Sarasota HME900

Headmounted Electronics
User Guide
P/N HB-HME900

Revision D

Part of Thermo Fisher Scientific

Thermo SCIENTIFIC

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User Guide

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Revision D

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NOTICE

Read this manual before working with the product. For personal and system safety, and optimum product performance, make sure you thoroughly understand the contents before installing, using or maintaining this product.

For equipment service, please contact Thermo Fisher Scientific.

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SECTION 1

General Description

Function

The headmounted electronics unit (Series II HME900) consists of a complete density converter and calculations unit. The unit accepts period and thermometry inputs from a density meter, plus an additional 4 – 20 mA pressure input from a separate transducer, if required. The unit calculates line density and other density related variables available, as noted, in the calculations section of this manual.

Assemblies and Connection

The assembly consists of two circuit cards, one containing the processing, and converter elements, the other the field interface and intrinsic safety isolation components. These two cards replace the standard interconnection PCB in the frequency output density meter, intercepting the period and RTD connections in the terminal enclosure and replacing the frequency and RTD outputs. The six connections of the frequency output density meter are replaced by the density meter supply (terms. 1 & 2), HART signalling loop (terms. 3 & 4), Headmount pressure TX supply (terms 5 & 6) and the separate pressure TX connections (terms. 7 & 8).

Input / Output Isolation

The three separate input elements have been galvanically isolated to standards required to enable each field circuit to be considered as a separate intrinsically safe circuit (see the section on IS Installation).

Upgrade (IS Versions)

The headmounted electronics can be retrofitted to Series II (ATEX) approved frequency output density meters (900F series). However, because of differing intrinsic safety input / output parameters between the certified frequency output density meters and headmounted electronic versions, IS labels can only be fitted to those headmounted units modified at Thermo Fisher, or units modified in the field by Thermo Fisher approved service engineers.

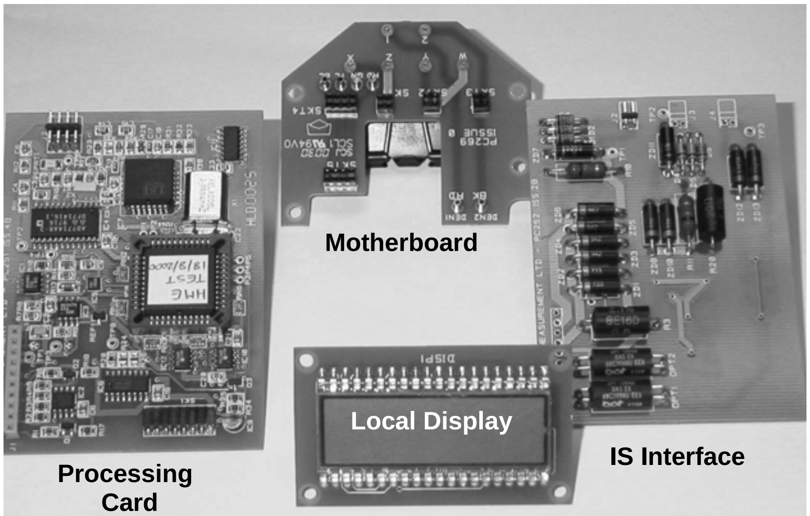
Upgrade (EEXd Versions)

The EExd certified version of the Series II 900F density meter may be modified in the field by simple replacement of the circuit cards, without recourse to Thermo Fisher trained personnel as the frequency and headmounted electronics versions share a common certificate.

Options

The integral local display option, available with the headmounted electronics module, is an LCD display mounted in the terminal box. The display is digital and driven by the headmounted electronics. This display option is not available without the headmounted converter option.
The local display unit has the option to display the Primary Variable (PV) output in engineering units or to oscillate between engineering units and percent full-scale. This option is switch selectable on the display PCB.

PCB Assemblies



The HME c onsists of th ree PCB cards and a motherboard (already present in the density meter), an IS interface card, a processing card and optional local display. The processing card and IS interface are joined with a flex-circuit.

PCB Assembly Mounted

The PCB assemblies mount within the terminal box held in place by card guides and a simple closure. The closure is held in place with two part plastic rivets. See disassembly / assembly section.

SECTION 2

Specification

Note: This specification relates to the electronics unit only.

Inputs

Temperature

Input type	PT100 RTD (density TX)
Range	-200 to +200°C
Resolution	Better than .0015%
Accuracy at reference (20°C)	±0.1°C (-200 to + 200°C) ±0.05°C (0 to + 200°C)
Drift (-20 to + 50°C)	±0.05°C (typical), ±0.1°C (max)

Pressure

Input type	4-20mA
Resolution	Better than 0.01%
Accuracy at reference (20°C)	Better than 0.1% point
Drift (-20 to + 50°C)	±0.1% (typical), ±0.2% (max)

Period

Input type	Current pulse 6 –18mA
Period input (3 ranges)	10 ms – 250 us (100 to 4000 Hz)
Standard range	2500us to 250 us (400 to 4000 Hz)
Resolution	±2 ns
Accuracy at reference (20°C)	As resolution
Drift (-20 to + 50°C)	±25 ppm (typical), ±50 ppm (max)

Outputs

4 – 20 mA HART

Output type	4 – 20 mA
Operating voltage	13 – 28 VDC at terminals
Resolution	0.015% span
Accuracy at reference (20°C)	±0.1% of point
Drift (-20 to + 50°C)	±0.08% FS (typical), ±0.175% FS (max)

Local Display

4.5 Digit 7 segment LCD display
Resolution 0.1 or 0.01% depending on display variable

Other Input / output

Density Supply

Operating voltage	13 – 28 VDC at terminals
Current	Modulated at density meter frequency 6 to 18 mA

Enclosure Temperature (PCB mounted PRT)

Measurement element	100 ohm PRT
Accuracy	±0.5% point
	-40 to +80°C
Range	-20 and +60°C
Alarm points	

SECTION 2

Specification

Environmental

Enclosure Ingress Protection	IP65
Ambient Temperature	-20 to + 60°C
Humidity	95% Non condensing
Electromagnetic Compatibility	Meets the requirements of EN61326 (2006)

Hazardous Area

Intrinsic Safety	EEX ia IIC T4 (ambient = -20 to +60°C) ATEX certificate
Flameproof	EEX d IIC T4 (to 120°C process temperature) EEX d IIC T3 (to 180°C process temperature) (only when mounted on FD910, FD950 or FD960 density meter)

SECTION 3

Mechanical Configuration

900F to 900H Upgrade

Note: To ensure correct supply of upgrade parts the user must supply the original density meter serial number, sales order number and mod state information.

The upgrade of a 900F Series II d ensity meter to a 900H version requires the removal of the existing interconnection PCB (PC270), the insertion of the HME card assembly (two cards joined by a flat interconnection cable and the addition of a new terminal designation label.

Modification of IS 900F Series II meters may only be carried out by Thermo Fisher, or Thermo Fisher authorised personnel.

If the unit is to be labelled as Intrinsically Safe then a new Intrinsically safe label plate must be fitted. This label will only be issued to Thermo Fisher approved engineers.

Removal and Replacement of Printed Circuit Cards

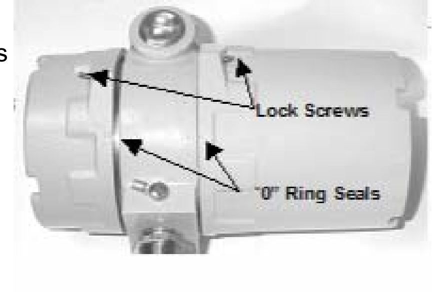
To gain access to the electronics cards for change / replacement the electronics enclosure cover must be removed by u ndoing the anti-vibration screw and unscrewing the larger of the tw o covers. Once access to the electronics has been gained the PCB retention bracket must be removed by removing the four two part plastic rivets as shown in the diagram overpage.

Once the interconnection PCB (P270) has been removed the HME PCB set (PC251 + PC252) can be introduced into the card enclosure. Ensure the connectors for each card locate correctly in the back plane. Once the cards have been introduced then either the o riginal electronics card retention bracket can be replaced or, if a local display option is to be fitted, the module fitted in place of the retention bracket (ensuring the connections are correctly mated). Th e two part plastic rivets are then replaced and a new mod state label fitted. If a local display option has been added then replace the original electronics enclosure cover with the replacement windowed cover and retighten the anti-vibration screw.

Having modified the electronics it is now necessary to add a n ew terminal designation label. To do this remove the terminal compartment cover (after releasing the ant-vibration screw), degrease the area where the label is to be fitted using Isopropyl Alcohol or similar solvent and fit the self adhesive label.

Terminal box Electronics Cover

The terminal box consists of two Compartments: a large electronics enclosure and a smaller terminal enclosure. Both the electronics and the terminal covers are locked closed with a tamperproof set screw. This must be loosened before unscrewing the cover.



Removing PCB

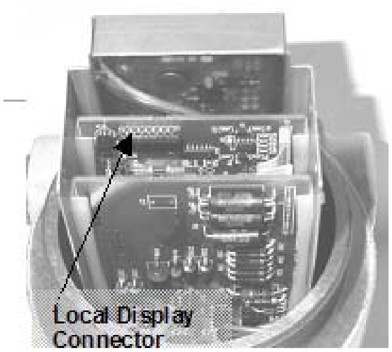
To remove / change PCB's the plastic rivets (4 off) and the retention bracket must be removed.

The PCB's and card guides are then accessible.

Replacing PCB's

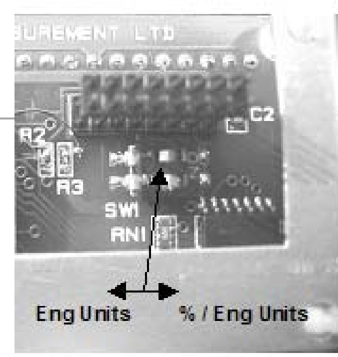
When replacing the HME PCB's care must be taken to ensure location of the connectors and of the board linking ribbon cable.

Note the connector for the local display option.



Local Display (operation)

The local display has an option switch (SW1). The switch has two poles. Pole 1 (indicated) controls the display such that when closed (to the right) the display is engineering units and when open (to the left) the display switches between engineering units and percent full scale every 5 seconds.



Local Display (Units)

The local display has an escutcheon containing pockets for the variable name and units. The name and units are available on a sheet (supplied). The required names and units should be removed from the sheet and slipped into the required pocket. The plastics rivets holding the escutcheon in place also locate the name and units labels.

SECTION 4

Electrical Installation

General

Installation of a density meter, with the headmounted electronics option, requires the connection of two supply loops, a density meter supply and a HART signal supply. The connection terminals are suitable for wire sizes up to 4mm square cross section

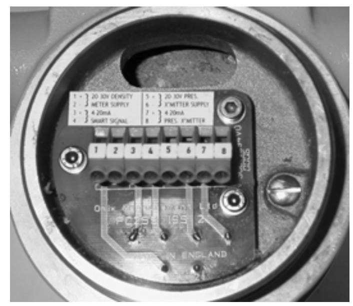
Cable

Recommended cable type: BS 5308 part 1. 1986. Type 2 Polyethylene insulated, bedded, single wire armoured, PVC sheathed. 0.5 mm square 16/0.02 multi-pair with individual pair screens.

The number of pairs required depends on whether or not a pressure transducer is required. If no pressure transducer is required then 2 pairs are sufficient.

