiring Completion
	Wire for communications (and power).	HART Bus Wiring
	Connect battery and apply power to the MFT.	Installation Checkout
	Proceed to 4110 HLE configuration procedure.	LE Configuration (Section 3)

3 Configuration

The 4110 HART Level Encoder (HLE) must be configured to provide an initial calibration level and to connect the backup battery. When used in conjunction with the Varec 4100 Multifunction Transmitter (MFT), the configuration of the 4110 HLE is performed automatically as part of the configuration of the MFT.

The 4110 HLE and 4100 MFT can be configured using a 1200 Handheld Terminal (HHT), 268 HHT, or from a host program such as Varec's TankView. For a more complete description of 4100 MFT configuration, refer to the Installation and Operations Manual for the 4100 Multifunction Transmitter.

3.1 Handheld Device Options

3.1.1 268 Handheld Terminal

The 268 HHT provides a local terminal interface to configure the 4110 HLE at tankside. It is connected directly to the 4110 HLE with two banana plugs.

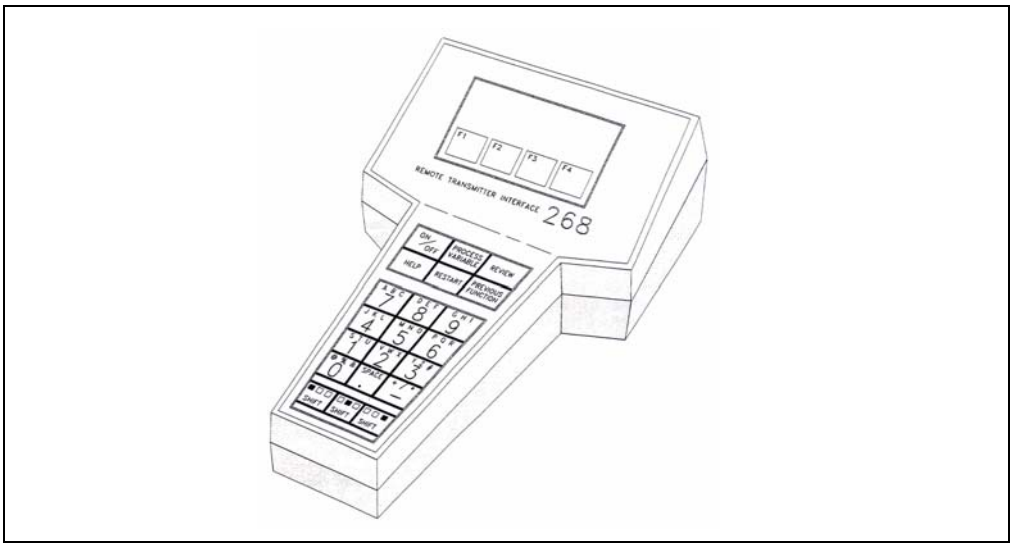

Figure 3-1: 268 Handheld Terminal

3.1.2 1200 Handheld Terminal

The 1200 Handheld Terminal (HHT) provides a local terminal interface to configure the 4110 HLE and encoder at tankside. It can be physically attached via two banana plugs to the 4110 HLE terminals.

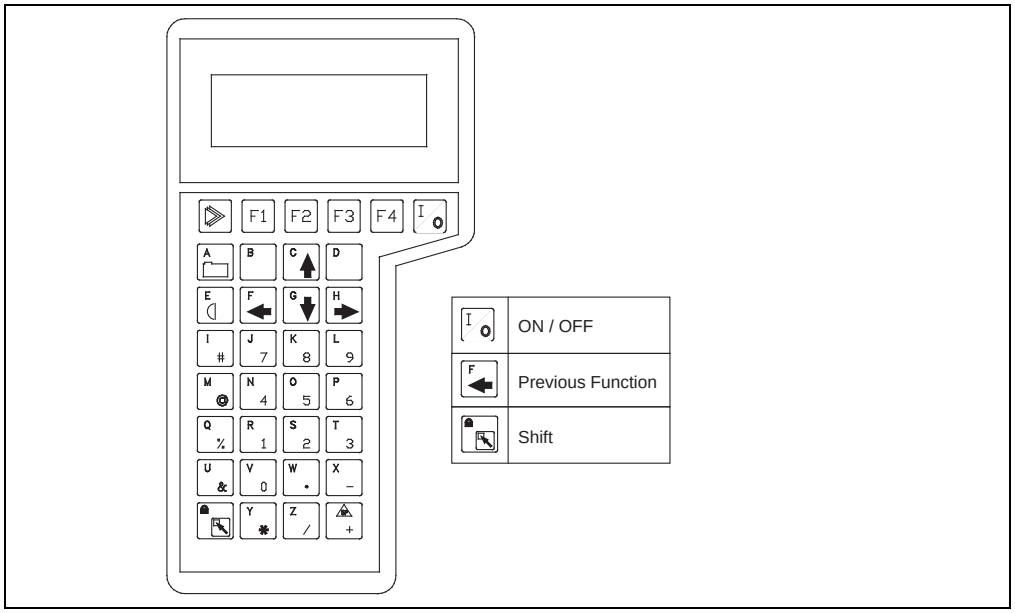

Figure 3-2: 1200 Handheld Terminal

3.2 Using the Handheld Device with the 4110 HLE

Configuration of the 4110 HLE is accomplished with the 268 or 1200 HHT in terminal mode. In this mode, the handheld device simply functions as a keyboard and monitor for the 4110 HLE. Menus are shown on a 4-line by 20-character display and selections can be made with the keyboard.

Function keys F1 through F4 are used to scroll through the 4110 HLE menus and to select configuration parameters.

Function Key	Handheld	Description
F1	268 / 1200 HHT	Scroll Up
F2	268 / 1200 HHT	Scroll Down
F3	268 / 1200 HHT	Alter/Backspace
F4	268 / 1200 HHT	Enter
PREVIOUS FUNCTION	268 HHT	Return to previous menu or abort data entry
 (Previous Function)	1200 HHT	

To select numbers, press the appropriate number key. To select an alpha character, press the shift key followed by a numeric/letter key.

