Instructions
and
Operating Manual

X96S
DENSITY GAUGE

RONAN
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MEASUREMENTS DIVISION

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NOTE: Regulations will be supplied with the Radiation Safety Manual.

Overview

The X96S is a family of measurement products that is intended to replace the current X99 and obsolete X96N product families. These products:

- use nuclear measurement techniques,
- support all features of the current X99 and obsolete X96N products,
- support up to 32 scintillation or ionization detectors,
- optional communication protocols,
- improved user interface options[1],
- more user functionality, and
- more product flexibility.

Advantages

- Non-contact measurement
- Displays in customers' units
- Most applications can be solved with low-energy sources
- Not affected by:
  - -extreme temperatures
  - -caustic processes
  - -sterile processes

Gamma's Advantages

- Mounts external to the process (no components exposed to process material)
- Not affected by changing process conditions
- Does not make material radioactive
- Does not change the material
- Can be shielded by lead

X96S Advantages

- Multiple communication protocols (HART, Fieldbus)
- Identical interface on local display as via HART
- Blind transmitter in detector on self-contained design
- Custom configuration of display
- Surface, panel or rack mount available
- Field mountable
- Push button calibration
- Empty pipe monitor

[1] This includes the ability to have a simple or complex user interface a remote user interface or even no user interface.

Basic Concepts

Communications

The Ronan X96S Density gauge provides both 4-20 mA current loop and other communication protocols (HART, Fieldbus)

4-20 MA

For many years, the field communication standard for process automation equipment has been a 4-20 mA current loop signal. The current varies in proportion to the process variable being represented. In typical applications, a signal of 4mA will correspond to the lower limit (0%) of the calibrated range and 20mA will correspond to the upper limit (100%) of the calibrated range. Thus, if the system is calibrated for 1 to 3 SGU, then an analog current of 12mA (50% of range) will correspond to a density of 2 SGU.

HART

HART® Field Communications Protocol extends the 4-20mA current loop standard to enhance communication with smart field instruments. The HART protocol was designed specifically for use with intelligent measurement and control instruments, which traditionally communicate using 4-20mA analog signals. HART preserves the 4-20mA signal and enables two-way digital communications to occur without disturbing the integrity of the 4-20mA signal. Unlike other digital communication technologies, the HART protocol maintains compatibility with existing 4-20mA systems, and in doing so, provides users with a backward compatible solution. HART Communication Protocol is well established as the "de facto" industry standard for digitally enhanced 4-20mA-field communication.

The enhanced communications capability of intelligent field instruments employing the HART protocol, offers significantly greater functionality and improved performance over traditional 4-20mA analog devices. The HART protocol permits the process variable to continue to be transmitted by the 4-20mA analog signal and additional information pertaining to other variable, parameters, device configuration, calibration, and device diagnostics to be transmitted digitally at the same time. Thus, a wealth of additional information related to plant operation is available to central control or monitoring systems through HART communications.

Variables

There are three types of variables, communications variables, device variables and configuration variables.

Communications Variables

Four communication variables, PV (Primary Variable), SV (Secondary Variable), TV (Tertiary), and QV (Quaternary) are defined. PV is assigned to the primary 4-20 mA loop. Other communication protocols are also communicated over this loop. (HART, Fieldbus) SV is assigned to an optional secondary 4-20 mA loop.

Device Variables

The Ronan X96S Density gauge has several device variables: SGU, % solids weight, degree Twad, degree Brix, degree Baum hv, degree Baum lt, degree API, degree Ball, % steam quality, 5 acids.

Configuration Variables

The Ronan X96S Density Gauge has many configuration variables that are accessed through its menus.

Theory

Theory of Radiation Gauging

Radiation gauges operate on the principle of radiation absorption and transmission.

A beam of gamma radiation is directed from the source holder, through the pipe (or vessel) and its process material, and onto the surface of the detector.

Radiation that is not *absorbed* by the material through which it passes, is *transmitted* to the surface of the detector. Process measurement is possible because the amount of radiation *absorbed and transmitted* is predictable.

The absorbed radiation is directly related to the density (or mass) of process in the pipe while the transmitted radiation is inversely related to the density (or mass) of process in the pipe.

Therefore, an **increased process density results in a decrease of transmitted radiation.**

Since the radiation that's not being *absorbed* is being *transmitted*, the process density can be inferred by measuring the amount of radiation reaching the detector at any point in time. The detector's output signal, in counts, also *varies inversely* to the process condition.

When the process is light (low density) the detector is exposed to a maximum amount of radiation which produces a HIGH output of counts. When the process is heavy (high density) the process material "shields" the detector and prevents radiation from reaching the detector, producing a LOW output of counts.

The X96S Microprocessor converts the detector signal to the user's device variables. The X96S Microprocessor is capable of simultaneously displaying density in two different sets of units. These different representations of the density value are called D1 and D2.

The X96S displays the output measurement range in the selected user units. Channel 1 and Channel 2 can be set independently. For both channels, the "zero" of the measurement range represents the lowest device variable, while the "span" of the measurement range represents the highest device variable.

Reduction of the signal "noise" due to radiation statistics is handled in the stage of signal processing known as digital filtering. Digital filtering is a form of statistical averaging used to smooth, or dampen, random radiation as well as process-related noise. Increasing the digital filter's "time constant" decreases signal noise.

Dynamic tracking permits the gauge response to temporarily by-pass the digital filter. This is helpful in some processes where sudden or drastic step changes in process must be observed in their true, or unfiltered, state.

Software also compensates for the decay of the radioactive source activity. On-going adjustments are made automatically for the rate of decay, or source half-life.

Principles of Operation

The detector's raw output signal is processed through several stages of software in the X96S.

Some of the more significant stages of signal processing are:

- Units Conversion – conversion of device variables into user-selected units
- Measurement Range – 4-20 mA output defined by the user-selected range in user-selected units.
- Digital Filtering – signal smoothing to reduce statistical radiation noise
- Dynamic Tracking – quick gauge response to quick process changes.
- Source Decay Compensation – automatic compensation for the radioisotope decay
- Calibration (Referencing) – calibration of gauge to user process.

The Calibration (or Referencing) procedure relates detector output (in counts) to numeric values that accurately represent the actual process density.

The density algorithm (or curve) used by the X96S software is a logarithmic function. That is, the relationship between the detector output and the process density is mathematically expressed as:

$$I_d = I_o e^{-ut(d-d_o)}$$

Where:

I_d = detector signal with process density (d)
I_o = detector signal with reference density (d_o) in pipe
u = the absorption coefficient
t = pipe internal diameter
d = density usually expressed in SpG
d_o = reference density

The "calibration constant" (1/ut) is used by the X96S software to calculate process density.

Password

Notice:

To access the Programming Menu, the Password is **101010**.

Step 1: Power Up – You should now be on the Status Screen.

Step 2: Press F3 to go back.

Step 3: Now enter the password. (All digits are set at 000000 at this point.)

Press  to get the digit to be # one

Press  2 times (The third digit should be highlighted.)

Press  to get the digit to be # one

Press  2 times (The fifth digit should be highlighted.)

Press  to get the digit to be # one

Press F4 (enter)

Note: If the wrong password was entered, press **F1 (ALL0)** to set all the digits to the number 0 and you can begin re-entering the password from the beginning. Pressing **F2 (RST0)** will set the individual digit that is highlighted back to the number 0.

Note: For security reasons, each digit will always be displayed as an asterisk.

Menus/Operation

Menu Trees

The Ronan X96S Density Gauge uses a tree structured menu system.