Connections

The picture on the right shows the termination arrangements in the terminal box. Connections are:

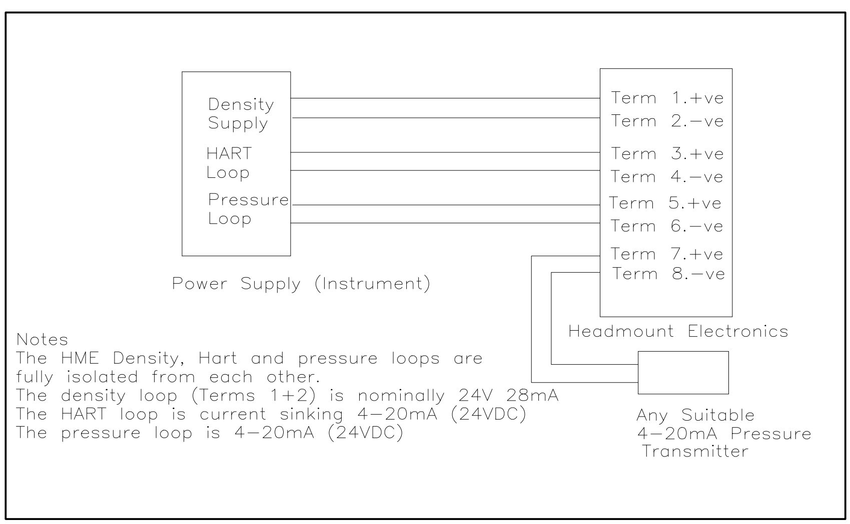


1. Density Meter: +ve supply input.
2. Density Meter: –ve supply input
3. HART 4: – 20 mA +ve supply input
4. HART 4: – 20 mA –ve supply input
5. Pressure transmitter: +ve supply input
6. Pressure transmitter: –ve supply input
7. Pressure transmitter: +ve supply output
8. Pressure transmitter: –ve supply output

Input Voltage / Currents

The drawing below shows the schematic connection diagram for the headmounted electronics. The individual loop currents and voltages are:

- Terminals 1 + : Nominal voltage 24V; current pulse at density meter period 6mA to 16mA (typical)
- Terminals 3 + 4: Nominal voltage 24V; current 4 – 20 mA
  3.8 mA indicates variable below zero point } Alarm Point
  20.3mA indicates variable above full scale }
- Terminals 5 + 6: Maximum voltage 30V; nominal voltage as pressure transducer current 4 – 20 mA
- Terminals 7 + 8: As pressure transmitter, limited by max 30V input into terminals 5 + 6.



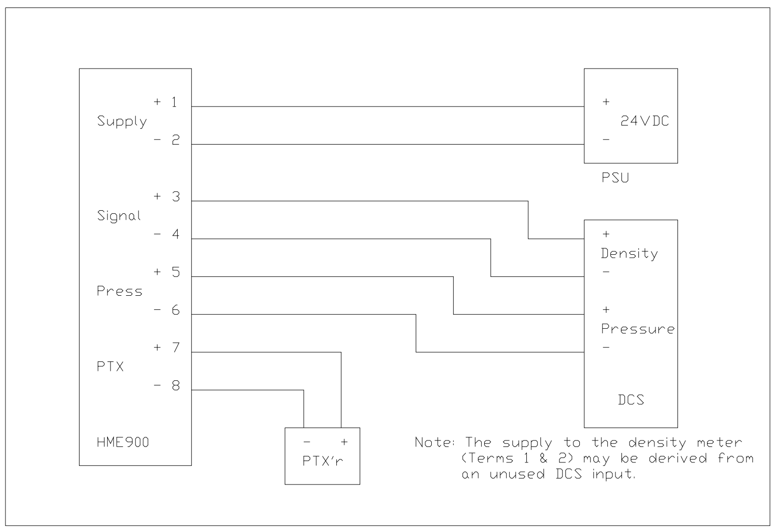
Connection to Control Room Equipment

When connecting to control room equipment or a DCS the following should be noted.
The three main loops (density meter, HART and pressure transducer) are isolated.

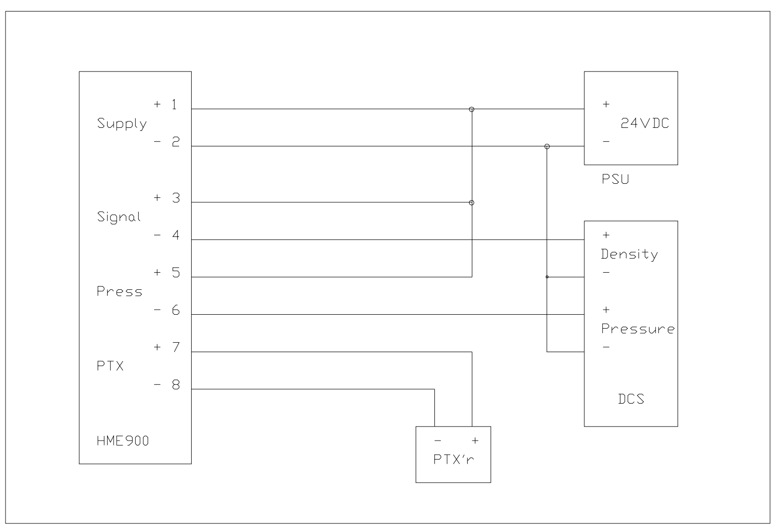
- The density, HART and pressure transducer loops all require power from the control room equipment or DCS.
- Because the HART Loop is fully isolated is can be considered as current sinking (into the +ve input) or current sourcing (from the –ve input).
- No pressure input is required if a "Fixed Pressure" is set during the instrument configuration. (See configuration).
- Where a pressure input is required, and a pressure transducer is already in use then the signal cabling may be re-routed via the headmounted electronics with minor changes to the field wiring and no change to the previously installed control room instrumentation or signal configuration.

The following drawings show typical methods of installation.

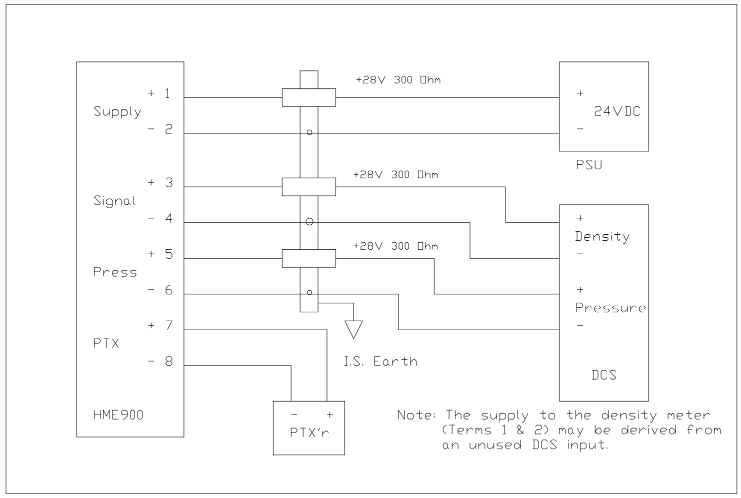
Sourcing Current into DCS (With Pressure Transducer)



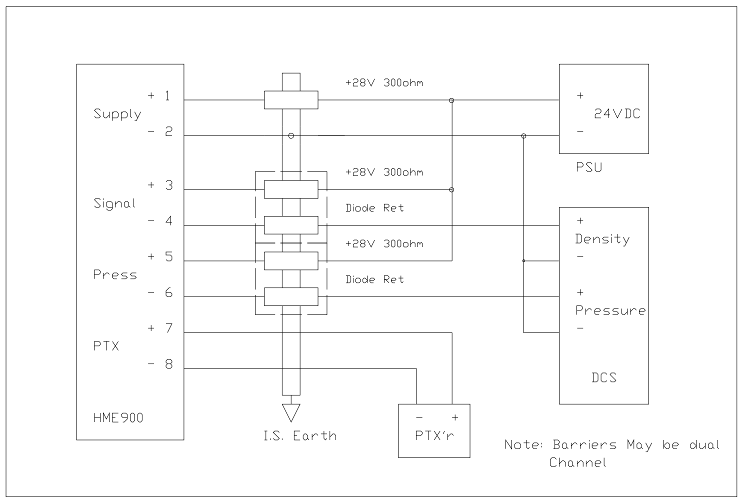
Sinking Current from DCS (With Pressure Transducer)



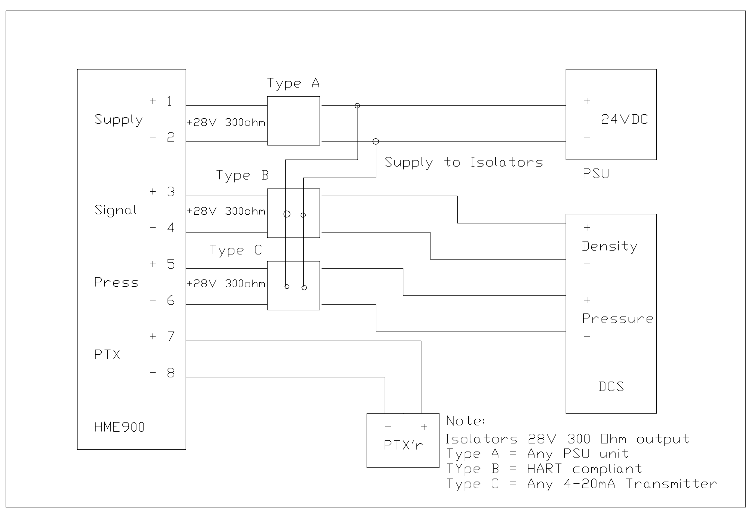
Current Sourcing Using Zener Barriers



Current Sinking Using Zener Barriers



Connection Using Galvanic Isolators



HART considerations

General

The HME900 is tested and configured during manufacture. If HART protocol is to be used in the field to interrogate or re-configure the instrument some special precautions must be taken during installation.

FSK Frequencies

HART protocol transmits and receives data from the field instrument using an FSK (Frequency Shift Keying) code. The code consists of two frequencies (12200Hz and 2200Hz) where 1200Hz represents a logical "1" and 2200Hz represents a logical "0". The protocol is a "Master / Slave" type, where the field instrument is the "Slave", only responding with data when requested by a "Master".

The protocol is designed to operate with 4 – 20mA transmitters, where the Slaves (Field Instruments) send data by modulating the current loop at 1200 and 2200 Hz while the Master sends data by superimposing a modulating voltage at 1200 and 2200 Hz.

Supply Impedance

To operate correctly the supply voltage to the field instrument must have sufficient impedance to allow the field voltage to be modulated by the Master. Sufficient impedance is also needed to allow the current modulation generated by the slave to be read as a voltage by the master. (If the supply impedance was zero then the supply would remain constant no matter what voltage was superimposed).

The HART specification requires a device supply impedance in the range 230 to 1100 ohms to work correctly. As long as this impedance exists in the supply then a HART talker (master or secondary master) can be connected across the load resistor or terminals of the slave device.

Barriers / Isolators

When barriers are used care must be taken to ensure the barrier does not saturate (removing the additional superimposed HART signal).

Where galvanic isolators are used only those types suitable for use with HART devices should be used.