For example, to enter the alpha character “N”; first press the shift key (middle shift on 268 HHT), then press the number 5. To enter the alpha character “R”; first press the shift key (right-hand shift on 268 HHT), then press the number 6.

Warning! The 1200 HHT on the 4110 HLE is not Intrinsically Safe. Care must be taken to only use in a non-hazardous environment.

3.3 Configuring the 4110 HLE with a Handheld Device

When the 4110 HLE is used with the Varec 4100 MFT, its configuration is done via the MFT. However, there are situations when the 4110 HLE will be used with a different HART host. In those situations the 268 HHT can be used in much the same way it is used with the 4100 MFT. That is, the 4110 HLE will talk to it in “Dumb Terminal” mode. The 4110 HLE reserves HART address 15 for this purpose.

To configure the 4110 HLE directly with a handheld device, perform the following steps (the startup procedure is also shown in Figure 3-4 on page 14):

1. Connect the 4110 HLE to a 15-50 VDC power source in series with a 300 +/- 100 ohm resistor for bench configuration.
2. Make sure the handheld device is not connected to the HART bus.
3. Turn the handheld device OFF and then ON. It will first go through its self-test, then try to communicate to a HART sensor at address 0. It will fail and display a “Xmtr/ 268 HHT not in communication” warning message.
4. Press F2 to select Multi-Drop mode and connect the handheld device to the 4110 HLE terminals provided.
5. Press F2 to select an address to communicate to.
6. Press F2 to select the next available address. Address 15 should be displayed.
7. Press F4 to select address 15 for the 4110 Hart LE. The handheld device establishes a connection to the 4110 HLE.
8. Press any key. A version number is displayed, and you are asked to select Display or Alter Mode. See the following figure for an example with the 268 HHT.

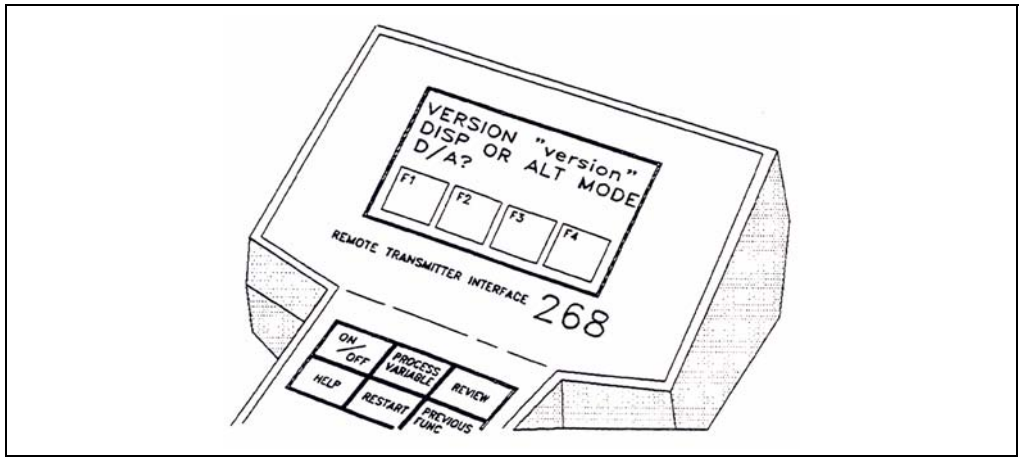

Figure 3-3: 268 HHT Version Display

9. Select the appropriate mode as described in the following table:

To Do the Following	Select ...	By Pressing ...
View configuration parameters	Display Mode	’D’ followed by F4
View and change configuration parameters	Alter Mode	’A’ followed by F4

10. Navigate through the menu to view or modify the configuration data as needed. The Display Mode menu tree is shown in Table 3-1 and in Figure 3-5 on page 15. The Alter Mode menu tree is shown in Table 3-2 and in Figure 3-6 on page 16.

Note! Modifications done in Alter Mode do not take effect unless 'EXIT AND SAVE' is selected. This will cause the modifications to be saved to EEPROM and used. If you disconnect the 268 HHT or select the 'Quit' command, any modifications will be lost.

Menu Item	Description
Level Units	FT-IN-16TH/Feet/Meters
HART Address	0 - 14
Serial Number (Long Address)	(Non-Alphanumeric)
Level	
HART Damping	-16 to 16
Reverse Encoder?	Y/N
Encoder Battery Status	Good/Bad
EEPROM Status	Good/Bad
EPROM Status	Good/Bad
RAM Status	Good/Bad
Reset Count	Number of times power was cycled
Poll Count	Number of times polled on the HART bus
Raw Count	0 - 65535
Check Disk Delta	0 - 127
Exit	

Table 3-1: 4110 HLE Display Mode Menu

Menu Item	Description
Level Units	FT-IN-16TH/Feet/Meters
Calibrate Level	
HART Address	0 - 14
Serial Number (Long Address)	(Non-Alphanumeric)
HART Damping	-16 to 16
Reverse Encoder?	Y/N
Encoder Battery Off?	Y/N
Exit and Save	Y/N
Quit	