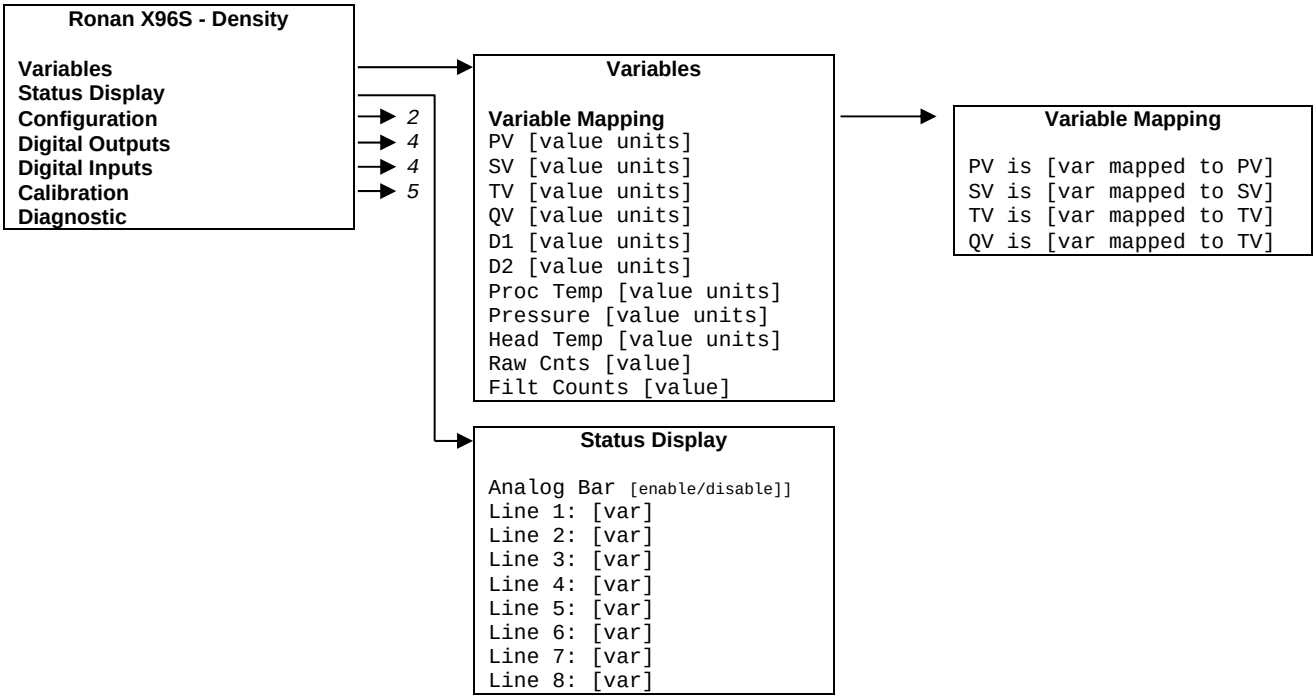


Figure 3-1 – Root, Variables and Displays Menus

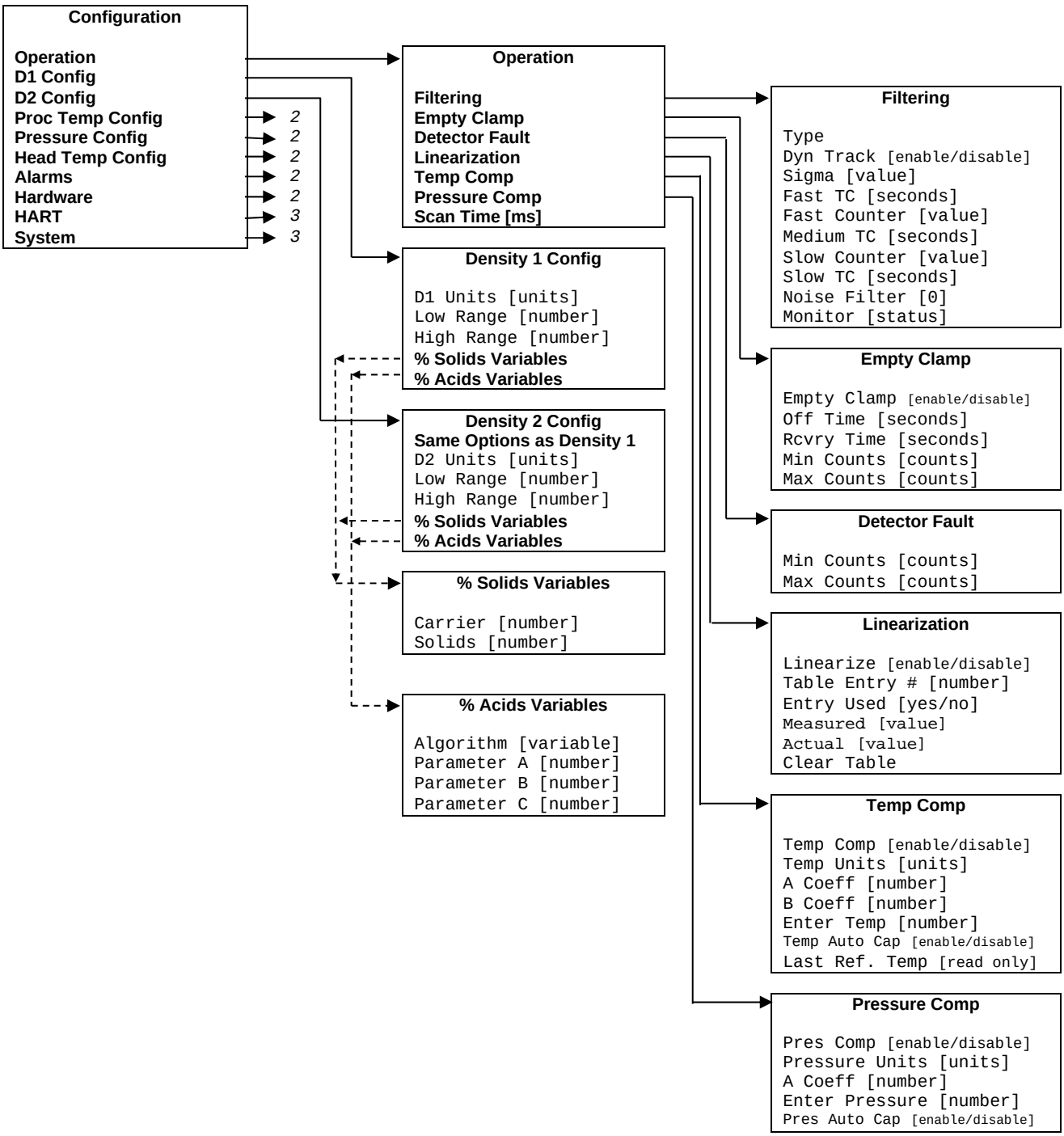


Figure 3-2 – Configuration Menus (1 of 3)

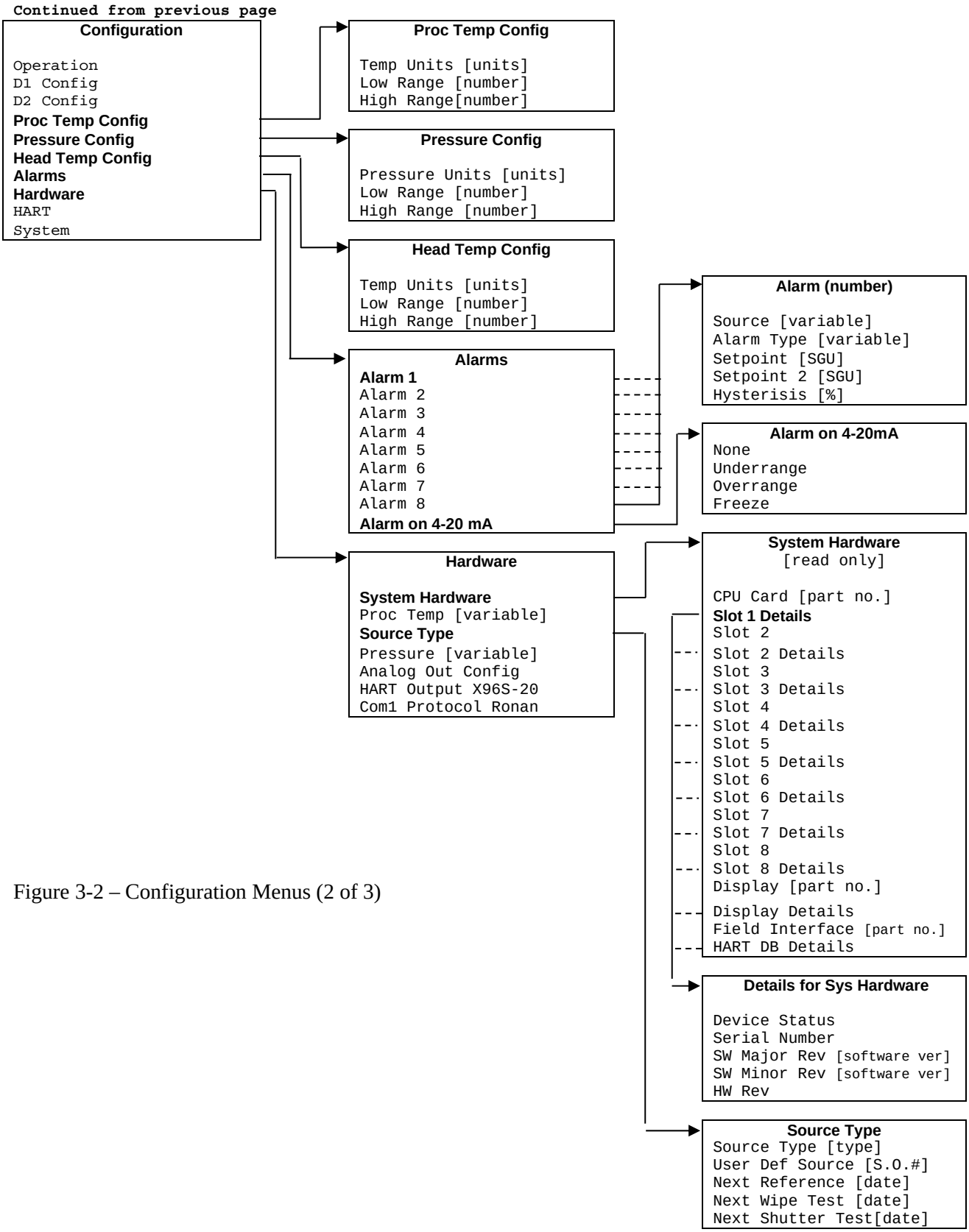


Figure 3-2 – Configuration Menus (2 of 3)