Cable / Power Supply Considerations

As well as HART device load resistance, the following cabling and supply requirements must be met:

The product of the load resistance and the cable capacitance must be less than 65 (Resistance in ohms, capacitance in Micro-Farads)

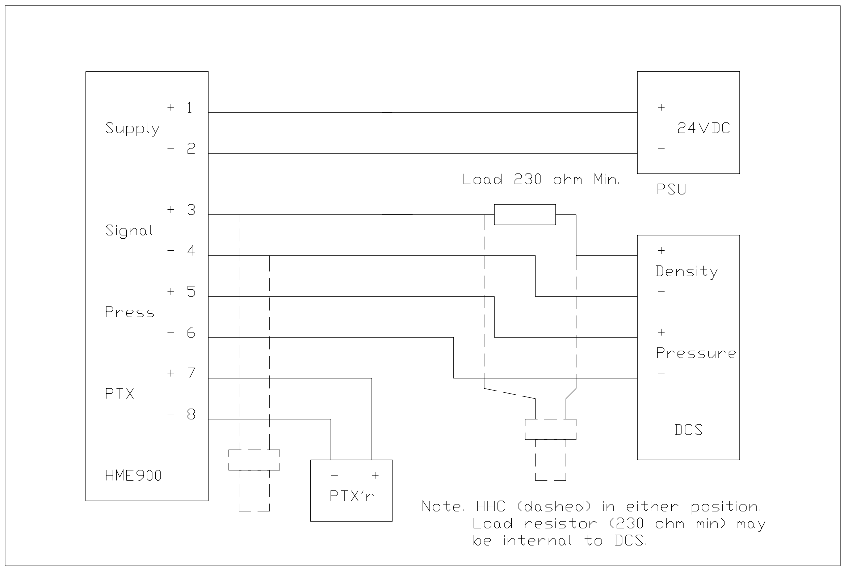
- The power supply ripple (47 – 125 Hz) must be less than 0.2Vpp
- Power supply noise (500Hz – 10KHz) must be less than 1.2mVrms
- Power supply internal impedance (not including HART load) less than 10 ohms*

*When a single supply is used to power several HART Devices.
Care should also be taken when connecting other active devices into a HART loop.

Connecting HART Communicators Non – hazardous area / Exd Systems

As already noted, for HART communications to take place the impedance of the supply loop must be a minimum of 230 ohms.

Where the loop has an impedance lower than 230 ohms an additional resistance must be added to the system. Where the added resistance is greater than 230 ohms the communicator can be connected directly across the resistor, otherwise the communicator may be connected directly across the signal terminals.

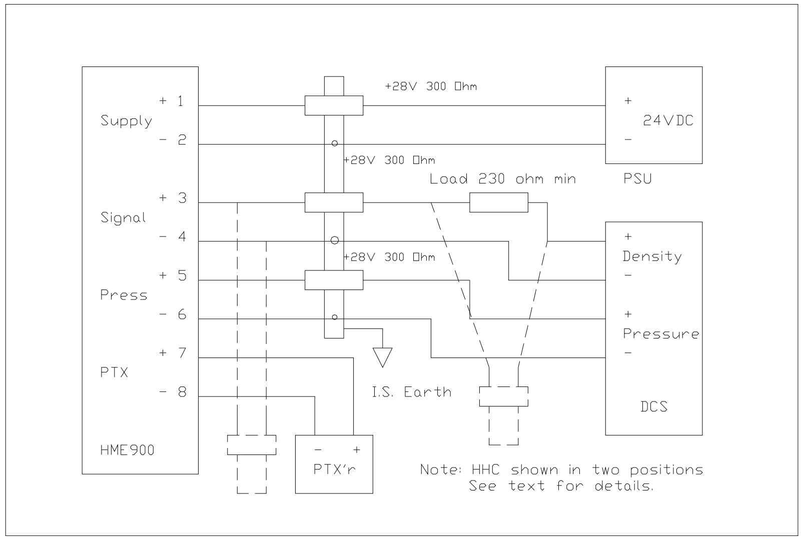


Intrinsically Safe System with Zener Barriers

Where barriers are used and the power supply has an impedance greater than 230 ohms the communicator may be connected directly across the power supply or load in on the safe side of the barrier.

Alternatively the communicator may be connected across the supply on the Hazardous side of the barriers, with the barrier impedance acting as the load.

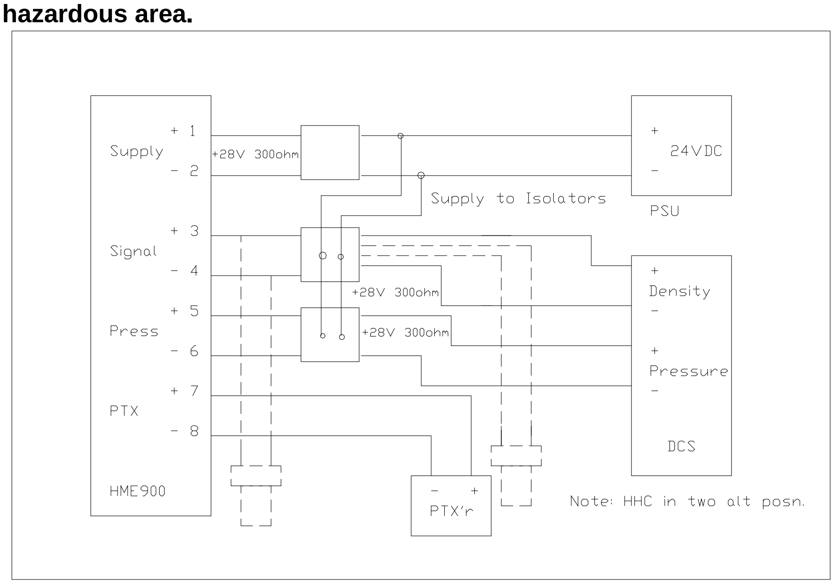
The disadvantage of connecting on the safe side of the barrier is that the barrier impedance, combined with the cable capacitance, may make communications impossible because of attenuation or excessive CR time constant.



IS Systems with Galvanic Isolators

Where galvanic isolators are used the communicator can (if the supply has high enough impedance) be connected across the safe area signal loop. However, communications are often better if the communicator is connected across the isolator output. Several HART type isolators have special safe area connections for the communicator. These terminals normally meet the impedance requirements for satisfactory communications.

Note: **If connection is made to the hazardous side of an IS interface the equipment connected must be suitable for connection in the hazardous area.**



Installation in Flammable Atmospheres

General

The headmounted electronics are certified as EEx ia IIC T4 when mounted on a FD/ID/PD900 series density meter, or EEx d IIC T3/T4 when mounted in an EExd certified FD9X0 density meter.

When making a flameproof installation no special circuit requirements are required. It is only necessary to use suitable cable and suitable glands.

When making an Intrinsically safe installation care must be taken to ensure that the system (including the density meter) is safe for the zone and atmospheres involved.

Care must be taken to ensure that relevant national or international standards and codes of practice are adhered to and that the input parameters for the hazardous area equipment are not exceeded. The following is given as a guide. However, the user should still ensure the information is correct and up to date by consulting relevant standards during installation.

Requirements

An intrinsically safe system including the headmounted electronics must combine all of the following:

- Certified Instrument (900 Series density meter)
- Associated apparatus designed and certified to limit voltage current and power to required values
- Interconnection cable of suitable specification such that the total capacitance and inductance (or L/R ration) does not exceed the values noted in EN50020 (latest revision) for the voltages concerned (See note on C + L Calculation)
- When required (i.e. with Zener Barrier systems), an approved Intrinsically safe earth

Certification Details (Parameters)

The Headmounted Electronics is certified to ATEX certificate Number BAS01ATEX1002X. The X indicates special requirements within the certification, which is noted on the certificate. Where the certificate includes an X suffix the vendor should supply a complete copy of the certificate with the goods.

The main details as noted on the certificate are shown below. However, the user should check the information against the supplied certificates.

Input Output Parameters:

Amplifier Terminals 1 & 2

Ui = 28.5V	**(Maximum input voltage)**
Ii = 100 mA	**(Maximum Input Current)**
Pi = 0.7 Watts	**(Maximum Input Power)**

HART Input Terminal 3 & 4

Ui = 28.5V	**(Maximum input voltage)**
Ii = 100 mA	**(Maximum Input Current)**
Pi = 0.7 Watts	**(Maximum Input Power)**

Continued: Certification Details (Parameters)

Input Output Parameters (Continued)

Pressure Tx Supply Terminals 5 & 6

Ui = 28.5V	**(Maximum input voltage)**
Ii = 100 mA	**(Maximum input current)**
Pi = 0.7 Watts	**(Maximum input power)**

Pressure Tx input Terminals 7 & 8

Uo = Ui (Terms 5 & 6)	**(Maximum output voltage)**
Io = Ii (Terms 5 & 6)	**(Maximum output current)**
Po = Pi (Terms 5 & 6)	**(Maximum output power)**

Associated Apparatus

Suitably certified Associated Apparatus (Zener Barriers or Galvanic Isolators) must be used to limit the maximum voltage, current and power input into each terminal pair to no higher than the noted values.

In general a Barrier or Isolator certified with a safety description 28V 300 ohm, suitable for ‘ia’ operation will limit the input parameters to 28V, 93mA and 0.66 Watts. This is suitable for each of the inputs.

In general a barrier (zener type) will require an intrinsically safe earth connection (busbar). Isolators will not need an intrinsically safe earth.

Cable Parameters

Cable parameters for intrinsically safe systems must be such that energy stored in or available for release during cable open circuit or short circuit (faults or operations) cannot cause ignition of the flammable atmosphere.

Figures quoted are taken from EN 50020 (1994) for a 28 volt 300 ohm supply.

Gas Group	IIC	IIB	IIA
Capacitance micro-farads	0.083	0.65	2.15
Inductance mH	3.05	9.15	24.4
L/R uH/Ohm	56	210	444

The figure given are the maximum allowable (including a factor of safety) for each of the gas groups. When considering the reactive parameters of the field wiring the user has to consider the whole of the stored energy, inductive and capacitive, that may be released during a cable fault (short or open circuit).

This total energy comes from three possible sources:

- The energy stored in the barrier or isolator (Associated Apparatus)
- The energy stored in the cable
- The energy stored in the hazardous area equipment (Apparatus)

To enable the user to make a safe estimate of the total inductance and capacitance of the system component certified IS Apparatus and IS Associated Apparatus is certified with Input / output parameters including equivalent Capacitance and Inductance, (Ce and Le).

Continued: Cable Parameters

The maximum stored power, capacitive and inductive, will be proportional to the sum of the equivalent capacitance of the associated apparatus barrier / isolator) the capacitance of the wiring and the equivalent capacitance of the IS apparatus. Similarly the inductive energy will be proportional to the sum of the equivalent inductance of the associated apparatus (barrier / isolator) the inductance of the wiring and the equivalent inductance of the IS apparatus. The sum of these three should **never exceed** the total figure given in the table above (for a 28V 300 ohm system).

In the case of the headmounted electronics the terminals are assessed as having zero equivalent inductance and capacitance appearing at the terminals, so the user only has to take the barrier / isolator inductance and capacitance into account when estimating maximum allowable cable inductance / capacitance.

Total cable capacitance = Max allowable capacitance (from standards) less equivalent capacitance of the barrier / isolator.

ATEX Certified Barriers And Isolators

For ATEX certified isolators or barriers the maximum output and cable parameters are noted on the certificate.

In these cases the sum of the reactive components of the cable and field apparatus should not exceed the values noted on the barrier / isolator certificates.

Other Considerations For use in Hazardous Areas

See appendix A for other notes on considerations for use of electrical equipment in flammable atmospheres.

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SECTION 5

Use and Configuration

General

The headmounted electronics unit is fully configurable via HART protocol. The unit can be interrogated and configured using either a Rosemount 275 HHC (Hand Held Communicator), with the Sarasota DD (Device Descriptor) for full configuration, or with WinHME (Thermo Fisher's configuration program) running on a PC using a HART serial port modem adapter.

If no communicating device is available limited diagnostics is available. See below.

4 – 20mA Error Outputs

The headmounrted electronics (without local display or HART interrogation device) has limited error-signaling capability.

The current output (normally 4 – 20mA) has no normal over or under range capability. If the calculated output is less then the configured zero (LRV, Lower Range Value) the current output will be set to 3.8mA. If the calculated output is greater then the configured full scale (URV, Upper Range Value) the current output will be set to 20.8mA.