Table 3-2: 4110 HLE Alter Mode Menu

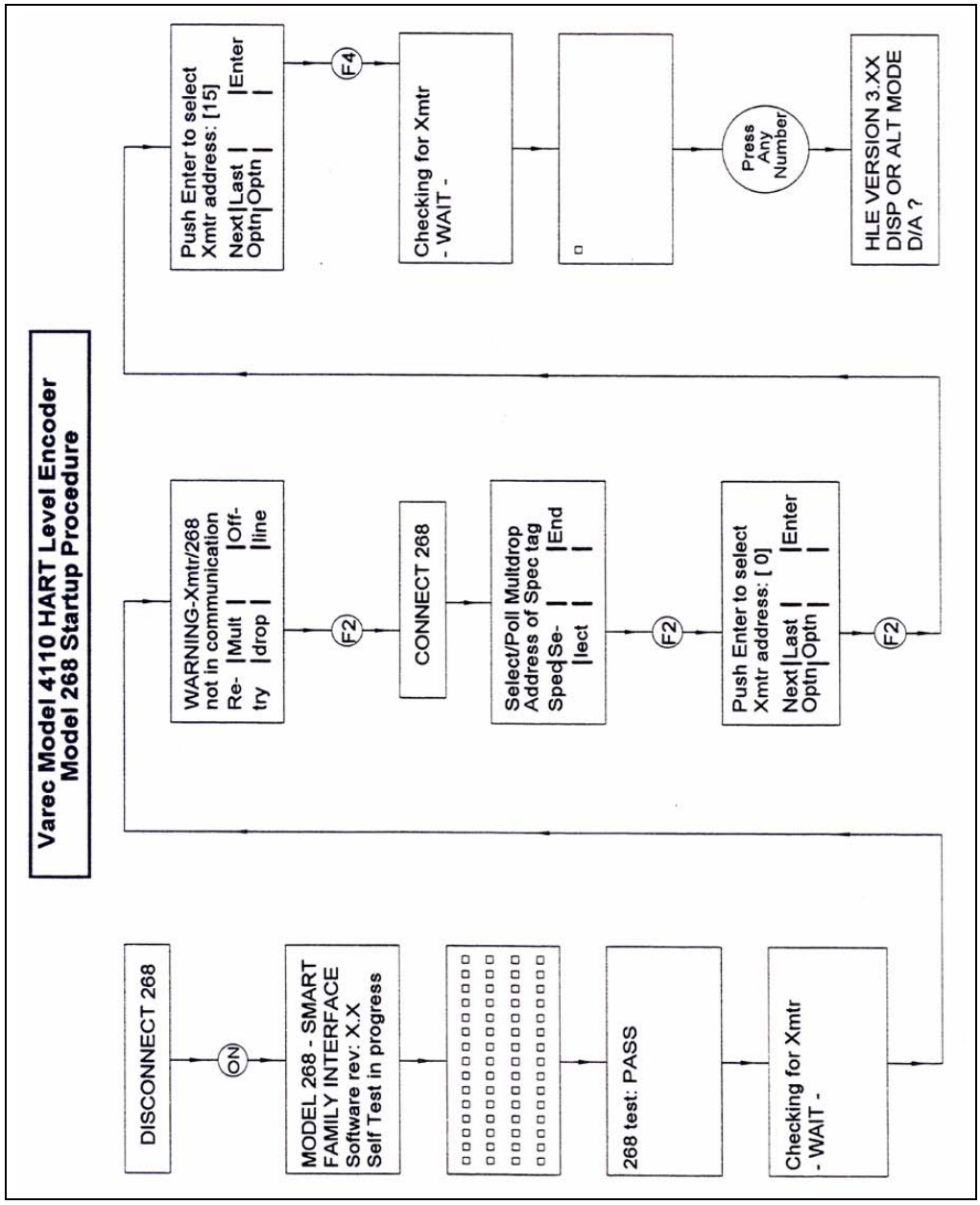

Figure 3-4: 268 HHT Menu Tree – Startup Procedure

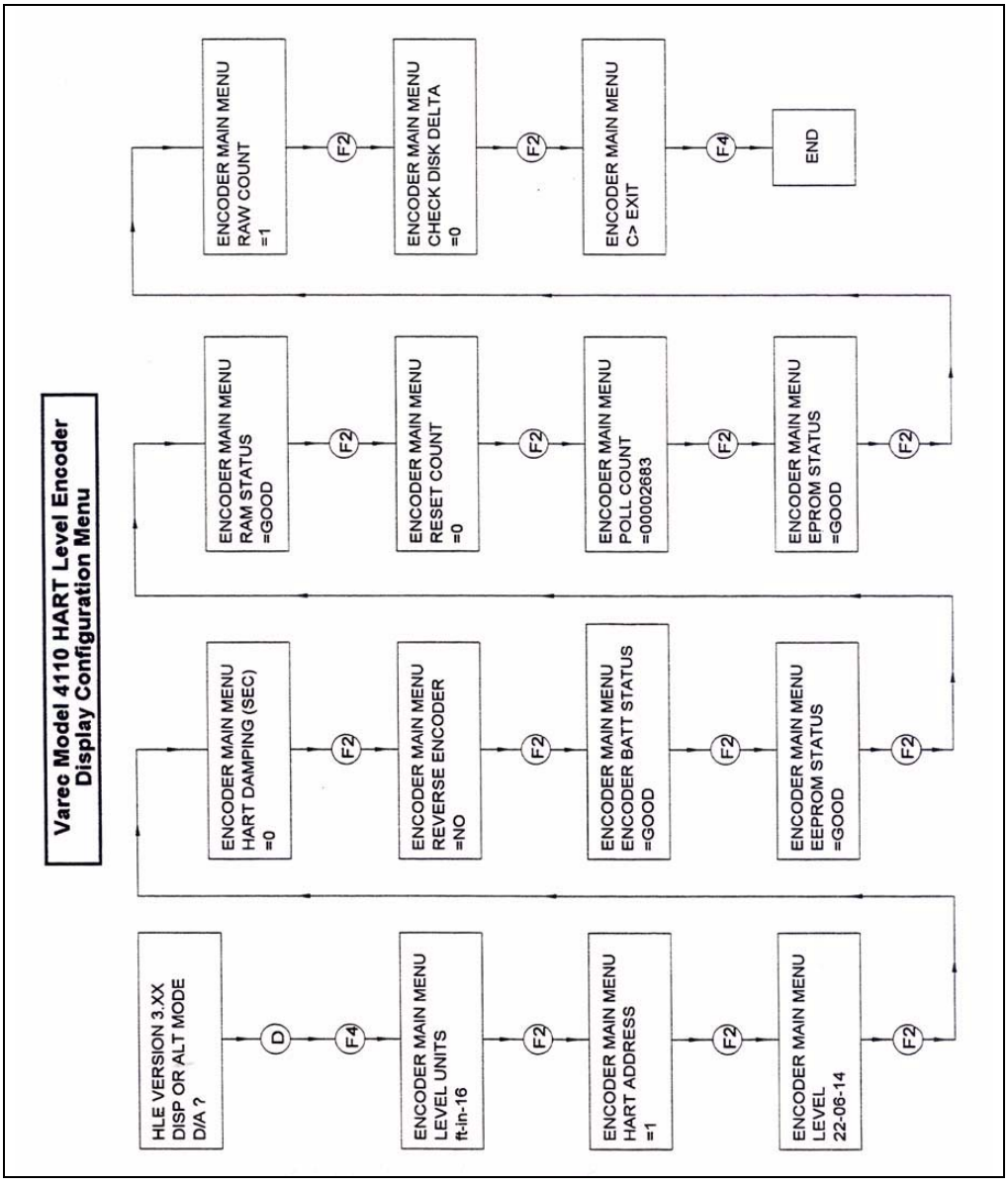

Figure 3-5: 268 HHT Menu Tree - Display Configuration

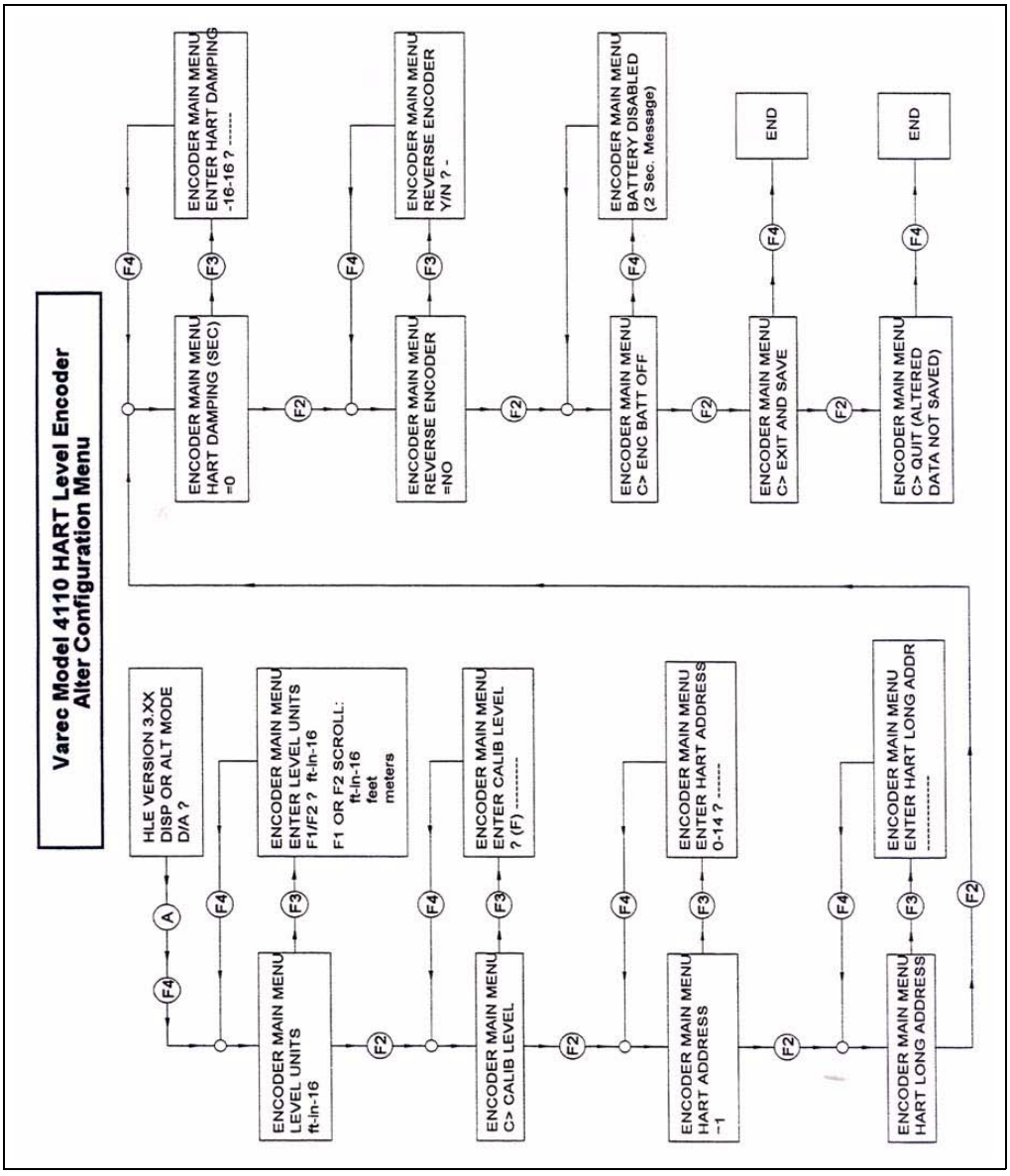

Figure 3-6: 268 HHT Menu Tree - Alter Configuration

4 Maintenance and Troubleshooting

4.1 Maintenance

The 4110 HLE is designed and manufactured to provide accurate and reliable operation without a requirement for regularly scheduled maintenance.

Caution! When performing service or repair of any kind on the 4110 HLE, follow all instructions relative to power on/off requirements.

Note! It is recommended that all necessary repairs be performed by a factory trained service engineer.

4.2 Battery Replacement

The 4110 HLE contains a battery module to maintain incremental count information during power outages. The battery shelf life is ten years and active life is 14 days or more. The battery is expected to provide ten years of maintenance-free service at a typical installation.