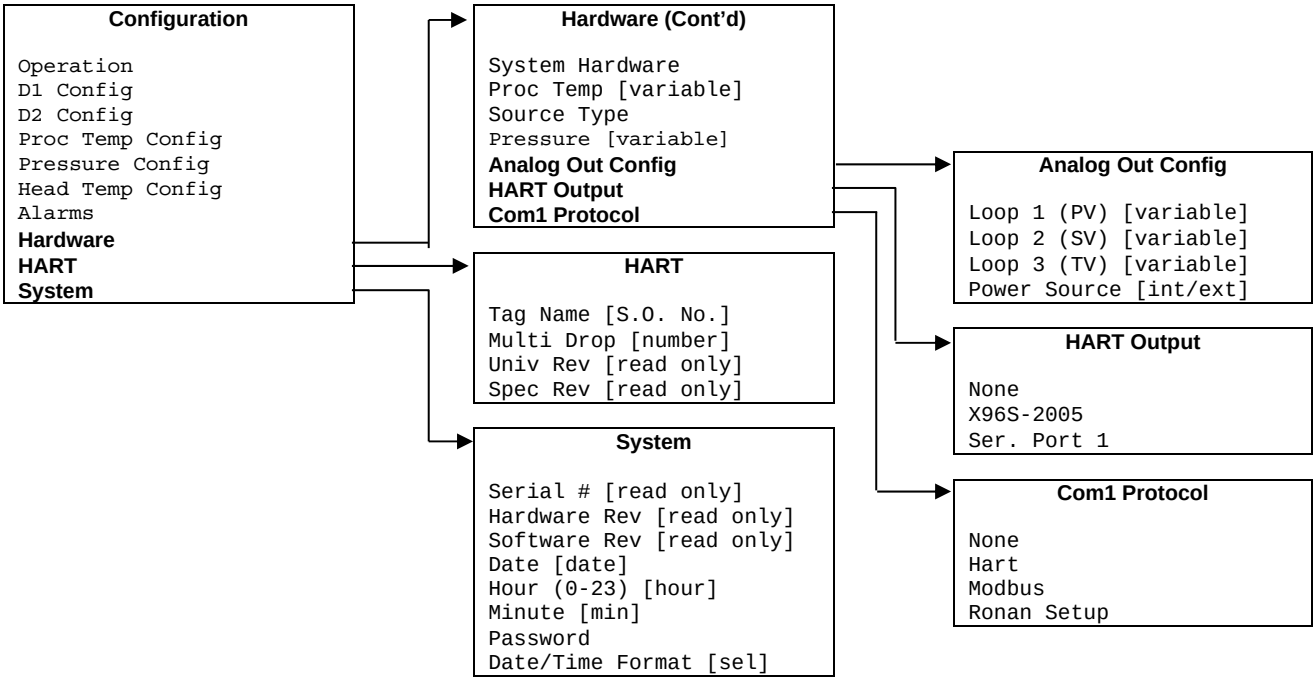


Figure 3-2 – Configuration Menus (3 of 3)

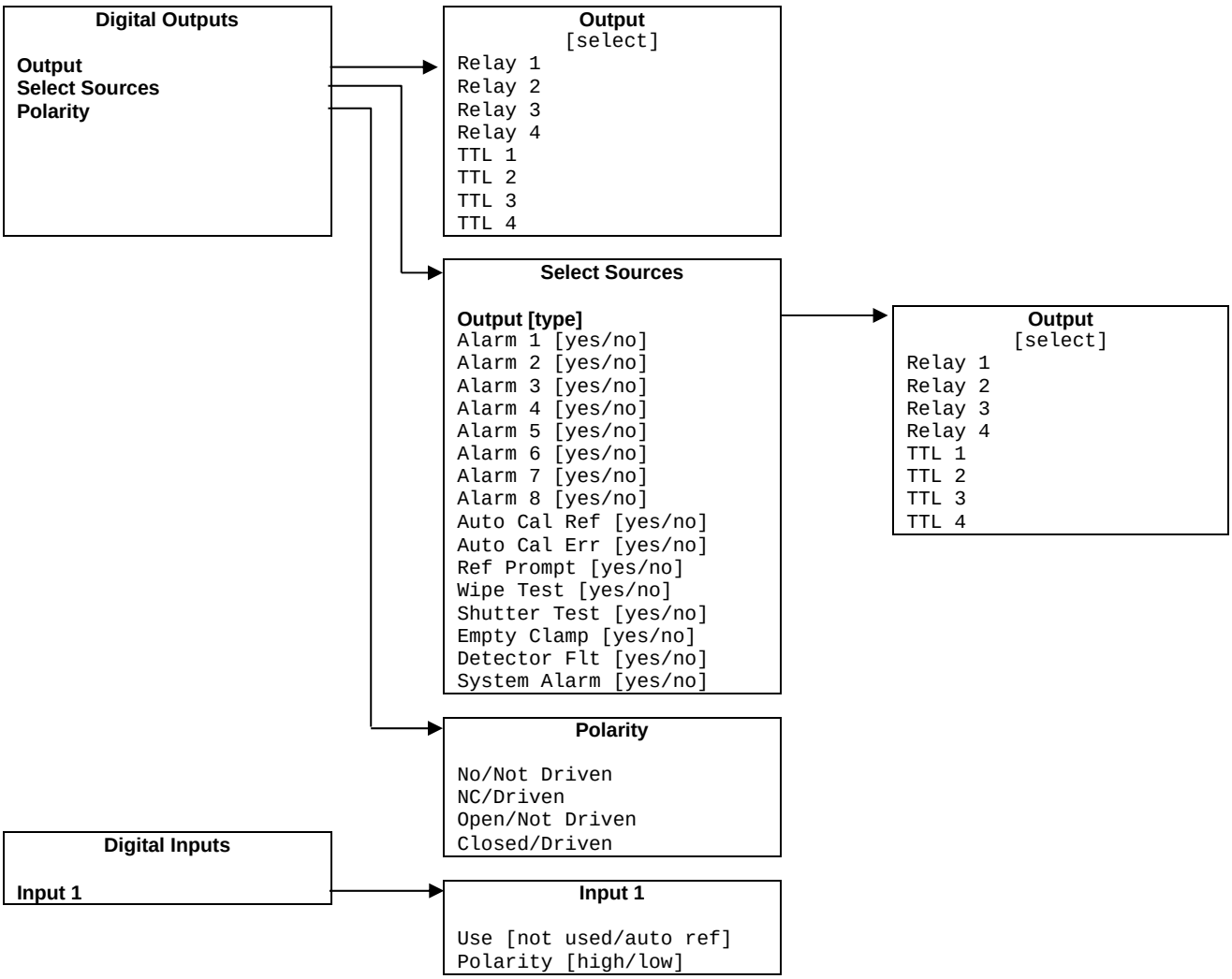
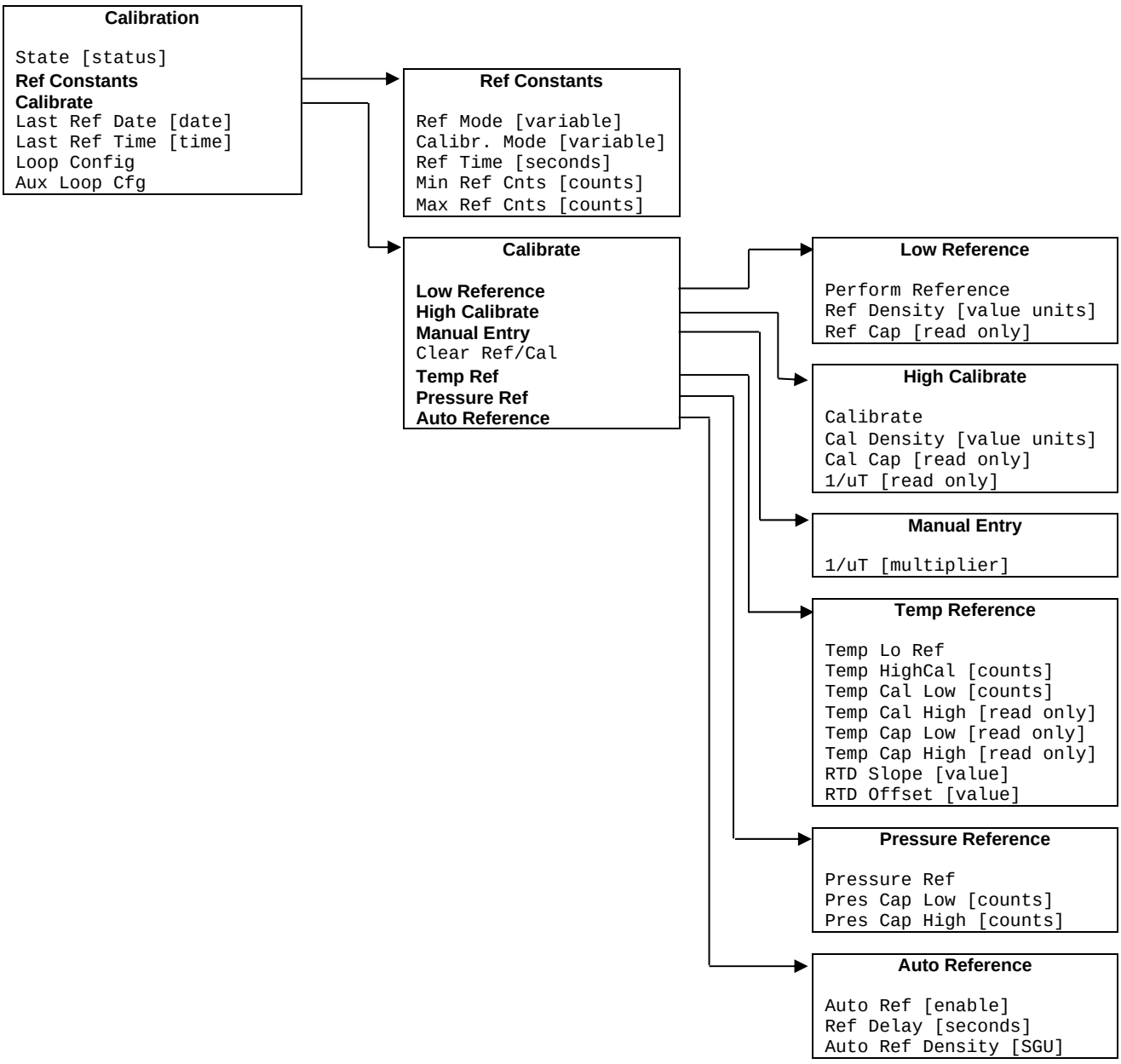