If either of these values appear at the output then the unit is in a fault condition. (Most probably an out of range error).

Error Display

If a local display is fitted then a number of error codes may be displayed as follows:

- Error 01 LSL (Lower Sensor Limit) alarm
- Error 02 USL (Upper Sensor Limit) alarm
- Error 03 EEPROM (Electrically Erasable Programmable Read Only Memory) error
- Error 04 ADC (Analog to Digital Converter) error
- Error 05 Pressure input error
- Error 06 PRT input error
- Error 07 Period input error
- Error 08 RAM (Random Access Memory) error
- Error 09 ROM (Read only Memory) error

Configuration

General

The headmounted electronics is configurable by the user using HART protocol. The configuration can be broken down into 7 main sections.

Standard HART Data

Allows entry of range values, tag numbers etc.

Transducer Constants

Entered by the user (T0, D0 and K, TC and PC). All constants relating to the connected density transducer, obtained from the calibration certificate.

HME Configuration

Allows selection of calculations, transducer type, input types, etc.

Pressure input

Allows selection of transducer range.

Calibration

Not available to the user. The user can restore factory calibration settings if the calibration is corrupted in any way.

Dynamic Variables

A HART device can have four output variables. The primary variable drives the 4 – 20 mA loop and is displayed on the local display when fitted. The other three variables are available in digital form to a HART reader. All four variables can be read by the user.

CDF Setup

Allows the user to define a density-related function via a user entered table of data (Customer Defined Function).

Other Information

Device Information Allows the user to read the HART device information regarding the density meter.

Calibration data The user can view hardware calibration constants for checking.

Detail Configuration

This section is written assuming configuration using the Thermo Scientific WinHME PC program. All Win HME functions except CDF writing are available using the Rosemount 275 Hand Held Communicator with the Sarasota DD.

Installing Win HME

Win HME software is installed by copying from the supplied disc to the required Windows folder on the PC to be used. A short cut may be located on the desktop if required.

The minimum requirements to run Win HME are:

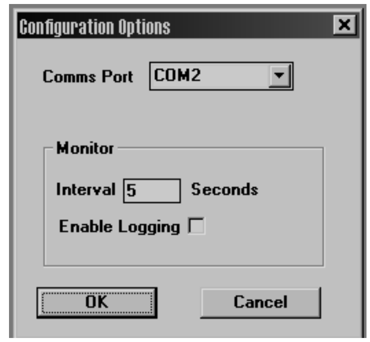
- Any PC running Windows 3.1 or later
- 0.5 M-byte hard disc (or run from floppy)
- RS232 communications port
- plus a HART compatible modem

Starting Win HME

On starting Win HME the following window will be displayed ►

This allows the user to configure:
Comms Port:
The port to which the HART modem is connected.
Interval:
Update interval of the monitor or logging software if enabled.
Enable Logging:
Enables the four variables to be logged (background task).

Note that the serial protocol is automatically set to that required by HART (1200 Baud 1 start 8 data parity and 1 stop bit).



Unit Search

After initial configuration of the communications and clicking on OK the following window will be added. ►

HART allows slave devices to be given unit numbers. Unit number 0 allows the slaved device to have a 4 – 20 mA output. Unit numbers 1 to 15 allow multi dropping but disable the current output, fixing it at 4 mA so that data may only be read via HART protocol.

Address 0

This is the normal address for a single 4 – 20 mA device and should be selected in most cases

Broadcast Command

When the address of the unit is unknown and only one is connected then the “Broadcast command “ may be used. This is a command from the master device that changes the unit address of any connected HART device to zero. The unit answers as unit address zero. Note that the unit address (nickname) may require changing after communication.

Global Search

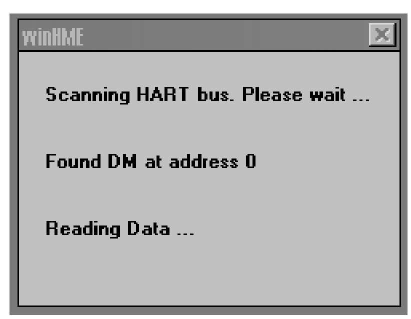
When a number of devices are multi dropped the “Global Search” command interrogates each address in turn, opening a file for each device found

Reading Data

As Win Hme reads data from a device it will display the window shown. This shows the address of the current device being read.

If no device is found then an additional window will display one of the following responses:

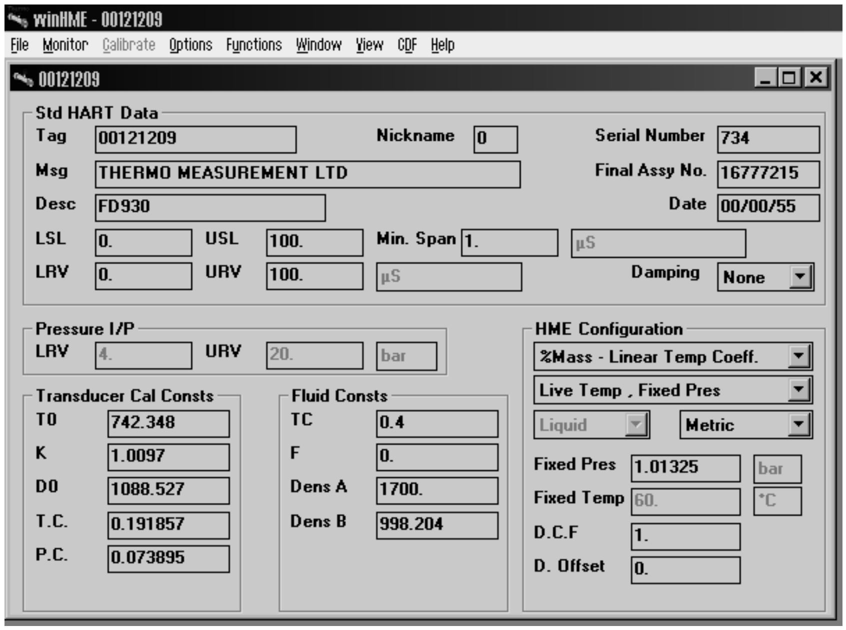
No Hart Unit found at address 0. Would you like to try a Broadcast Command?



No response to Broadcast Command. Please check connections and try again later.
No HART communicators found. Please check connections and try again later.
If asked to try again then the configurations option window (Comms Port, etc.) can be re-opened from the **Options** drop down menu position.

Main Screen

Having read the data from a device the main display (shown) is displayed. Data can be changed by deleting a particular location box and re-entering data. Note that data is written to the HART device on the return / enter keystroke, after entering data.
The Standard HART Data is listed below.



Tag

Any user entered string up to 8 characters long

Message

Any user entered string up to 32 characters long

Description

Any user-entered string up to 16 characters long (Normally set as the instrument type)

LSL

Lower Sensor Limit Lowest value sensor output can be set to (corresponds to lowest cal range of sensor)

USL

Upper Sensor Limit. Highest value sensor output can be set to (corresponds to highest cal range of sensor)

LRV

Lower range variable Value for 4 mA output (Zero value)

URV

Upper range variable. Value for 20mA output. (Full scale value)

Min Span

Minimum allowable span value (URV – LRV)

Nickname

Unit address 0 – 15. Note that only 0 allows a 4 – 20mA output. If a unit address outside the range 0 – 15 is entered the unit address will not be changed.

Serial Number Any integer value in the range 0 – 16777215

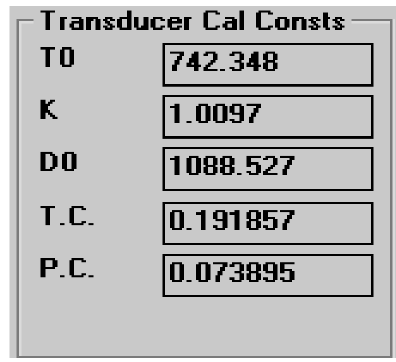
Final Assy Number Any integer value in the range 0 – 16777215

Date DD/MM/YY

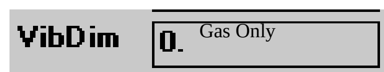
Damping 0 – 32 seconds (0, 1, 2, 4, 8, 16, 32 secs) Equivalent to the same C*R time constant.

Note that the units for the PV variable are set automatically on assignment of variables.

Transducer Constants These are the calibration constants, unique to the density transducer connected to the headmounted Electronics and are found on the calibration certificates issued with the transducer.



The constants used are those at **15°C**. For a gas density meter two sets of constants are given. One set for VIBDIM = 0 and one for VIBDIM = val.



Note: Constants are examples only

VIBDIM is a constant related to the velocity of sound of the gas in a gas density meter. If the gas being measured is a hydrocarbon then use the cal data for VIBDIM = val else use the cal data for VIBDIM = 0.

VIBDIM is not made available on the setup screen if a liquid meter is connected.

T0 Calibration constant relating to period output of the meter at zero density

K Fit correction factor for the meter (normally close to 1)

D0 Calibration constant relating to the density at zero period.

TC Transducer temperature coefficient (change in period output per degree change of temperature from calibration temperature).

PC Transducer pressure coefficient (change in period output per unit change in pressure from calibration pressure).

Vibdim Velocity of sound correction constant for gas meters. (Not available when connected to a liquid meter)

Fluid Constants

General

These are the constants relating to the fluids being measured. The constant list changes dependent on the HME configuration (liquid / gas). This is set by code embedded in the HME900 being read.

Liquid Constants

TC The change in density (kg/m^3 or lb/ft^3) from reference temperature (15°C or 60°F).

F Constant Compressibility factor. (Kg/per mega bar or Lb/Ft^3per mega psi)

DensA Reference density of component A in a binary, i.e. two part, mix

DensB Reference density of component B in a binary mix. (A & B used to calculate % mass or % vol of A in a mix)

Gas Constants

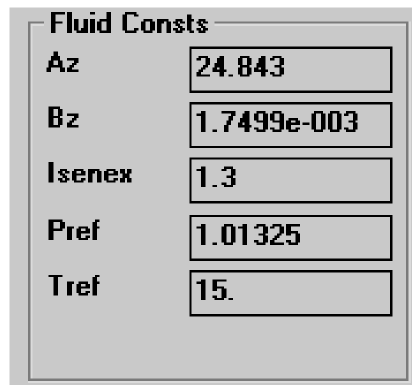
Az Redlich Kwong Equation of state constants (used in calculation of compressibility)

Bz Redlich Kwong Equation of state constants (used in calculation of compressibility)

Isenex Isentropic Exponent (Ratio of specific heats for the gas Cp/Cv)

Pref Reference Pressure (barA (metric) psiA (Imperial))

Tref Reference Temperature (°C (metric) °F (Imperial))

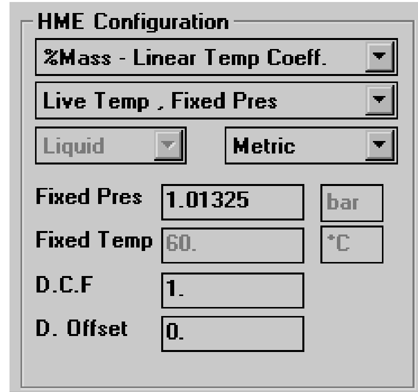


Note: Constants are examples only

HME Configuration Panel

This panel allows the user to configure the calculations, input live or fixed values, units (metric or imperial) and density correction values. The panel consists of three user selectable drop down menus to select configurables and data locations for fixed values (if used) and density correction factors.