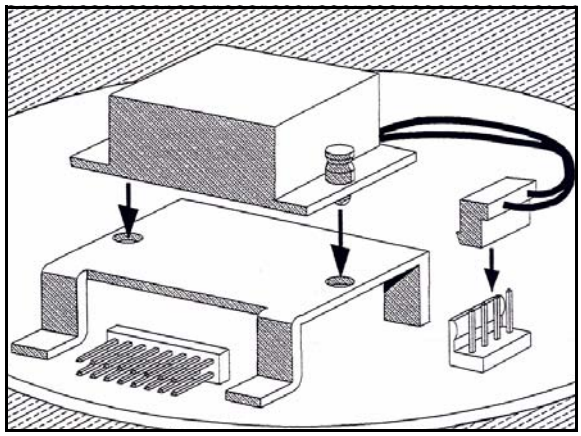

Figure 4-1: 4110 HLE Battery Replacement

The battery condition is monitored by the 4100 MFT or other HART host. A low battery condition is reported as an alarm to the host computer.

The design of the battery module is intrinsically safe. Battery replacement can therefore be accomplished while the 4110 HLE is mounted on the tank gauge.

Warning! Power to the HART Bus/LE must be off before attempting to replace the battery. Do not apply power to the 4100 MFT or 4110 HLE until battery module replacement is complete and all covers have been replaced.

Battery replacement is accomplished in the following manner:

1. Turn off all power to the LE.
2. Remove the cover from the LE.
3. Locate the battery mounting bracket module (see Figure 4-1 on page 17). Remove the two 4-20 screws holding the battery mounting bracket to the CPU circuit board and lift the bracket from the slots.

4. Locate and remove the connection (J1) from the battery module to the CPU circuit board.
5. Remove the battery.
6. Place the new battery onto the CPU circuit board and connect to J1. Be careful to observe the polarity on the connector.
7. Insert the battery mounting bracket into the slots on the CPU circuit board. Secure the bracket with 4-20 screws.
8. Install the cover onto the LE.
9. Turn on power to the LE.
10. Calibrate the 4110 HLE level setting.

Caution! The 4110 HLE must be calibrated after battery replacement or level measurements will be incorrect.

4.3 Troubleshooting

The following equipment may be required for testing and troubleshooting:

- 1200 Hand Held Terminal (HHT), 268 HHT or Digital Volt Meter “DVM”

4.3.1 268 HHT Error Messages

The following error messages can be encountered while using the 268 HHT.

Message	Description
INVALID ANSWER	The operator was expected to enter either a 'Y' for yes or an 'N' for no and something different was entered.
INVALID FLOAT	The operator entered an invalid floating point number. The proper format for floating point entry is [spaces][sign]number['.'][number]['E'][sign][number] where the fields surrounded by brackets([]) are optional. Leading spaces are permitted, however spaces within the number are not allowed. A maximum number of 15 characters is allowed. The exponent (value after 'E') cannot be larger than 30 nor less than -30.
INVALID INPUT	The operator was given a choice of two different characters to enter and something else was entered.
INVALID NUMBER	The operator entered an invalid number.
NEGATIVE NUMBER	The operator entered a negative number when asked for a positive float number.
NOT ALTERABLE	The operator attempted to alter a Command, Informational, or Menu Item using the F3 (Alter) key.
NOT IN ALTER MODE	The operator attempted to alter a Configuration Item using the F3 (Alter) key while in the Display Mode.
NUMBER TOO LARGE	The operator entered a number that is beyond the limits of a particular Configuration Item.
TOO MANY CHARACTERS	The operator attempted to enter more than the allowed number of characters.

Table 4-1: 268 HHT Error Messages

4.3.2 4110 HLE Unresponsive - No Level Displayed in Host Device

There are 3 possible procedures that can be used to identify the problem with an unresponsive unit.

Note! Refer to Safety Precautions at the front of this manual before working on the 4110 HLE in the field.

1. Is there loop power supplied to the HLE?

   - Measure at JP1 a 2-pin connector on CPU board. There should be 16 to 18 VDC.
   - If the voltage is zero, then there is a contact problem at TB1 on terminal board.
   - This can be verified by measuring voltage at TB2.
   - The problem can be solved by stripping and reinserting the 2 wires at TB1.
   - Alternatively, contact Varec for a replacement terminal board with screw down connectors at TB1.

2. Is the Power Convertor Operational?

   - If loop power of 16 – 18 VDC is verified from step one above then the power converter needs to be tested.
   - Measure between pin 14 and 28 of U15, “PROM W/ LABEL 02-9679”.
   - There should be a measurement of 5.00 VDC +, - 0.011. A reading lower then this value indicates the CPU board is defective – Contact Varec for a replacement.

3. Refer to Chapter 3, Configuration. utilizing the 1200/260 HHT Scroll through the menus and verify that all internal checks are OK.

   - The check disk delta should = zero, if there is any count, then the problem could be the encoder assembly, sensor module, or the sequential counters on the CPU board – Contact Varec for Assistance.

4.3.3 BAD EPROM Message on Handheld Terminal

On Occasion when the system is subject to a power surge or a proximity lightening hit then a memory device may become corrupt. This will render the product inoperable and a “BAD EEPROM” message will appear in the HART Host. Changing a parameter reloads the table data in the device and clears this error.

Note! See Figure 3-6 for instructions on how to navigate the menu system of your hand-held device.

1. Connect the handheld terminal to the 4110 HLE
2. Navigate to the "Alter mode" (press ALT A F4).

Change a reading to any other value (press F3). For example, changing the units setting from fractional english to a different value.

3. Exit and save.
4. Navigate back to Alter mode and change the Units value back to the original setting.
5. Exit and save.

Re-calibrate the level of the 4110 HLE by following instructions in Chapter 3, Configuration.