Figure 4-1– Digital Output and Digital Input Menus


Calibration
State [status]
Ref Constants
Calibrate
Last Ref Date [date]
Last Ref Time [time]
Loop Config
Aux Loop Cfg
Ref Constants
Ref Mode [variable]
Calibr. Mode [variable]
Ref Time [seconds]
Min Ref Cnts [counts]
Max Ref Cnts [counts]
Calibrate
Low Reference
High Calibrate
Manual Entry
Clear Ref/Cal
Temp Ref
Pressure Ref
Auto Reference
Low Reference
Perform Reference
Ref Density [value units]
Ref Cap [read only]
High Calibrate
Calibrate
Cal Density [value units]
Cal Cap [read only]
1/uT [read only]
Manual Entry
1/uT [multiplier]
Temp Reference
Temp Lo Ref
Temp HighCal [counts]
Temp Cal Low [counts]
Temp Cal High [read only]
Temp Cap Low [read only]
Temp Cap High [read only]
RTD Slope [value]
RTD Offset [value]
Pressure Reference
Pressure Ref
Pres Cap Low [counts]
Pres Cap High [counts]
Auto Reference
Auto Ref [enable]
Ref Delay [seconds]
Auto Ref Density [SGU]

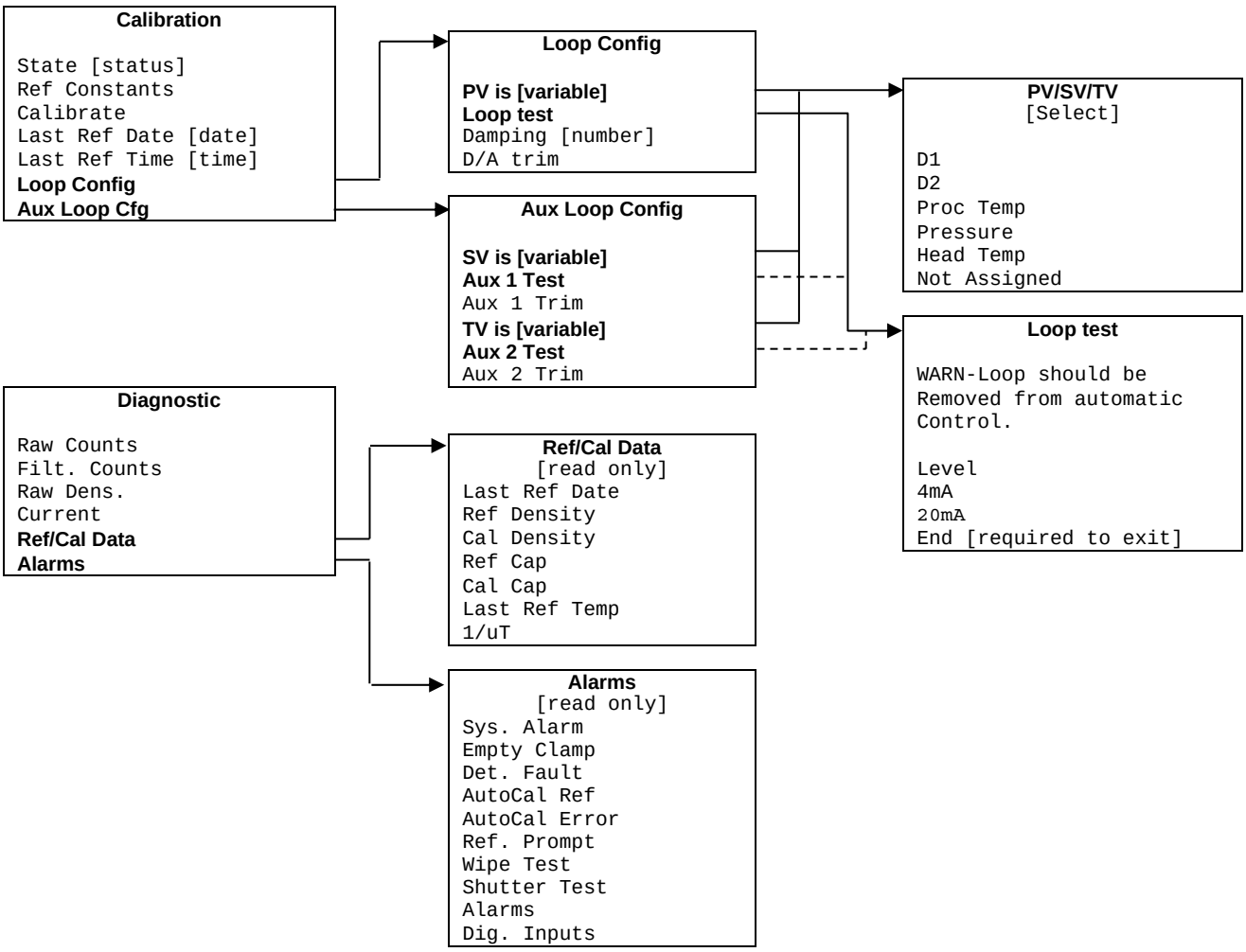


Figure 3-5 – Calibration Menus

Root Menu

The root menu is titled “Ronan X96S – Density”. It contains the following items:

ITEM	FUNCTION
Variables	**Selecting this takes the user to the Variables menu.**
Status Display	Selecting this takes the user to the Displays menu.
Configuration	Selecting this takes the user to the Configuration menu.
Digital Outputs	Selecting this takes the user to the Digital Outputs menu.
Digital Inputs	Selecting this takes the user to the Digital Inputs menu.
Calibration	Selecting this takes the user to the Calibration menu.
Diagnostic	Selecting this takes the user to the Diagnostic menu.