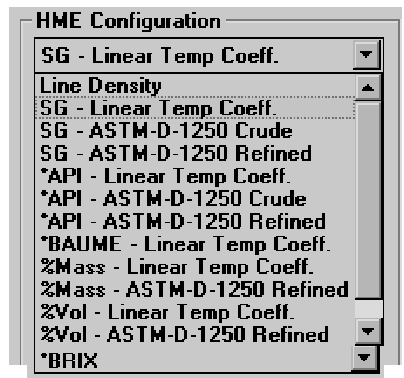
The operation is listed in the order of the drop down menus.



First Dropdown

This section allows the user to select the equations to be carried out in the headmounted electronics. Again the lists of available functions change depending on whether the transducer type is liquid or gas.

Liquid Transducers



Line density — Actual density at the density meter at line temperature and pressure.

SG Lin TC — Specific gravity calculated from reference density using a linear temperature coefficient (entered as TC in Fluid Constants).

SG ASTM Crude — Specific gravity calculated from density at reference using ASTM-D1250 with K0, K1 and K2 for crude oil.

SG ASTM Ref — Specific gravity calculated from density at reference using ASTM-D1250 with K0, K1 and K2 for refined products.

°API Lin TC — Process gravity calculated from reference density using a linear Temperature Coefficient (entered as TC in Fluid Constants.)

°API ASTM Crude — Process gravity calculated from reference density using ASTM-D1250 with K0, K1 and K2 for crude oil.

°API ASTM Refined — Process gravity calculated from reference density using ASTM-D1250 with K0, K1 and K2 for refined products. (See *)

°BAUME Lin TC — Gravity calculated from reference density using a linear temperature Coefficient (entered as TC in Fluid Constants).

%Mass (Lin TC) — % Mass of product A by calculation of density at reference conditions of products A and B using the single entered (average) linear temperature coefficient for the mixed fluids.

%Mass (ASTM) — % Mass of product A by calculation of density at reference conditions of products A and B using ASTM-D-1250 constants for refined fluids.

%Vol (Lin TC) — % Volume of product A by calculation of density at reference conditions of products A and B using the single entered (average) linear temperature coefficient for the mixed fluids

%Vol (ASTM)

% Volume of product A by calculation of density at reference conditions of products A and B using ASTM-D-1250 constants for refined fluids

°BRIX

Calculates BRIX value of sugar solutions over the range 0 – 89%, 20 – 80°C.

Pressure Factor

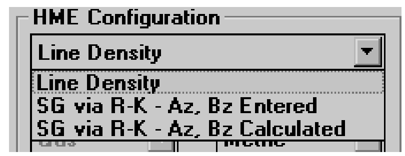
Special Notes (Liquid Density at Reference Conditions)

Regardless of the liquid temperature compensation used (Linear TC or ASTM) pressure compensation is carried out using the constant compressibility factor F. F should always be entered. If no pressure compensation is required F should be set equal to zero.

ASTM constants are fixed for crude oil but change depending on calculated reference density when the refined product calculation is used.

Gas Transducers

The user has the choice of measuring line density or line density and SG.



Line Density

SG and other density related variables are not available

SG RK Entered

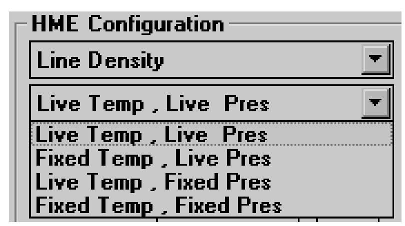
SG is calculated from pressure, temperature and compressibility. Compressibility is calculated using the Redlitch Kwong equation of state with Az and Bz values entered by the user.

SG RK Calc

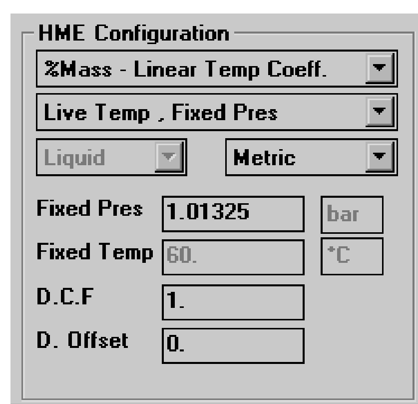
SG is calculated from pressure, temperature and compressibility. Compressibility is calculated using the Redlitch Kwong equation of state. The values of Az and Bz are calculated from molecular weight. The equation used to calculate Az and Bz is a fit and only suitable if the gas mixture is predominately hydrocarbon gas.

Input Configuration (Second Drop Down)

The inputs associated with the density meter are period, temperature and pressure. The period input is always live, from the density transducer. The temperature and pressure inputs can be live (from the internal PRT and external pressure transducer) or fixed by the user. The drop down box gives the choices available.



Other Elements Of Configuration



Gas/Liquid

This cannot be changed by the user. It is read from the connected HME900.

Metric/Imperial

Drop down allows the user to select metric or imperial units. Note that the density meter calibration constants must be in the correct units. Calibration certificates are available in metric or imperial units.

Continued: Other Elements Of Configuration

Fixed Pressure

Pressure entered by the user. Note that this window is not available for change unless the pressure is selected as “Fixed”.

Fixed Temp

Temperature entered by the user. Note that this window is not available for change unless the temperature is selected as “Fixed”.

DCF

Density Correction Factor is a multiplier used to adjust the density transducer output when an error is noted. Density out = Density (line) * D.C.F..

D Offset

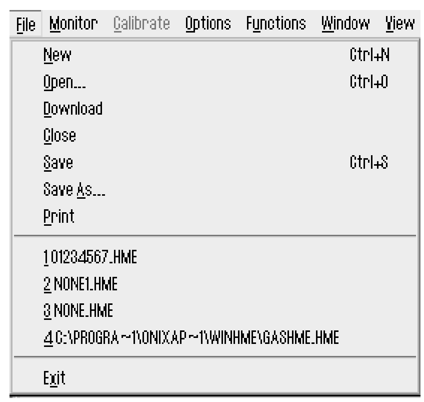
Allows the user to add an offset without affecting slope. Density out = Density Line + D Offset.

Pressure Transducer Scaling.

The pressure input is scaled by setting the LRV (4ma point) to the zero value of the transducer and the URV to the full scale value of the transducer. Note that the pressure must be entered in absolute units. If gauge transmitters are used then local atmospheric pressure must be added to the zero and full scale values before entering.

Menu Bar Functions

This section describes the drop down menus available on the menu bar



File Dropdown

File (New)

Not available to the user**.**

File (Open)

Allows the user to open a previously saved HME configuration data file for viewing in the active screen. Data can be modified and written back to the file.

File (Download)

Allows the user to download a previously saved (and modified if required) file to an operating headmount electronics unit. Note that this option may be used to restore data to a unit which has previously been “Saved”.

File (Close)

Closes the currently open details display. Does not save the data. Note that where multiple meters are being displayed on the active screen will be closed.

File (Save)

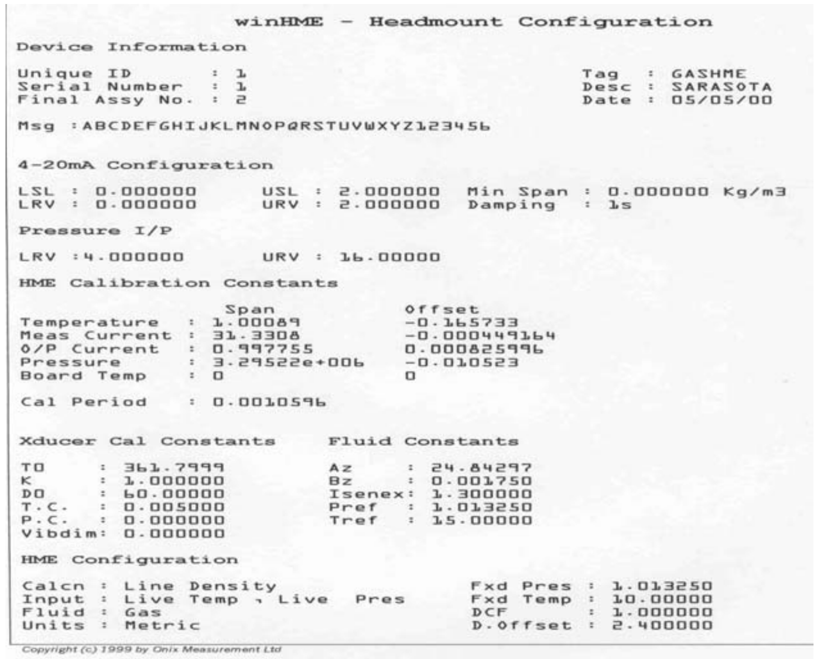
Saves the currently open and active configuration file. If the file has not been saved previously it will be saved with the default name “Current tag name”. HME. If it has been saved previously, and re-opened, it will be saved with the original name.

File (Save as)

Save the currently open and active configuration file with a new name.

File (Print)

Prints the currently opened configuration file on a form format for recording / filing.



```
                    winHME - Headmount Configuration
Device Information

Unique ID        : 1                                   Tag  : GASHME
Serial Number    : 1                                   Desc : SARASOTA
Final Assy No.   : 2                                   Date : 05/05/00

Msg  :ABCDEFGHIJKLMNOPQRSTUVWXYZ123456

4-20mA Configuration

LSL : 0.000000      USL : 2.000000   Min Span : 0.000000 Kg/m3
LRV : 0.000000      URV : 2.000000   Damping  : 1s

Pressure I/P

LRV :4.000000       URV : 16.00000

HME Calibration Constants

                    Span              Offset
Temperature    : 1.00089             -0.165733
Meas Current   : 31.3308             -0.000449164
O/P Current    : 0.997755            0.000825996
Pressure       : 3.29522e+006        -0.010523
Board Temp     : 0                   0

Cal Period     : 0.0010596

Xducer Cal Constants      Fluid Constants

TO      : 361.7999        Az     : 24.84297
K       : 1.000000        Bz     : 0.001750
DO      : 60.00000        Isenex: 1.300000
T.C.    : 0.005000        Pref   : 1.013250
P.C.    : 0.000000        Tref   : 15.00000
Vibdim: 0.000000

HME Configuration

Calcn : Line Density                    Fxd Pres  : 1.013250
Input : Live Temp , Live  Pres          Fxd Temp  : 10.00000
Fluid : Gas                             DCF       : 1.000000
Units : Metric                          D.Offset  : 2.400000
```


Example of Printed Report

Exit

Closes WinHME down.

Calibrate Drop Down

The calibrate function is not normally available to the user as calibration of the electronics cannot be carried out without suitable test equipment and connection jigs.

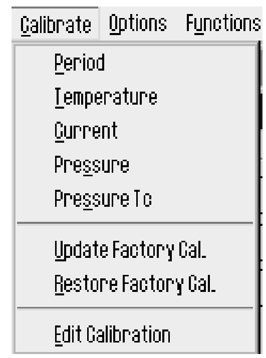
The calibration drop down can be enabled by starting WinHME from the command line and adding a space and then /C.

\WINHME.EXE /C.

It is not recommended that the slash C be left as the default start string.

Period

Factory use only.



Temperature

Factory use only.

Current

Calibrates the output current circuits. The unit switches to forced output current mode, applies a near 4mA current to the output loop. The user measures the current and enters the value. The instrument applies a near 20mA current to the loop; the user measures the value and enters the value. New calibration constants are calculated and down loaded to the headmounted unit. Note that the output current must be measured to 0.01% accuracy.

Pressure

This allows the user to calibrate the headmounted current input circuits. The unit requests current values to be input, the user injects the required current and new calibration constants are calculated and downloaded to the headmounted electronics.

Pressure TC

Factory Use Only.