4.4 Major System Assemblies and Components

The major system assemblies and components for the 4110 HLE are identified in Table 4-1 and illustrated in Figure 4-2.

Item	Part No.	Description	Quantity
1	08-09208	Encoder CPU Board	
2	08-09216	Terminal Board Assy	
3	08-09220	Sensor Board Assy	
4	13-11569	O-Ring Kit	
	13-05956-102	Adapter kit for mounting to L&J 92514, 92020 and 92030 gauges	
	13-05956-202	Adapter kit for mounting to L&J 92006 and Whessoe Varec 2006, 2026, and 2036 gauges	
	13-07231	Adapter kit for mounting to Sakura LT-101 gauge (Metric only)	

Table 4-2: Major System Assemblies and Components

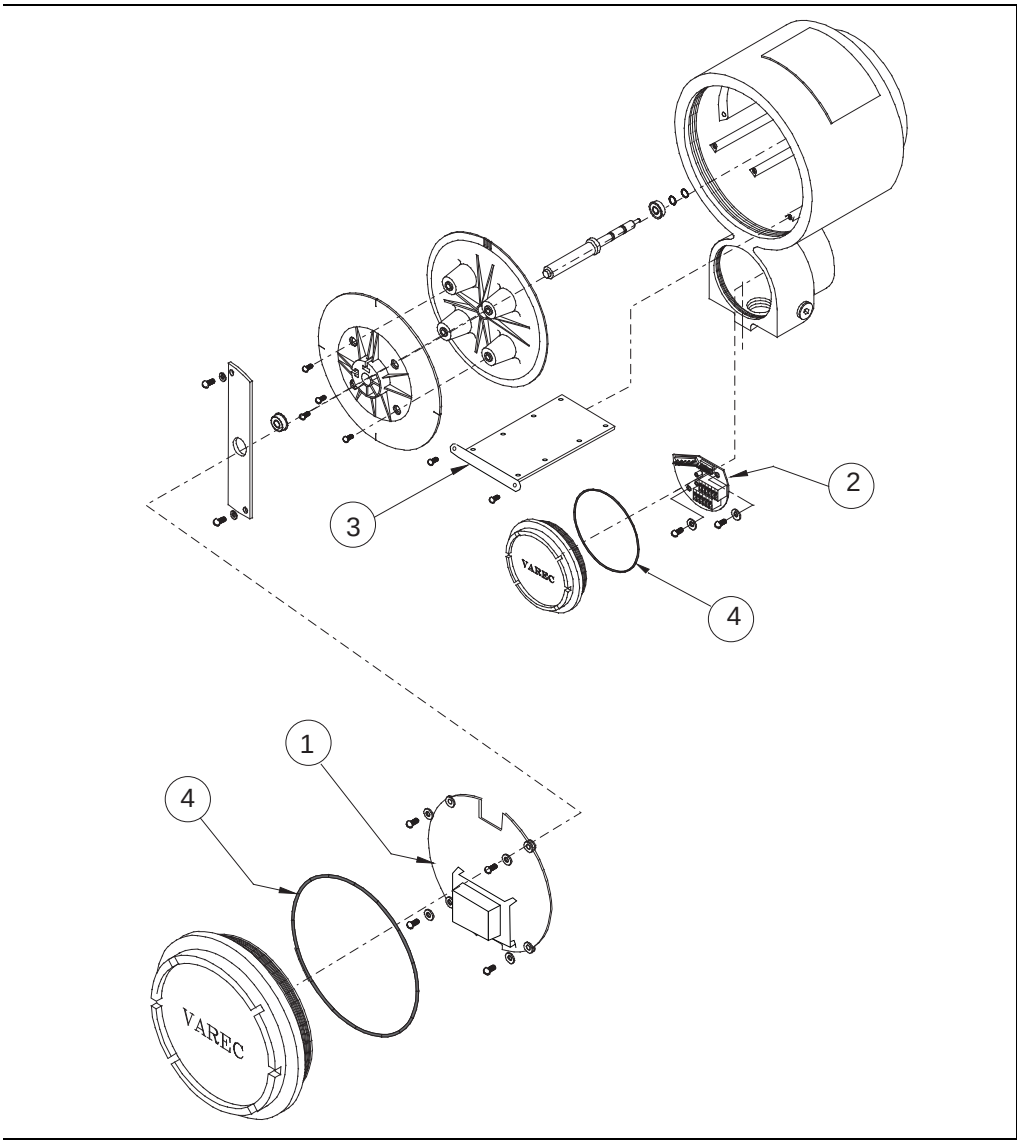

Figure 4-2: Major System Assemblies and Components

5 Specifications and Reference Data

5.1 General Information

Manufacturer	Varec, Inc.
Instrument designation	4110 HLE
Function	Function
Power Input	18 VDC nominal 12.5 VDC minimum 30 VDC maximum
Power supply	HART® Master
Power consumption	8 mA nominal @ 18 VDC (0.13 W)
Encoder type	Optical incremental
Sensor arrays	Two (2) fixed position, infrared
Battery operation	10 x 24 hours – maximum
Battery shelf life	Ten (10) years
Communications	Hart 5.0 digital compliant

5.2 Certification & Approvals

FM	Explosion Proof Class I, Division 1, Groups C & D Intrinsically Safe Class I,II,III, Division 1, Groups A – G Non-incendive Class I, Division 2, Groups A – D Dust Ignition Proof Class II,III, Division 1, Groups E- G Special Class II,III, Division 2, Groups F & G
CSA	Class 1, Division 1, Groups C & D Class II, Division 1, Groups E, F & G Class III Enclosure Type 4 Class 1, Groups A, B, C & D Class II, Groups E, F & G

5.3 Environmental

Operating temperature	-40 to 85 °C (-40 to 185 °F)
Surge protection	Meets or exceeds ANSI/IEEE 62.41