Variables Menu

The menu titled “Variables” contains the following items:

ITEM	FUNCTION
Variable Mapping	Selecting this takes the user to the Variable Mapping menu.
PV	Shows the current value of PV (the Primary Variable).
SV	Shows the current value of SV (the Secondary Variable).
TV	Shows the current value of TV (the Third Variable).
QV	Shows the current value of QV (the Fourth Variable).
D1	Shows the current value of D1 (the Density Variable).
D2	Shows the current value of D2 (the Density Variable in alternate units).
Proc Temp	Shows the current value of Proc Temp (the Process Temperature).
Pressure	Shows the current value of Pressure (the Process Pressure).
Head Temp	Shows the current value of Head Temp (the Head Temperature).
Raw Counts	Shows the current Raw Counts value from the detector.
Filt Counts	Shows the current Filtered Counts value from the detector.

Variable Mapping Menu

The “Variable Mapping” menu allows the user to select the device variable to be mapped to PV, SV, TV, and QV. It contains the following items:

ITEM	FUNCTION
PV is	Shows the device variable assigned to PV and allows the user to change the selection.
SV is	Shows the device variable assigned to SV and allows the user to change the selection.
TV is	Shows the device variable assigned to TV and allows the user to change the selection.
QV is	Shows the device variable assigned to QV and allows the user to change the selection.

Each PV, SV, TV, and QV may each select one of the following:

SELECTION	MEANING
D1	Density represented in units that are used locally
D2	Density represented in alternate units
Proc Temp	Process temperature
Pressure	Process pressure (if available)
Head Temp	Head temperature (if available)
Not Assigned	Blank line

Status Display Menu

The menu titled “Status Display” is used to configure the device status display. It contains the following items

ITEM	FUNCTION
Analog Bar	Shows the current state of the analog bar display (enabled or disabled) and allows the user change the state.
Line 1:	Shows the data to be displayed on line 1 of the status display and allows the user to change the selection.
Line 2:	Shows the data to be displayed on line 2 of the status display and allows the user to change the selection.
Line 3:	Shows the data to be displayed on line 3 of the status display and allows the user to change the selection.
Line 4:	Shows the data to be displayed on line 4 of the status display and allows the user to change the selection.
Line 5:	Shows the data to be displayed on line 5 of the status display and allows the user to change the selection.
Line 6:	Shows the data to be displayed on line 6 of the status display and allows the user to change the selection.
Line 7:	Shows the data to be displayed on line 7 of the status display and allows the user to change the selection.
Line 8:	Shows the data to be displayed on line 8 of the status display and allows the user to change the selection.

Each line can select one of the following:

SELECTION	MEANING
D1	Density represented in units that are used locally
D2	Density represented in alternate units,
Proc Temp	Shows the temperature of the process in Deg F, Deg C, Deg R, Kelvin
Pressure	Process pressure (if available)
Head Temp	Head temperature (if available)
4-20 mA	4-20 mA output level
Raw Cnts	Raw counts (from scintillation detector) or raw analog measurement (from ionization detector
Filt. Cnts	Filtered counts (from scintillation detector) or (from ionization detector)
Date & Time	Current date and time
Diagnostic	Selecting this takes the user to the Diagnostic Menu
Not Assigned	Blank line

Configuration Menu

The Configuration menu is used to access area configuration menus. It contains the following items:

ITEM	FUNCTION
Operation	Selecting this takes the user to the Operation menu.
D1 Config	Selecting this takes the user to the D1 Config menu.
D2 Config	Selecting this takes the user to the D2 Config menu.
Proc Temp Config	Selecting this takes the user to the Proc Temp Config menu.
Pressure Config	Selecting this takes the user to the Pressure Config menu.
Head Temp Config	Selecting this takes the user to the Head Temp Config menu.
Alarms	Selecting this takes the user to the Alarm menu.
Hardware	Selecting this takes the user to the Hardware menu.
HART	Selecting this takes the user to the HART menu.
System	Selecting this takes the user to the System menu.

Operation Menu

The Operation menu is used to access the menus and variables that control the processing of the density data. It contains the following items:

ITEM	FUNCTION
Filtering	Selecting this takes the user to the Filtering menu.
Empty Clamp	Selecting this takes the user to the Empty Clamp menu.
Detector Fault	Selecting this takes the user to the Detector Fault menu.
Linearization	Selecting this takes the user to the Linearization menu.
Temp Comp	Selecting this takes the user to the Temp Comp menu.
Pressure Comp	Selecting this takes the user to the Pressure Comp menu.
Scan Time	Shows the amount of time to accumulate each density sample and allows the user change the time value.

Filtering Menu

The Filtering menu is used to configure the parameters associated with the mold level measurement filter, utilizing the standard scan rate. It contains the following items:

ITEM	FUNCTION
Type	Shows and allows the user to change to the RC 1st Order type of filtering (Resistance Capacitance Filtering) or the Walking Average type of Filtering.
Dyn Track	Shows the current state of the dynamic tracking filter (enabled or disabled) and allows the user to change the state.
Sigma	**Shows the (sigma) multiplier used to determine maximum number of raw counts variation (for scintillation) or raw analog value (for ion chamber) that the input can vary from the current filtered counts before changing to the dynamic filter. Sigma is the square root of the current filtered counts. Also allows user to change this number.**
Fast TC	Fast Time Constant value to be used when the Fast Counter reaches zero.
Fast Counter	Shows the fast count down counter value. If the gauge has been in dynamic tracking long enough to be using Medium filter and the raw counts continue to exceed the sigma value, the fast counter value is decreased each consecutive scan. The Fast counter value resets and returns to the original value if the raw counts do not continue to exceed the sigma value. Once the Fast TC is triggered, it will continue to be used until the counts are within the sigma value for the Fast counter number of times consecutively. Also allows user to change this number.
Medium TC	Medium Time Constant value is to be used when the Slow Counter reaches zero.
Slow Counter	Shows the slow count down counter value. If the gauge is in dynamic tracking, and the raw counts continue to exceed the sigma value, the slow counter value is decreased each consecutive scan. The Slow counter value resets and returns back to the original value if the raw counts do not continue to exceed the sigma value. Also allows user to change this number.
Slow TC	Slow Time Constant value is to be used if the Slow Counter has not reached zero
Noise Filter	Shows the maximum number of potentially erroneous measurements in a row to bridge before deciding that a step change has occurred in the density value. Also allows user to change this number. Erroneous measurement is defined when the raw signal is 4 times the pre-selected sigma multiplier.
Monitor	Shows the current state of the filtering mechanism.

Monitor (filter state) is one of the following:

ITEM	MEANING
Error	Filter is not initialized (this state should not occur during normal operation of the X96S Density Gauge)
Fill	The walking average buffer is filling
Track	The walking average buffer is filled and the filter is tracking changes in the density value
Refill	A step change has occurred and the walking average buffer is refilling

Empty Clamp Menu

The X96S uses a mechanism called empty clamp to protect detectors (particular scintillation detectors) from saturation conditions.

I.e.: The pipe is typically full, but where the pipe goes empty, therefore causing too much radiation to reach the detector, possibly damaging the electronics. The Min Counts and the Max Counts parameters set the threshold (in raw counts[2]) for activation of the empty clamp function. These Count values should be set above (Max Counts) the Reference Counts, and below (Min Counts) the Calibrate Counts, and beyond your normal measurement range.

The Empty Clamp menu is used to configure the parameters associated with the mechanism that shuts off power to the detector if the detector receives more radiation than it is capable of measuring. It contains the following items:

ITEM	FUNCTION
Empty Clamp	Shows the current state of the empty clamp mechanism (enabled or disabled) and allows the user change the state.
Off Time	Shows and allows the user to change the number of seconds that power to the detector be shut off when the empty clamp mechanism activates before turning the detector on to see if the radiation level has dropped to a value that the detector is capable of measuring. Typical value is set for 30 seconds.
Rcvry Time	Shows and allows the user to change the number of seconds that power will be applied to the detector when the empty clamp mechanism has activated to see if the radiation level has dropped to a value that the detector is capable of measuring. Typical value here is between 1 – 10 counts. (0 counts disables the minimum count.)
Min Counts	Shows and allows the user to change the minimum number of counts that are used to determine that the detector is saturated (exposed to more radiation than it is capable of measuring).
Max Counts	Shows and allows the user to change the maximum number of counts that are used to determine that the detector is exposed to more radiation than it is capable of measuring. (Typical count is 40,000 per seconds; maximum count is 160,000)

Detector Fault Menu

The Detector Fault menu is used to provide an alarm if the detector fails. This alarm is assigned to one of the digital outputs (Relay/TTL).