Update Factory Cal

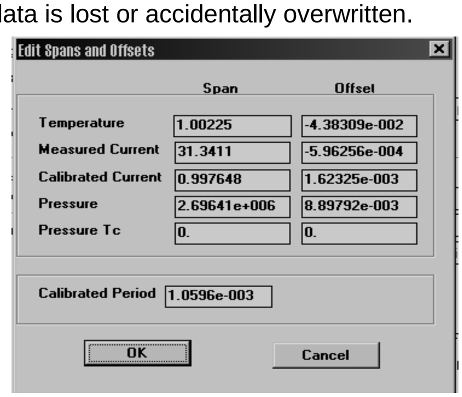
This should not be used except after a full factory calibration. This function causes the present calibration data to be moved to the "Factory Default Location". If bad data is moved to this location then only a full factory calibration can restore full instrument accuracy.

Restore Factory Cal

This causes the original factory calibration factors to be installed as the used calibration factors. This function should be used to restore the factory calibration if calibration data is lost or accidentally overwritten.

Edit Cal

This function allows the user to re-enter calibration data if all data, including factory calibration default is lost. The data should be entered exactly as on the HME900 configuration Data report. When the data is correct it is downloaded to the HME900 by clicking on OK.

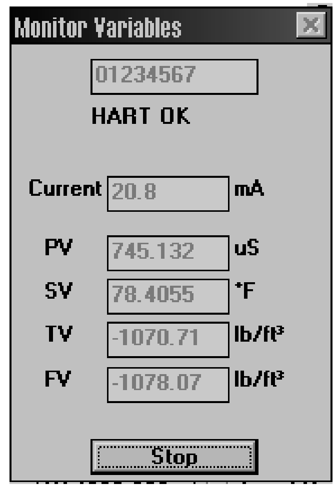


Monitor Drop Down

General

Shows the four variable values as transmitted from the headmounted electronics.

The update rate is as set from the window opened using the options drop down. If logging is enabled then the data shown is the data that is logged. Logging takes place at the interval set for monitor update.



Options Drop Down

Brings up the comms port / update time and log enable window (see section Starting WinHME).

Logging

When Logging is enabled data is logged to the default file "Unit Tag No" dot TXT. The file is tab delimited and can be transferred to any data-handling package that can accept the tab-delimited file. Note that if logging is paused and then re-started the file will be over written. To avoid this the file should be re-named before restarting logging.

Time	mA	uS	°F	lb/ft³	lb/ft³
17:17:57	20.799999	745.154175	78.812798	49.456799	41.930401
17:18:01	20.799999	745.153076	78.812202	49.455601	41.930401
17:18:06	20.799999	745.157349	78.809799	49.455299	41.930401
17:18:12	20.799999	745.154175	78.807999	49.453602	41.930401
17:18:17	20.799999	745.159485	78.803497	49.452801	41.930401
17:18:21	20.799999	745.159485	78.808701	49.451801	41.930401
17:18:26	20.799999	745.157349	78.808403	49.4538	41.930401
17:18:33	20.799999	745.15625	78.806801	49.452801	41.930401
17:18:36	20.799999	745.157349	78.805298	49.453098	41.930401
17:18:41	20.799999	745.154175	78.806801	49.452499	41.930401
17:18:46	20.799999	745.153076	78.803001	49.4524	41.930401

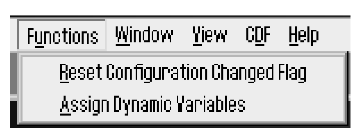
Example of Log File

Functions Drop Down

Allows user to assign dynamic values to output variables or reset configuration-changed flag.

Reset Configuration Flag

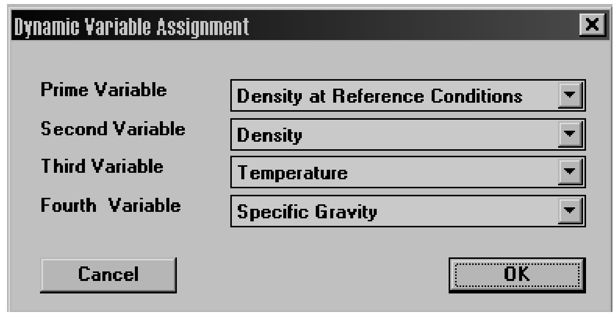
When a HART transducer is used with a HART DCS or other control equipment the DCS or control equipment reads all required transducer information from each transducer on start-up.



To ensure that the transducer information cannot be changed locally without the DCS being updated a configuration change flag is set whenever data is changed. On noting the flag the DCS must re-read all the transducer data, or raise an alarm and be re-programmed by hand. The Reset Configuration Changed Flag option allows the user to clear the flag after setting data, if required.

Assign Dynamic Variables

The headmount electronics allows four variables to be displayed (read using HART).

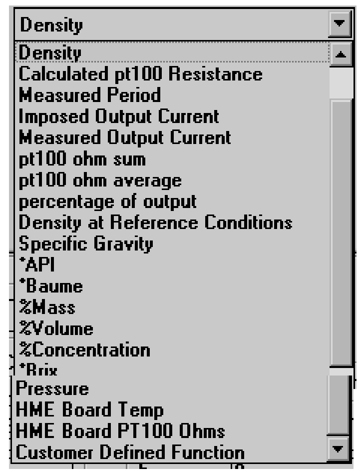


The prime variable is displayed by the local display (if fitted) and also, assuming the nickname (ident.) is zero, transmitted over the 4 – 20mA loop.

Each of the four variable windows has the same drop down listing the available options.

Choice of Output Variables

Any of the listed variables can be connected to any of the four variable outputs. Note that the chosen variables are also logged when logging is available.



Window

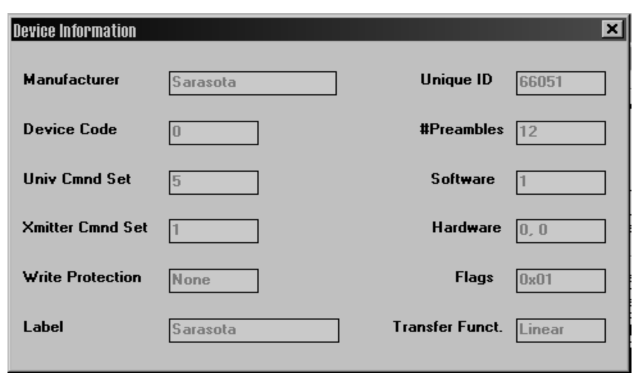
The Window drop down is a standard windows menu, relating to the position of windows on the users screen.

View Drop Down

The View drop down menu allows the user to view specific device information of the device calibration constants. Being able to view device calibration constants allows the user to note any corruption of calibration data by comparing current calibration constants with constants recorded at calibration.

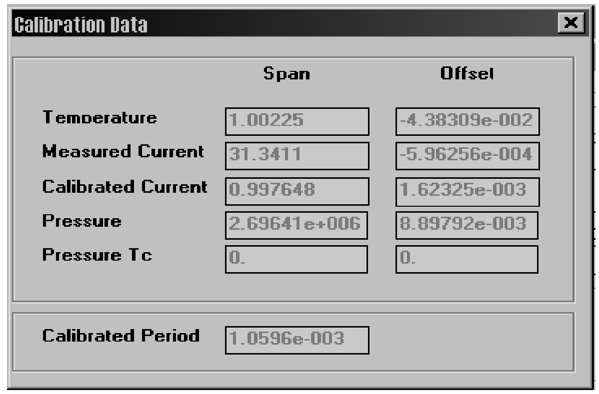
Device Information

The device information is general relating to the protocol version, software and Device Descriptor version and the unique ID. The unique ID may be used to track the instrument throughout its service life.



Calibration Data

The calibration data includes the constants used to trim the gain and zero of various input and output circuits. Span constant adjusts the slope while the Offset constant adjusts the zero of the circuit.



The pressure TC relates to the temperature coefficient of the pressure input and is only measured and entered for special projects. The calculated period constant is a multiplier that is used to correct the processor clock when used to measure period.

CDF Drop Down Menu

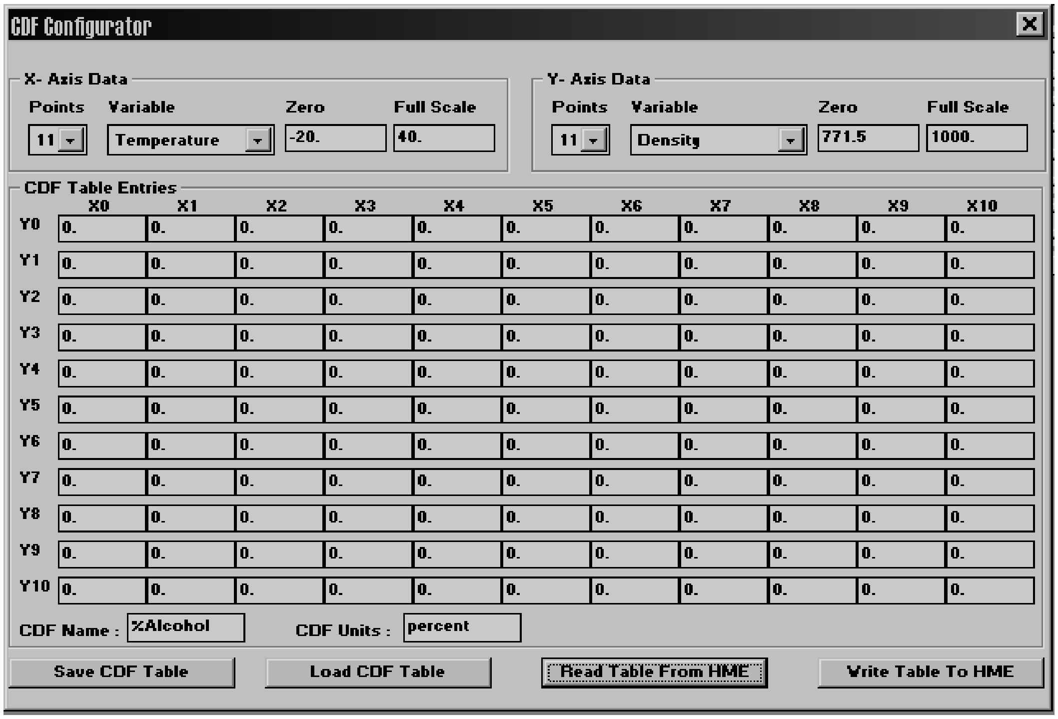
The CDF (Customer defined function) allows an output variable to be expressed as a function of two input variables. This is done by producing a lookup table relating the input variable to the output.

This table can be single dimension (input variable and output) or two dimensional with two input variables, one X axis and one Y axis with the output variable at the intersection the two axis points.