5.4 Performance Specifications

Encoder range	0 to 128 ft (0 to 39 m)
Encoder accuracy	0.04" (1 mm)
Communications range	Maximum 1000ft to 4200 MFT
Encoder resolution	0.04" (1 mm)
Rotational speed	1000 RPM @ 100% accuracy without losing synchronization with the level gauge

5.5 Physical Specifications

Gland entries	3 x ¾" or 3 x 2½" NPT (both sized plugs are provided)
Shipping weight	16 lb (7.25 kg)
Dimensions	7.5" diameter x 12" height x 8.0" depth (190 mm x 308 mm x 203 mm)
O-Rings seals	Dual O-rings on Encoder Shaft (Buna-N) Electronics & Integral Junction Box covers (Buna-N)
Enclosure	NEMA Type 4 Polyester coated die-cast aluminum - grade 360

6 Theory of Operation

6.1 Overview

The 4110 HLE, in conjunction with a HART host such as the Varec4100 Multifunction Transmitter (MFT), represents a flexible system for use in liquid level measurement and/or other measurement applications.

Liquid level measurement is provided by the 4110 HLE coupled to a Varec 2500 or other level gauge. The 4110 HLE is an external HART compatible device and is polled by the HART host over 2-wire, intrinsically safe HART bus.

When used with Multifunction Transmitter (MFT), measurement information is collected from the 4110 HLE and other HART compatible devices and transmitted over a field communications bus to a host.

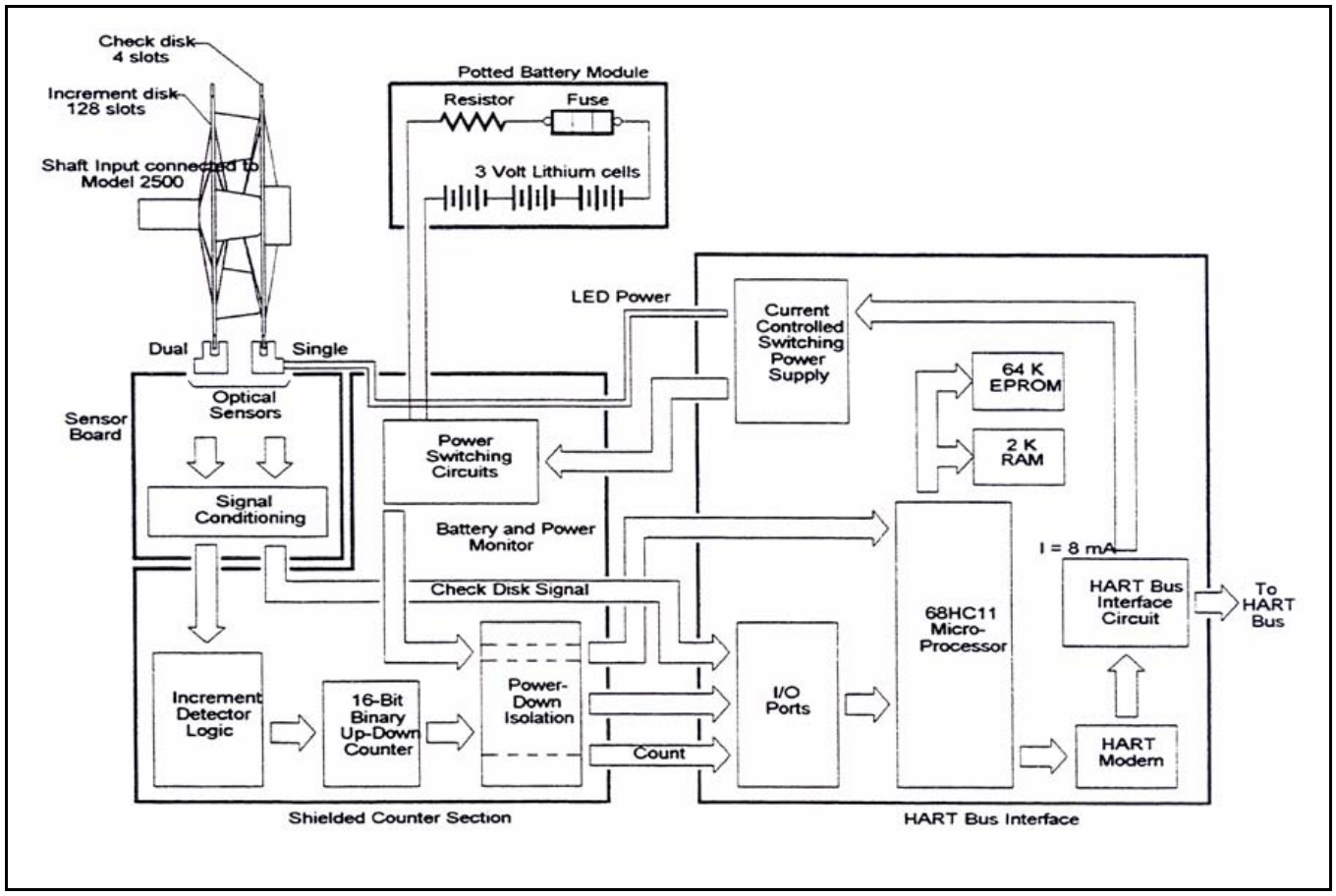

Figure 6-1: 4110 HLE Block Diagram

6.2 4110 HLE Operation

The 4110 HLE utilizes a proprietary incremental count technique for determining liquid level. Two code disks are provided in the encoder with each disk containing a number of slots. Optical sensors for each disk detect rotation by sensing the passing of these slots. The primary disk contains 128 slots and is used to calculate the actual liquid level. The secondary or check disk contains only four slots and is used to verify or check the level from the primary disk. The count obtained from these sensors is stored in encoder memory.

The encoder provides a back-up battery to provide continuous operation during power outages. This battery is a non-rechargeable battery having a continuous operating lifetime of 14 days or more and a shelf life of ten years. The encoder monitors the voltage of the back-up battery and provides a battery low warning to the host in the event the battery needs replacement.