Min Counts	Shows and allows the user the minimum number of counts the detector would operate under normal operating conditions. Any counts below this value means the detector failed. (typical count is 1 if scintillation; 0 if ion chamber)
Max Counts	Shows and allows the user the maximum number of counts the detector would operate under normal operating conditions. Any counts above this value means the detector failed. (Typical count is 80,000 per second; maximum count is 160,000)

[2] The threshold is in raw counts since the overload is a function of the radiation effect on the detector and not related to any corrected or converted data.

Linearization Menu

The X96S is capable of performing a multi-point linearization of the density data when required by an application. The linearization table contains 32 entries, numbered 1 through 32. Each entry consists of a measured value, an actual value, and a flag that indicates if the entry is used[3].

The Linearization menu is used to control the linearization mechanism. It contains the following items:

ITEM	FUNCTION
Linearize	Shows the current state of the Linearization mechanism (enabled or disabled) and allows the user change the state.
Table Entry	Shows and allows the user to select an entry in the linearization table.
Entry Used	Shows and allow the user to set the entry
Measured	Shows and allows the user to set the displayed indicated value associated with this linearization table entry. This is the nonlinear value calculated by the X96S when linearization is disabled.
Actual	Shows and allows the user to set the actual value associated with this linearization table entry. This value is the physically measured value of the process.
Clear Table	This invokes a method that clears all entries in the linearization table.

Temp Comp Menu

Temperature compensation in the X96s is calculated as a quadratic function[4]. If temperature compensation is to be used, the process temperature can be captured automatically for you during Referencing by enabling Temp Auto Cap. If you choose to enter the temperature manually, the entered value should be the temperature of the process material during the Referencing function.

Process temperature is typically read via platinum or nickel, 2 or 3-wire RTD attached to the X96S. In these cases, the X96S needs no temperature calibration. You can optionally feed a 0-10volt or 4-20mA signal into the X96S from another source that represents the range of temperature for your process. In this case, you will need to perform a Temp Ref to set the range of measurement. You will also need to define the type of temperature device you are using in the **Hardware Menu, Proc Temp** menus.

The Temp Comp menu is used to control the temperature compensation mechanism[4]. It contains the following items:

TEM	FUNCTION
Temp Comp	Shows the current state of the temperature compensation mechanism (enabled or disabled) and allows the user change the state.
Temp Units	Shows and allows the user to set the temperature units used to by the temperature compensation mechanism.
A Coeff	Shows and allows the user to set the “A” coefficient that relates temperature to changes in density.
B Coeff	Shows and allows the user to set the “B” coefficient that relates temperature to changes in density.
Enter Temp	Shows and allows the user to set the process temperature at the time that the gauge was Referenced (if Auto Cap was ‘enabled’ during Referencing).
Temp Auto Cap	This invokes a method that captures the process temperature automatically during gauge Referencing.
Last Ref Temp	Shows the temperature of the process at the time the last reference was completed

[3] Not all of the entries need to be used and the entries do not need to be used in any particular order.

[4] compensated density = uncompensated density + (**A Coeff** * temperature delta) + **(B Coeff** * temperature delta^2)

Temp Units is one of the following:

ITEM	MEANING
degC	degrees Celsius
degF	degrees Fahrenheit
degR	degrees Rankine
Kelvin	degrees Kelvin

Pressure Comp Menu

Pressure compensation is calculated based on the pressure input. The pressure-input range is selected in the **Configuration Menu, Pressure Config Menu.**
The Pressure Comp menu is used to control pressure compensation mechanism[5]. It contains the following items:

ITEM	FUNCTION
Pres Comp	Shows the current state of the pressure compensation mechanism (enabled or disabled) and allows the user change the state
Pressure Units	Shows and allows the user to see the pressure units used to by the pressure compensation mechanism
A Coeff	Shows and allows the user to set the "A" coefficient that relates pressure to changes in density
Enter Pressure	Shows, and allows the user to set, the process pressure at the time that the gauge was Referenced (if Auto Cap was 'enabled' during Referencing).
Pres Auto Cap	This invokes a method that captures the process temperature automatically during gauge Referencing

Pressure Units is one of the following:

ITEM	MEANING
PSI	Pounds per square inch
Bar	Bar
G/Sqcm	Grams/square centimeter
Kg/Sqcm	Kilograms/square centimeter
Pa	Pascal
KPa	Kilopascal
atm	Atmosphere

[5] compensated density = uncompensated density + (**A Coeff** * pressure delta)

D1 Config Menu

The D1 Config menu is used to configure the parameters associated with the density measurement. It contains the following items:

ITEM	FUNCTION
D1 Units	Shows and allows the user to set the density units used
D1 Low Range	Shows and allows the user to set the density value to be mapped to 4ma on the current loop output, if D1 is selected to control that current loop.
D1 High Range	Shows and allows the user to set the density value to be mapped to20ma on the current loop output, if D1 is selected to control that current loop.
% Solids Variables	**Selecting this takes the user to the % Solids Variables menu**
% Acids Variables	Selecting this takes the user to the % Acids Variables menu

D1 Units is one of the following:

ITEM	MEANING
SGU	specific gravity
degTwad	degrees twaddle
degBrix	degrees brix
degBaum_hv	degrees baume heavy
degBaum_lt	degrees baume light
degAPI	degrees API
Percent_sol_wt	percent solids by weight
degBall	degrees balling
percent_StmQual	percent steam quality
% Acids	percent acids

% Solids Variables Menu

The % Solids Variables menu is used to configure the parameters associated with the percent of solids measurement. It contains the following items:

ITEM	FUNCTION
Carrier	Shows and allows the user to set the density of the carrier.
Solids	Shows and allows the user to set the density of the solids.

% Acids Variables Menu

The % Acids Variables menu is used to configure the parameters associated with the percent of acids measurement. It contains the following items:

ITEM	FUNCTION
Algorithm	Allows the user to select the desired algorithm.
Parameter A	Allows the user to adjust the Parameter A value.
Parameter B	Allows the user to adjust the Parameter B value.
Parameter C	Allows the user to adjust the Parameter C value

Algorithm Menu

The Algorithm menu allows the user to select the calculation associated with the percent of acids measurement.

ITEM	MEANING
None	Not used
Linear	A (Y) + B
Quadratic pos/neg	A (Y)^2 + B (Y) + C
Logarithmic	In (Y) + A
Quadratic, neg/pos	A(Y)^2 + B(Y) + C

D2 Config Menu

The D2 Config menu is used to configure the parameters associated with the alternate representation of the density measurement. It contains the following items:

ITEM	FUNCTION
D2 Units	Shows and allows the user to set the density units used for the alternate representation of the density measurement
D2 Low Range	Shows and allows the user to set the density value to be mapped to 4ma on the current loop output, if D2 is selected to control that current loop.
D2 High Range	Shows and allows the user to set the density value to be mapped to20ma on the current loop output, if D2 is selected to control that current loop.
% Solids Variables	Selecting this takes the user to the % Solids Variables menu
% Acids Variables	Selecting this takes the user to the % Acids Variables menu

`D2 Units is one of the following:`

ITEMS	MEANING
SGU	specific gravity
degTwad	degrees twaddle
degBrix	degrees brix
degBaum_hv	degrees baume heavy
degBaum_lt	degrees baume light
degAPI	degrees API
Percent_sol_wt	percent solids by weight
degBall	degrees balling
Percent_StmQual	percent steam quality
Percent Acids	percent acids

% Solids Variables Menu

The % Solids Variables menu is used to configure the parameters associated with the percent of solids measurement. It contains the following items:

ITEM	FUNCTION
Carrier	Shows and allows the user to set the density of the carrier
Solids	Shows and allows the user to set the density of the solids

% Acids Variables Menu

The % Acids Variables menu is used to configure the parameters associated with the percent of acids measurement. It contains the following items:

ITEM	FUNCTION
Algorithm	Allows the user to select the desired algorithm
Parameter A	Allows the user to adjust the Parameter A value
Parameter B	Allows the user to adjust the Parameter B value
Parameter C	Allows the user to adjust the Parameter C value

The Algorithm menu allows the user to select the calculation associated with the percent of acids measurement.