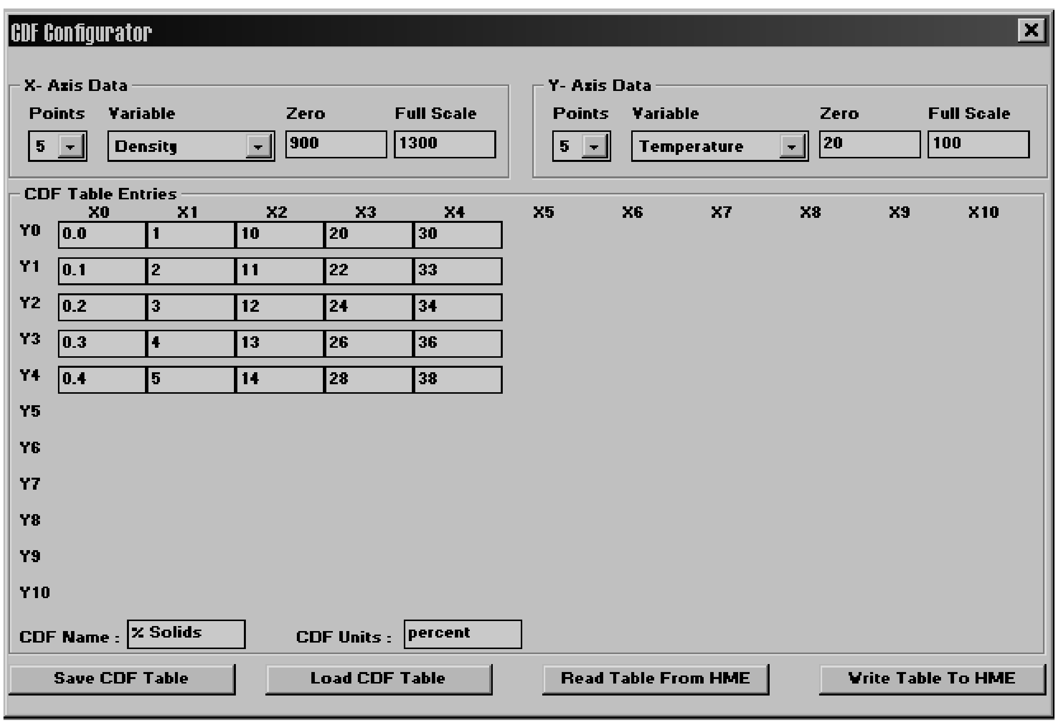
The variables to be connected to the X and Y-axes are selected from drop down menus. The number of points on each axis is entered. The maximum number of points in the table is the number of X-axis points times the number of Y-axis points and is limited to 121 points.

The minimum and maximum value of each axis is entered. These values equate to the first and last axis point to be used. The intervening axis points must be equi-spaced between the first and last values. This allows data to be entered into the table without having to enter X and Y-axes values.

The examples on the following page are a blank 11 * 11 table and a table for an output function of % solids generated from inputs of density (line) and temperature.



Blank 11 * 11 table



Output function of % solids

CDF Example Axis Value Calculation

Assume a five by five table is generated where the Y-axis is density and the X-axis temperature.

The Density range is 900 to 1300 Kg/m³. These values correspond to axis values of Y0 = 900, Y4 = 1300. The intermediate axis points are (Full Scale – Zero)/(Number of Y points less 1).

Therefore Y-axis values are:
Y0 = 900, Y1 = 1000, Y2 = 1100, Y3 = 1200 and Y4 = 1300 Kg/m³.

Similarly for temperature, Zero = 20° (X0 axis value), Full-scale = 100° (X5 axis value). Intervening values = (100 – 20)/4 = 20° intervals.

Therefore X axis values are:
X0 = 20, X1 = 40, X2 = 60, X3 = 80 and X4 = 100°

The data written into the table is the data that corresponds with each of the axis values.
When in operation the headmounted electronics unit carries out a linear interpolation within the table to estimate the output value dependent on the input values.

Care should be taken to ensure that the table axis values are not exceeded by the input variables.

Save CDF Table

Standard CDF tables can be saved by clicking on “Save CDF”, restored from disc by “Load CDF Table”, copied down to a mounted unit by “Write table to HME “ and read from a headmounted unit by “Read table from HME”.

Note that a table generated in WinHME is not written to the connected headmounted unit until the “Write table to HME” button is activated.

SECTION 6

Equation Sets

Line Temperature

$$T = W_2 * R^2 + W_1 * R + W_0$$

T	Line Temperature in °C[°F]
R	PRT Resistance in ohms

For Temperature Range 0 to +200°C

W_2	$1.069075 * 10^{-3}$	[$1.9243348 * 10^{-3}$]
W_1	2.3424906	[4.2164829]
W_0	-244.93846	[-408.88021]

For Temperature Range -200 to 0°C

W_2	$1.420603 * 10^{-3}$	[$2.5570854 * 10^{-3}$]
W_1	2.288622	[4.1195196]
W_0	-243.07426	[-405.53367]

Absolute Temperature

$$T = \theta + 273.15\ [\ 459.67\ ]$$

T	Temperature in ºK [ºR]
θ	Temperature in ºC [ºF]

Line density (Liquid)

$$\rho_m = D0 * \frac{(t - t'_0)}{t'_0} * \left[2 + K * \frac{(t - t'_0)}{t'_0} \right]$$

Where

$$t'_0 = T0 + TEMPCO * (T - T_{cal}) + PRESCO * (P - P_{cal})$$

and

ρ_m	Measured line density in Kg/m^3 [lb/ft^3]
T0	Calibration constant of spool in µS
t'_0	Corrected cal constant of spool in µS
D0	Calibration constant of spool in Kg/m^3 [lb/ft^3]
K	Calibration constant of spool in Kg/m^3/ºC [lb/ft^3/ºF]
TEMPCO	Temperature coefficient of spool in µs/ºC [µs /ºF]
PRESCO	Pressure coefficient of the transducer in µs/bar [µs/psi]
t	Measured period in µS
T	Measured/fixed line temperature in ºC [ºF]
P	Measured/fixed absolute pressure in BarA [psiA]
T_{cal}	Calibration temperature of densitometer. 15 ºC [60 ºF]
P_{cal}	Calibration pressure of densitometer. 1.01325 barA [14.696 psiA]

Density Correction

$$\rho_m = \rho_m * DCF + D\_OFFSET$$

ρ_m	Measured line density in Kg/m^3 [lb/ft^3]
DCF	Density correction factor – default 1.0
D_OFFSET	Density offset - default 0.0

Reference Density Via Linear TC (Liquid)

$$\rho_{15[60]} = [\ \rho_{line} + (\ T - 15\ [60]\ ) * TC] * PCF$$

Where

$\rho_{15[60]}$	Density at reference conditions in Kg/m^3 [lb/ft^3]
ρ_{line}	Calculated line density in Kg/m^3 [lb/ft^3]
T	Line temperature in ºC [ºF]
TC	Temperature coefficient of liquid in Kg/m^3/ ºC [lb/ft^3/ºF]
PCF	Pressure correction factor

Pressure Correction Factor (Liquid)

$$PCF = (P - P_{ref}) * (F * 10^{-6})$$

Where

P	Absolute pressure in BarA [psiA]
Pref	Reference pressure 1.01325 BarA [14.696 psiA]
F	Compressibility factor of the fluid Kg/Mbar [lb/Mpsi]

Reference Density Via ASTM-D-1250 (Crude oil)

$$\rho_{15[60]} = \rho_{line} * \frac{1}{VCF} * PCF$$

$\rho_{15[60]}$	Density at reference conditions in Kg/m^3 [lb/ft^3]
ρ_{line}	Calculated line density in Kg/m^3 [lb/ft^3]
VCF	Volume correction factor
PCF	Pressure correction factor

Note: ***Iterative*** **calculation. On 1st pass** $\rho_{15[60]} = \rho_{line}$

$$VCF = \exp[\ -\alpha 15 \Delta T(\ 1.0 + 0.8 \alpha 15 \Delta T\ )\ ]$$

$$\Delta T = (T - 15[60])$$

and

$$\alpha 15 = \frac{K0}{\rho_{15}^{\ 2}}$$

VCF	Volume correction factor
K0	ASTM-D-1250 Factor for crude oil 613.9723 [341.0957]
α_{15}	Coefficient of thermal expansion
ρ_{15}	Density at reference conditions in Kg/m^3 [lb/ft^3 *16.0185]
ΔT	Difference in line temperature and base temperature
T	Line temperature in ºC [ºF]

Reference Density Via ASTM-D-1250 (Refined Products)

$$\rho_{15[60]} = \rho_{line} * \frac{1}{VCF} * PCF$$

$\rho_{15[60]}$	Density at reference conditions in Kg/m^3 [lb/ft^3]
ρ_{line}	Calculated line density in Kg/m^3 [lb/ft^3]
VCF	Volume correction factor
PCF	Pressure correction factor

Note: ***Iterative*** **calculation. On 1st pass** $\rho_{15[60]} = \rho_{line}$

$$VCF = \exp[\, -\alpha 15 \Delta T(\, 1.0 + 0.8 \alpha 15 \Delta T \,)\,]$$

$$\Delta T = (T - 15[60])$$

$$\alpha 15 = \frac{K0}{\rho_{15}{}^{2}} + K\frac{1}{\rho_{15}} + K2$$

K0	ASTM-D-1250 Factor (See table)
K1	ASTM-D-1250 Factor (See table)
K2	ASTM-D-1250 Factor (See table)
α_{15}	Coefficient of thermal expansion
ρ_{15}	Density at reference conditions in Kg/m^3 [lb/ft^3 *16.0185]
ΔT	Difference in line temperature and base temperature
T	Line temperature in ºC [ºF]

Density range	K0	K1	K2
1075-839 Kg/m³ 67.11-52.38 lb/ft³	186.9696 103.872	0.4862 0.2701	0 0
839.5-788 Kg/m³ 52.41-49.19 lb/ft³	594.5418 330.301	0 0	0 0
787.5-770.5 Kg/m³ 49.16-48.10 lb/ft³	2680.320 1489.087	0 0	-0.003363 -0.001868
770.0-653.0 Kg/m³ 48.07-40.77 lb/ft³	346.4228 192.4571	0.4388 0.2438	0 0

Specific Gravity (Liquid)

$$SG = \frac{\rho_{15[60]}}{\rho_{water}}$$

Where

SG	Specific gravity of fluid in SG units
$\rho_{15[60]}$	Density at reference conditions in Kg/m^3 [lb/ft^3]
ρ_{water}	Density of water at 15ºC [60ºF] i.e 999.0879 Kg/m^3 [62.3677 lb/ft^3]

Degrees API (Liquid)

$$°API = \frac{141.5}{SG} - 131.5$$

SG Specific gravity of fluid in SG units

Degrees BAUME (Liquid)

$$If\ SG > 1.0$$

$$°BAUME_{heavy} = 145 - \frac{145}{SG}$$

$$If\ SG < 1$$

$$°BAUME_{light} = \frac{140}{SG} - 130$$

$°BAUME_{heavy}$ °BAUME for fluids with SG >1.0
$°BAUME_{light}$ °BAUME for fluids with SG <1.0
SG Specific gravity of fluid in SG units

Percent Mass Product A (Liquid)

$$\%\ Mass\ A = \frac{\rho_{15[60]A}(\rho_{15[60]} - \rho_{15[60]B})}{\rho_{15[60]}(\rho_{15[60]A} - \rho_{15[60]B})} * 100.0$$

$\rho_{15[60]}$ Density of mixture at reference conditions in Kg/m^3 $[lb/ft^3]$
$\rho_{15[60]A}$ Density of product A at reference conditions Kg/m^3 $[lb/ft^3]$
$\rho_{15[60]B}$ Density of product B at reference conditions Kg/m^3 $[lb/ft^3]$

Percent Volume Product A (Liquid)

11 Percent Volume of Product A

$$\%\ Volume\ A = \frac{(\rho_{15[60]} - \rho_{15[60]B})}{(\rho_{15[60]A} - \rho_{15[60]B})} * 100.0$$

$\rho_{15[60]}$ Density of mixture at reference conditions in Kg/m^3 $[lb/ft^3]$
$\rho_{15[60]A}$ Density of product A at reference conditions Kg/m^3 $[lb/ft^3]$
$\rho_{15[60]B}$ Density of product B at reference conditions Kg/m^3 $[lb/ft^3]$

Customer Defined Function

To enable the computation of more complex functions based on the standard HME variables the HME has a lookup table facility. Any function using the calculated or input variables may be calculated even if the relationship is non-linear.

There are 122 variables allocated to the lookup table. Given this total the lookup table can have any number of rows and columns such that the total variable usage is not greater than 122.