The encoder contains a microprocessor to control all functions. The encoder transmits absolute level data to a host computer over the 2-wire HART bus and is configured over the HART bus. Encoder configuration can be performed via the 268 HHT. An access port to the 2-wire HART bus is provided on the encoder enclosure.

Power for the encoder is provided by the HART bus. The encoder presents a HART bus load of less than two HART devices (less than 8 mA load).

A block diagram of the 4110 HLE is provided in Figure 6-1 on page 23.

6.3 HART Damping

The 4110 HLE implements a flexible damping scheme to stabilize the level in turbulent tanks. The amount of damping is specified by entering the number of seconds in the ‘HART DAMPING’ parameter. This parameter can be entered via the 268 HHT using the Alter menu. If connected to an MFT, this value is downloaded to the Encoder when the ‘HART DAMPING’ value is entered in the MFT.

The HART Encoder can perform two types of damping on the measured level. The first is an instantaneous and the second is a rolling average.

The instantaneous is similar to damping schemes used by other HART devices. It is selected by entering a damping value between 1 and 16 seconds.

The rolling average is an average of level readings sampled every 200 milliseconds. It is selected by entering a damping value between -1 and -16 seconds.

6.4 HART Protocol Implementation

The 4110 HLEis a digital HART device. The 4-20 mA output is not used. Only the HART digital data is available. The Encoder can have an address of 1-14. Address 15 is reserved for the 268 HHT ASCII terminal mode.

The 4110 HLE implements HART 5.0 commands. To successfully communicate with the Encoder via the HART protocol you need to do the following steps:

1. Get the Encoder’s long address via the Read Unique ID command (0). The Encoder is shipped with a short address of 1.

2. Configure the Encoder. This step needs to be done only once. The Encoder’s EEP-ROM will retain the configuration. The following commands configure the Encoder.

   Write the units of measure using the Write Primary Variable Units command (44). The unit code can be meters (unit code 45) or feet (unit code 44). The default is feet.

3. Write the damping value via the Write Damping Value command (34). This is optional. Damping defaults to 0.

4. Calibrate the Encoder. The Encoder is incremental with battery backup. This step tells the Encoder the current level. This step only needs to be done once or when the battery dies due to an extended power loss condition, about 1-2 weeks. As shipped, the battery in the Encoder is turned off. This command automatically enables the battery. Be careful when using this command to do initial testing, since if power is removed the battery will be drained. The battery can be turned off by physically disconnecting it from the CPU board. If you do not want to open the Encoder, you can use the EEPROM Control command (39), with an EEPROM control code of 2. The level is calibrated via the Enter/Exit Fixed Current Mode command (40).

5. Read the Level. Use the Read All Dynamic Variables command (3). Level is the first process variable returned. It is available in meters (unit code 45) or in feet (unit code 44). While reading the level, you need to examine the Field Device Status, second status byte.

6. If Bit #0 is set, the Encoder has a bad level. Can be caused by a low battery, Encoder has never been calibrated, or a bad check disk condition. Solution: Replace battery or recalibrate the level.

7. If Bit #1 is set, the battery is low. The battery is checked on power up and once every 24 hours thereafter. Solution: Replace the battery.

8. If Bit #7 is set, this indicates an Encoder malfunction. This could be due to a bad check disk, bad EEPROM checksum, bad EEPROM checksum, or bad RAM. Solution: Try to recalibrate the level. If this bit does not clear, contact the factory for replacement.

6.5 Encoder Hardware

The 4110 HLE consists of the following major assemblies.

- Shaft/Disk Assembly
- Sensor Assembly
- CPU Assembly
- Battery Module
- Terminal Board Assembly

6.6 Shaft/Disk Assembly

The shaft/disk assembly is the only moving component of the 4110 HLE and provides the basic rotational input to the optical sensors. The slots in the shaft/disk assembly are designed to eliminate any optical system calibration. The life expectancy of the shaft bearings and seals is greater than ten years.

6.7 Sensor Assembly

The sensor assembly contains the optical sensors and power conditioning circuits. Dual optical sensors are used to detect rotation of the disk assembly. The dual sensors detect the direction and amount of rotation. An auxiliary single optical sensor provides a check on the count obtained. Pulses obtained from the dual optical sensors are conditioned and provided as increment/decrement pulses to a 16-bit up-down counter. A change in count represents a change in absolute liquid level.

The conditioning circuitry on the sensor assembly provides power to the optical sensors and operates on power derived from the HART bus or on the external back-up battery.

6.8 HART/Microprocessor Assembly

The HART/microprocessor assembly contains the CPU, power supply, and interfaces necessary to manager 4110 HLE operation. The power conditioning circuitry also detects a battery low condition.

The CPU monitors the count maintained in a 16-bit register. The register stores pulse information from the sensor assembly. A check disk pulse from the sensor assembly is used to verify the count at ¼ of a disk revolution. The CPU maintains an absolute level measurement based on the level calibration count provided to monitor the health of the back-up battery. When battery voltage indicates the battery is near the end of its life, the CPU transmits a battery low indication to the MFT.

The power supply converts input power from the HART bus into the voltages necessary for normal encoder operation. The power supply limits current from the HART bus to 8 mA.

6.9 Battery Module

The battery module is a potted module containing a lithium non-rechargeable battery, series fuse, and current limit resistor. The battery has a 14-day or more active life and a ten-year shelf life. Under normal operating conditions, the battery should provide ten years of maintenance free operation.

6.10 Enclosure

The enclosure houses all of the components of the 4110 HLE and attaches to 2500 ATG or equivalent tank gauges. The enclosure is environmentally sealed, explosion proof, and provides external 268 HHT access to the HART bus.

7 Order Codes

	Approvals	
	A	FM
	B	CSA
N4110		Complete product designation

Notes

Your official representative

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