ITEM	MEANING
None	Not used
Linear	A (Y) + B
Quadratic pos/neg	A (Y)^2 + B (Y) + C
Logarithmic	In (Y) + A
Quadratic, neg/pos	A(Y)^2 + B(Y) + C

Proc Temp Config Menu

The Proc Temp Config menu is used to configure the parameters associated with the process temperature measurement. It contains the following items:

ITEM	FUNCTION
Temp Units	Shows and allows the user to set the units to be used for process temperature
Low Range	Shows and allows the user to set the temperature value to be mapped to 4ma on the current loop output, if process temperature is selected to control that current loop.
High Range	Shows and allows the user to set the temperature value to be mapped to20ma on the current loop output, if process temperature is selected to control that current loop.

Temp Units Menu

Temp Units is one of the following:

ITEM	MEANING
degC	degrees Celsius
degF	degrees Fahrenheit
degR	degrees Rankine
Kelvin	degrees Kelvin

Pressure Config Menu

The Pressure Config menu is used to configure the parameters associated with the process pressure measurement. It contains the following items:

ITEM	FUNCTION
Pressure Units	Shows and allows the user to set the units to be used for process pressure
Low Range	Shows and allows the user to set the pressure value to be mapped to 4ma on the current loop output, if process pressure is selected to control that current loop.
High Range	Shows and allows the user to set the pressure value to be mapped to20ma on the current loop output, if process pressure is selected to control that current loop.

Pressure Units Menu

Pressure Units is one of the following:

ITEM	MEANING
PSI	Pounds per square inch
Bar	Bar
G/Sqcm	Grams/square centimeter
Kg/Sqcm	Kilograms/square centimeter
Pa	Pascal
KPa	Kilopascal
atm	Atmosphere

Head Temp Config Menu

The Head Temp Config menu is used to configure the parameters associated with the detector electronics temperature measurement. It contains the following items:

ITEM	FUNCTION
Temp Units	Shows and allows the user to set the units to be used for head temperature
Low Range	Shows and allows the user to set the temperature value to be mapped to 4ma on the current loop output, if head temperature is selected to control that current loop.
High Range	Shows and allows the user to set the temperature value to be mapped to20ma on the current loop output, if head temperature is selected to control that current loop.

Temp Units is one of the following:

ITEM	MEANING
degC	degrees Celsius
degF	degrees Fahrenheit
degR	degrees Rankine
Kelvin	degrees Kelvin

Alarms

The Alarms menu is used to configure the parameters associated with the analog alarms. This applies to alarms 1-8 as well as the4-20 mA alarm.

ITEM	FUNCTION
Source	Shows and allows the user to set the alarm source
Alarm Type	Shows and allows the user to set the alarm type
Setpoint	Shows and allows the user to set the alarm set point
Setpoint2	Shows and allows the user to set the second alarm set point[6]
Hysterisis	Shows and allows the user to set the alarm hysterisis percent

Alarm Type (Alarms 1-8) is one of the following:

ITEM	MEANING
None	Alarm not yet set
Low	Alarm when the source is equal to or lower than Setpoint
High	Alarm when the source is equal to or higher than Setpoint
Range	Alarm when the source is equal to or lower than Setpoint OR the source is equal to or higher than Setpoint2

Alarm Type (Alarm 4-20 mA only) only occurs under one of the following three conditions:
1) System Failure
2) Empty Pipe Clamp
3) Detector Faults

The 4-20 can be configured as one of the following if in “alarm” conditions:

ITEM	MEANING
None	Does not affect the 4-20mA output.
Underrange	If an alarm, then the 4-20 mA is driven underrange.
Overrange	If an alarm, then the 4-20 mA is driven overrange.
Freeze	If there is an alarm, the 4-20mA output is frozen.

[6] The second alarm set point is only used when the alarm type is range.

Hardware Menu

The Hardware menu is used to define the type of hardware used to provide measurements and radiation. It contains the following items:

ITEM	FUNCTION
System Hardware	Shows the user the list of hardware modules in the system and the status of these modules.
Proc Temp	Shows and allows the user to set the type of device used to read process temperature.
Source Type	Selecting this item takes the user to the Source Type menu.
Pressure	Shows and allows the user to set the type of device used to read process pressure.
Analog Out Config	Shows and allows the user to set the source of power as internal or external.
HART Output	Shows and allows the user to adjust the HART output functions.
Com1 Protocol	Shows and allows the user to adjust the Com1 Protocols [None/Hart/Ronan Setup].

System Hardware

The System Hardware menu takes the user to a list of the hardware modules in the system and the status of these modules:

ITEM	FUNCTION
CPU Card	Shows the type of CPU card installed (in slot 1).
CPU Status	Shows the status of the CPU card.
DIO Card	Shows the type of DIO (Digital Input/Output) card installed (in slot 2).
DIO Status	Shows the status of the DIO card.
Slot 3 Card	Shows the type of card (if any) installed in slot 3.
Slot 3 Status	If a card is installed in slot 3, shows the status of the card, else shows None
Slot 4 Card	Shows the type of card (if any) installed in slot 4
Slot 4 Status	If a card is installed in slot 4, shows the status of the card, else shows None
Slot 5 Card	Shows the type of card (if any) installed in slot 5
Slot 5 Status	If a card is installed in slot 5, shows the status of the card, else shows None
Slot 6 Card	Shows the type of card (if any) installed in slot 6
Slot 6 Status	If a card is installed in slot 6, shows the status of the card, else shows None
Slot 7 Card	Shows the type of card (if any) installed in slot 7
Slot 7 Status	If a card is installed in slot 7, shows the status of the card, else shows None
Slot 8 Card	Shows the type of card (if any) installed in slot 8
Slot 8 Status	If a card is installed in slot 8, shows the status of the card, else shows None
Display X96-2002	Shows the type of display module (if any attached)
Display Details	Shows the status of the display module if attached, or else shows None
Field Interface	Shows the type of protocol interface (if any) present
HART DB Details	Shows the status of the protocol interface, if the interface is present, else shows None

Process Temperature

Proc Temp is one of the following:

ITEM	MEANING
None	No temperature measurement device configured
PT100, a=385	Platinum RTD with an alpha of 885 (commonly used in USA)
PT100, a=392	Platinum RTD with an alpha of 892 (commonly used in Europe)
Ni120	Nickel RTD
0-10 volts	Temperature measurement device that provides a 0 to 10-volt signal
4-20 ma	Temperature measurement device that provides a 4-20 ma signal

Source Type Menu

The Source Type menu is used to define the type of radiation source used. It contains the following items:

ITEM	FUNCTION
Source Type	Shows and allows the user to set the source type
Usr Def Source	Selecting this takes the user to the Usr Def Source menu
Next Reference	Shows the date of when the next Reference should be completed
Next Wipe Test	Shows the date of when the next Wipe Test should be completed
Next Shutter Test	Shows the date of when the next Shutter Test should be completed

Source Type is one of the following:

ITEM	MEANING
Unknown	Source type not known
co_60	Cobalt 60
cs_137	Cesium 137
am_241	Americium 241
Usr Def	Any source type other than the ones listed above OR a source of the nominal type listed above with a different half-life

The User Def Source menu is used to define the type of radiation source used. It contains the following items:

ITEM	FUNCTION
Name	Shows, and allows the user to set, the source type name
Half Life	Shows, and allows the user to set, the source half life

Pressure

Pressure is one of the following:

ITEM	MEANING
None	No pressure measurement device configured
0-10 volts	Pressure measurement device that provides a 0 to 10-volt signal
4-20 ma	Pressure measurement device that provides a 4-20 ma signal

Analog Out Config

The analog Out Config menu is used to set where the source of power is. It contains the following items:

ITEM	FUNCTION
Loop 1	Shows and allows the user to assign a source to Loop 1
Loop 2	Shows and allows the user to assign a source to Loop2
Loop 3	Shows and allows the user to assign a source to Loop 3
Power Source	Shows and allows the user to set whether the source of power is internal or external, to power the AO modules outputs

Loops 1-3 contain the following selections:

ITEM	FUNCTION
X96S-2005	Selecting this will assign the HART card to the desired loop
X96S-2004, chan 1	Selecting this will assign the Analog out card to channel 1.
X96S-2004, chan 2	Selecting this will assign the Analog out card to channel 2.
None	No card selected.

The HART Output menu is used to define the type of HART Output desired.