The HME calculates the CDF value by interpolation over the lookup table.

$$Z_{X,Y} = Z_{X1,Y1} + \left[\frac{Z_{X2,Y1} + Z_{X2,Y2} - Z_{X1,Y1} - Z_{X1,Y2}}{2(X_2 - X_1)} * (X_{var} - X_1) \right] + \left[\frac{Z_{X1,Y2} + Z_{X2,Y2} - Z_{X1,Y1} - Z_{X2,Y1}}{2(Y_2 - Y_1)} * (Y_{var} - Y_1) \right]$$

X_{var}	X Variable of CDF
X_1	Nearest CDF Table X value < Live X variable
X_2	Nearest CDF Table X value > Live X variable
Y_{var}	Y Variable of CDF
Y_1	Nearest CDF Table value < Live Y variable
Y_2	Nearest CDF Table value > Live Y variable
$Z_{X.Y}$	Interpolated CDF value
$Z_{X1,Y1}$	CDF Table value at X_1 , Y_1
$Z_{X2,Y1}$	CDF Table value at X_2 , Y_1
$Z_{X1,Y2}$	CDF Table value at X_1 , Y_2
$Z_{X2,Y2}$	CDF Table value at X_2 , Y_2

Line Density (Gas)

$$\rho_m = d'_0 * \frac{(t - t'_0)}{t'_0} * \left[2 + K * \frac{(t - t'_0)}{t'_0} \right]$$

$$t'_0 = T0 + TEMPCO * (T - T_{cal}) + PRESCO * (P - P_{cal})$$

$$d'_0 = D0 \left[1 - \left(\frac{VIBDIM * \overline{R}}{a * t} \right)^2 \right]$$

$$a = \left(\frac{ISENEX * P * \overline{L}}{\rho_m} \right)^{\frac{1}{2}}$$

If P = 0 or d_0' < 0.8D0 :-
d_0' = D0

On 1st Cycle d'_0 = D0

ρ_m	Measured line density in Kg/m³ [lb/ft³]
T0	Calibration constant of spool in µS
t_0'	Corrected cal constant of spool in µS
D0	Calibration constant of spool in Kg/m³ [lb/ft³]
d_0'	VOS corrected cal constant of spool in Kg/m³ [lb/ft³]
K	Calibration constant of spool in Kg/m^3/°C [lb/ft^3/°F]
TEMPCO	Temperature coefficient of spool µS/K [µS/°R]
PRESCO	Pressure coefficient of spool µS/bar [µS/PSI]
VIBDIM	Characteristics of vibrating element in mm [in]
ISENEX	Isentropic exponent of gas
t	Measured period in µS
T	Measured/fixed line temperature in K[°R]
T_{CAL}	Calibration temperature of densitometer 288.15 K [519.67 R]
P	Measured/fixed line pressure in Bar A [PSIA]
P_{CAL}	Calibration pressure of densitometer 1.01325 Bar A [14.696 PSIA]
L	Speed of sound factor 100 000 pa/Bar [4633.05567 lbdw/ft2/PSI]
R	VOS correction to density 1000 [10^6/12]

Rho air & Z Air

$$\rho_{air} = \frac{J * Pref}{Tref * Z_{air}}$$

$$Z_{air} = 1 - J\left[\frac{Pref}{Tref}\right]\left[\frac{A_r}{Tref^{1.5}} - B_r\right]$$

ρ_{air}	Density of air at reference conditions
Z_{air}	Compressibility factor of air at reference conditions
J	Gas constant 348.362 ºK.Kg/m^3/bar [2.69732428 ºR.lb/ft^3/psi]
Pref	Reference Pressure in bar [psi]
Tref	Reference Temperature in ºK [ºR]
A_r	Az value for air 6.18307495 º$K^{1.5}$.m^3/Kg [239.183045 º$R^{1.5}$$ft^3$/1b]
Br	Bz value for air. 0.0009235295 m^3/Kg [0.014793396 ft^3/lb]

Density at Reference Conditions (Gas)

$$\rho_c = \frac{\rho_m * Pref * T * Z}{P * Tref * Zref}$$

ρc	Density of gas at reference P & T kg/m³ [lb/ft³]
ρm	Measured gas density in kg/m³ [lb/ft³]
Pref	Reference pressure in Bar [psi]
Tref	Reference temperature in K [°R]
T	Absolute Temperature in K [°R]
P	Absolute Pressure in Bar [psia]
Z	Gas compressibility factor
Zref	Reference compressibility factor

Compressibility (Gas)

$$Z = \frac{1}{1 - B_z * \rho_m} - \frac{A_z * \rho_m}{T^{1.5} * (1 + B_z * \rho_m)}$$

If Bz * ρm > 1 , Z = 1

Z	Gas compressibility
Az	R-K fluid constant for Z in º$K^{1.5}$.m^3/Kg [º$R^{1.5}$.ft^3/1b]
Bz	R-K fluid constant for Z in m^3/Kg [ft^3/1b]
ρm	Measured density of Gas
T	Absolute Temperature in ºK [ºR]

Reference Compressibility (Gas)

On the first pass through the calculations, Zref = 1

$$Z_{ref} = 1 - G * \rho_{air} * \left(\frac{Az}{Tref^{1.5}} - Bz \right)$$

Subsequently

If Zref < 0.8 then set Zref = 0.8
If Zref > 1.145 then set Zref = 1.145

Zref	Reference compressibility
G	Relative density (SG)
Az	R-K fluid constant for Z in ºK$^{1.5}$.m^3/Kg [ºR$^{1.5}$.ft^3/1b]
Bz	R-K fluid constant for Z in m^3/Kg [ft^3/1b]
Tref	Reference temperature ºK [ºR]

Gravity / Relative Density (gas)

$$G = \frac{\rho_c}{\rho_{air}}$$

G	Relative density (SG)
ρc	Density of gas at reference P&T
ρair	Density of air at reference P&T

Molecular Weight

$$MW = G * 28.964$$

MW	Molecular Weight of gas
G	Relative density (SG)

Az & Bz From MW

Az & Bz can be calculated via molecular weight using the following formulae

$$Az = 7.25973245 + 1.14078006 * MW - 3.23133483 \, x \, 10^{-3} * MW^2$$

$$Bz = 8.21540275 \, x \, 10^{-3} - 2.74198514 \, x \, 10^{-4} * MW + 2.39199357 \, x \, 10^{-6} * MW^2$$

For Imperial HME’s

Az = Az * 38.683931
Bz = Bz * 16.0185

MW	Molecular weight
Az	R-K fluid constant for Z in K$^{1.5}$.m^3/Kg [°R$^{1.5}$.ft^3/1b]
Bz	R-K fluid constant for Z in m^3/Kg [ft^3/1b]

Appendix A

Special Notes for IS Applications - Limitations of Use

Ambient Conditions

The density instruments are designed for use in ambient conditions – 20ºC to + 60ºC. The process fluid temperatures within the instrument may exceed these ambient temperature limits but should remain within the temperature limits specified in the individual instruments specification.

The Electronics enclosure is rated at IP65. The instrument should be mounted in such a way as to ensure that higher protection rating is not required.

Pressure Ratings

The instruments are pressure tested to at least 1.5 times their published operating pressures. However exceeding the published pressure rating should be avoided. This will ensure that process fluid does not invade the electrical components within the instrument.

Power Supplies and Interconnections

The instruments are approved as intrinsically safe apparatus. All connections to the density meter should be via approved associated apparatus (barriers or isolators) that limit the voltage power and current to no more than the figures noted in the certificate.

Where a pressure transducer is connected then the pressure transducer must be approved for use in the hazardous area present. Also the user must consider the maximum voltage power and current figures noted in the pressure transducer certificate, as well as the figures published in the 900H certificate.
The approved associated apparatus (for the pressure transmitter supply) must limit the voltage power and current to no more than the figures noted in both the certificate for the 900H series density meter and the certificate for the pressure transducer.

Routine Maintenence

The routine maintenance developed to ensure that intrinsic safety is maintained should take into account:

- Local, national or international standards
- Location of the instrument
- Nature of the process fluid flowing through the density meter

Where the instrument is located in an aggressive atmosphere routine inspection should verify that the enclosure is not breached by corrosion or erosion, that all enclosure seals and glands are intact and that all covers are properly installed.

The equipment is not assessed for operation in dust conditions. Routine maintenance must ensure that the equipment remains dust free.

The compatibility of the materials of construction of the instrument with the process fluid is the responsibility of the operator. Where the possibility of corrosion or erosion of the instrument by the process fluid may exist the routine maintenance schedule should include inspection for internal corrosion / erosion of the instrument as well as external appearance.

Mechanical Installation

Whilst the alloy for the electronics enclosure is specified as having less than 6% magnesium, no particular statement is made regarding non-sparking properties of the alloy. Because of this care should be taken to minimise the risk of direct impact to the instrument or the electronics enclosure.

Repair or Modification

Any repair or modification of the IS protected instrument may invalidate the protection. Where a repair cannot be made by replacement of certified modules (plug in amplifiers or replacement barriers, etc.) then the unit must be returned to the manufacturer for replacement unit.

Other Hazards to The operator

The operator is responsible to ensure that the installation protects workers from possible physical injury due to excessive process temperature and pressure. The instrument itself will not cause harm due to:

- Contact, other than those hazards cause by the process or process fluid.
- Infra red, electromagnetic or ionising radiation.
- Other non-electrical dangers other than those caused by the process or process fluid.

Special Tools Required For HME900

Allen Key

1/16” Allen Key
Terminal box locking screw

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Appendix B

Toxic & Hazardous Substances Tables

The English and Chinese versions of the Toxic and Hazardous Substances tables are provided below.

Toxic & Hazardous Substances Table – Sarasota Density HME900

For Chinese Regulation: Administrative Measure on the Control of Pollution Caused by Electronic Information Products

Names and Content of Toxic and Hazardous Substances or Elements

Parts Name	Toxic and Hazardous Substances or Elements (HME900)					
	Pb	Hg	Cd	Cr6+	PBB	PBDE
Junction Box	o	o	o	o	o	o
Amplifier Board	x	o	o	o	o	o
Connection Board	x	o	o	o	o	o
Frequency Board*	x	o	o	o	o	o
Head Mount Boards*	x	o	o	o	o	o
Terminal Board	x	o	o	o	o	o
Pipe Assembly	x	o	o	o	o	o
Cabling	o	o	o	o	o	o
RTR 900**	x	o	o	x	o	o

○: Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in **SJ/T11363-2006**

x: Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in **SJ/T11363-2006**

* Product will contain either “Head Mount Boards” or “Frequency Board”
** Product may contain an optional RTR900 subassembly

有毒有害物质名称及含量的标识格式

部件名称	有毒有害物质或元素 (HME900)					
	铅（Pb）	汞（Hg）	镉（Cd）	六价铬（Cr6+）	多溴联苯（PBB）	多溴二苯醚（PBDE）
接线盒	o	o	o	o	o	o
放大器电路板	x	o	o	o	o	o
连接电路板	x	o	o	o	o	o
频率电路板*	x	o	o	o	o	o
头安装电路板*	x	o	o	o	o	o
终端电路板	x	o	o	o	o	o
管组件	x	o	o	o	o	o
缆线连接	o	o	o	o	o	o
RTR 900**	x	o	o	x	o	o

○：表示该有毒有害物质在该部件所有均质材料中的含量均在**SJ/T 11363-2006**标准规定的限量要求以下
x: 表示该有毒有害物质至少在该部件的某一均质材料中的含量超出**SJ/T 11363-2006**标准规定的限量要求

* 产品将包括“设备头安装电路板”或“频率电路板”
**产品可能带有 RTR900 子组件选配件

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