ITEM	FUNCTION
X96S-2005	Selecting this will assign the HART card
Serial Port 1	Selecting this will allow the user to use Serial Port 1
None	No HART Output desired

Com1 Protocol contains the following items:

ITEM	MEANING
None	No protocol selected
HART	HART protocol
Modbus	Modbus protocol
Ronan Setup	Ronan Setup protocol

HART Menu

The Hardware menu is used to provide information about the HART interface. It contains the following items:

ITEM	FUNCTION
Tag Name	Shows and allows the user to set the device tag name.
MultiDrop	Shows and allows the user to set the multi-drop address for a device (or 0 if the device is not used on a multi-drop loop).
Univ Rev	Shows the HART universal command revision to which this device is conferment
Spec Rev	Shows the HART specification revision to which this device is conferment.

System Menu

The System menu is used to provide information about the X96S. It contains the following items:

ITEM	FUNCTION
Serial #	Shows the device serial number
Hardware Rev	Shows the device hardware revision
Software Rev	Shows the device software revision
Date	Shows and allows the user to set the date
Hour (0-23)	Shows and allows the user to set the hour
Minute	Shows and allows the user to set the minute
Password	Shows and allows the user to set a password from the main display to allow access to all menus
Date/Time Format	Shows and allows the user to set the date/time format used on the status display

Date/Time Format is one of the following:

ITEM	MEANING
mm/dd/yy hh:mm:ss	North American date and 24-hour time
mm/dd/yyyy hh:mm:ss	North American Y2K date and 24-hour time,
mm/dd/yy hh:mm:ss am/pm	North American date and 12-hour time with am/pm indication
dd-mm-yy hh:mm:ss	European date and 24-hour time,
dd-mm-yyyy hh:mm:ss	European Y2K date and 24-hour time
dd/mm/yy hh:mm:ss	European date and 24-hour time
dd/mm/yyyy hh:mm:ss	European Y2K date and 24-hour time

Digital Outputs Menu

This menu is used to view and configure the digital outputs. It contains the following items:

ITEM	FUNCTION
Output	Shows and allows the user to select and configure a specific digital output (Relay 1-4 or TTL 1-4)
Select Sources	Selecting this allows the user to assign an array sources to the above digital output
Polarity	Shows and allows the user to set the above digital output

Relay and TTL Menus

The Relay and TTL menus are used to configure the X96S Relay Outputs and the 4 TTL Outputs. The Relay and TTL menus show the settings of the corresponding 4 Relay Outputs and 4 TTL Outputs, allowing the characteristics of the outputs to be changed. Each menu contains the following items:

ITEM	FUNCTION
Relay 1	Selecting this takes the user to the Relay 1 menu
Relay 2	Selecting this takes the user to the Relay 2 menu
Relay 3	Selecting this takes the user to the Relay 3 menu
Relay 4	Selecting this takes the user to the Relay 4 menu
TTL 1	Selecting this item takes the user to the TTL 1 menu
TTL 2	Selecting this takes the user to the TTL 2 menu
TTL 3	Selecting this takes the user to the TTL 3 menu
TTL 4	Selecting this takes the user to the TTL 4 menu

Select sources has the following options to assign:

ITEM	FUNCTION
Alarm 1 [yes/no]	Allows the user to assign Alarm 1 to the selected digital output
Alarm 2 [yes/no]	Allows the user to assign Alarm 2 to the selected digital output
Alarm 3 [yes/no]	Allows the user to assign Alarm 3 to the selected digital output
Alarm 4 [yes/no]	Allows the user to assign Alarm 4 to the selected digital output
Alarm 5 [yes/no]	Allows the user to assign Alarm 5 to the selected digital output
Alarm 6 [yes/no]	Allows the user to assign Alarm 6 to the selected digital output
Alarm 7 [yes/no]	Allows the user to assign Alarm 7 to the selected digital output
Alarm 8 [yes/no]	Allows the user to assign Alarm 8 to the selected digital output
Auto Cal Ref [yes/no]	Allows the user to assign Auto Cal Ref to the selected digital output
Auto Cal Err [yes/no]	Allows the user to assign Auto Cal Err to the selected digital output
Ref Prompt [yes/no]	Allows the user to assign Ref Prompt to the selected digital output
Wipe Test [yes/no]	Allows the user to assign Wipe Test to the selected digital output
Shutter Test [yes/no]	Allows the user to assign Shutter Test to the selected digital output
Empty Clamp [yes/no]	Allows the user to assign Empty Clamp to the selected digital output
Detector Flt [yes/no]	Allows the user to assign Detector Flt to the selected digital output
System Alarm [yes/no]	Allows the user to assign System Alarm to the selected digital output

Polarity has the following options to assign:

ITEM	FUNCTION
NO/Not Driven	Allows the user to configure the selected digital output as non-fail safe mode
NC/Driven	Allows the user to configure the selected digital output as fail-safe mode
Open/Not Driven	Allows the user to force the selected digital output open or not driven (relay de-energized) or driven (TTL not driven) **regardless of the state of the source**
Closed/Driven	Allows the user to force the selected digital output closed (relay energized) or driven (TTL driven) **regardless of the state of the source**

Digital Inputs Menu

This menu is used to view and configure the digital input(s). It contains the following item:

ITEM	FUNCTION
Input 1	Selecting this takes the user to the Input 1 menu

Input 1 Menu

The Input 1 menus (is used to configure the X96S digital input. It contains the following items:

ITEM	FUNCTION
Use	Shows, and allows the user to set, the use of the digital input
Polarity	Shows, and allows the user to set, the active state of the digital input

Use is one of the following:

ITEM	MEANING
Not Used	This digital input is not used
Auto Ref	A "true" on this digital input indicates that the 475 S should perform the auto reference procedure

Polarity is one of the following:

ITEM	MEANING
Low	A "true" is represented by a low signal on the digital input
High	A "true" is represented by a high signal on the digital input

Calibration Menu

This menu is used to view and control the calibration of the X96S Density Gauge. It contains the following items:

ITEM	FUNCTION
State	Shows the state of the density configuration process
Ref Constants	Selecting this takes the user to the Ref Constants menu
Calibrate	Selecting this takes the user to the Calibrate menu
Last Ref Date	Shows the date on which the gauge was most recently Low Referenced.
Last Ref Time	Shows the time on which the gauge was most recently Low Referenced
Loop Config	Selecting this takes the user to the Loop Config menu
Aux Loop Cfg	Selecting this takes the user to the Aux Loop Cfg menu

State is one of the following:

ITEM	MEANING
Fully Calibrated	Calibration complete
Uncalibrated	Needs reference and calibrate or slope.
Referenced	Needs calibrate or slope
Partial Cal	Needs reference or slope
Need Ref Density	Reference density must be entered
Need Cal Density	Calibration density must be entered
Invalid Data	Reference and calibrate data are inconsistent

Ref Constants Menu

This menu is used to view and control the reference constants used in the reference and calibration procedures. It contains the following items:

ITEM	FUNCTION
Ref Mode	Shows and allows the user to set the Reference Mode.
Calib. Mode	Shows and allows the user to set the Calibrate Mode.
Ref Time	Shows and allows the user to set the number of seconds of data to collect for a reference or calibrate sample.
MinRefCnts	Shows and allows the user to set the minimum raw value to use for a reference or calibrate sample.
MaxRefCnts	Shows and allows the user to set the maximum raw value to use for a reference or calibrate sample.

Ref Mode and Calib. Mode have to be selected to one of the following:

ITEM	MEANING
Empty	Nothing (just air) in measuring area.
Water	Measuring area filled with water.
Process	Process material in measuring area (density must be provided).
Absorber	Absorber placed in radiation path.

Calibrate Menu

This menu is used to access the various calibration procedures. It contains the following items:

ITEM	FUNCTION
Low Reference	**Selecting this takes the user to the Low Reference menu.**
High Calibrate	Selecting this takes the user to the High Calibrate menu.
Manual Entry	Shows and allows the user to set the density slope value.
Clear Ref/Cal	This invokes a method that clears the density reference.
Temp Ref	This invokes a method that performs the process temperature calibration.
Pressure Ref	This invokes a method that performs the process pressure calibration.
Auto Reference	Selecting this takes the user to the Auto Reference menu.

Low Reference Menu

This menu is used to perform the low reference procedure. It contains the following items:

ITEM	FUNCTION
Perform Reference	This invokes a method that performs the low reference procedure.
Ref Density	Shows and allows the user to set the reference density value.
Ref Cap	Shows the raw captured density counts.

High Calibrate Menu

This menu is used to perform the high calibrate procedure. It contains the following items:

ITEM	FUNCTION
Calibrate	This invokes a method that performs the high calibrate procedure
Cal Density	Shows and allows the user to set, the calibrate density value
Cal Cap	Shows the raw captured density counts
1/uT	Shows the calculated slope value (Same value as in Calibrate Menu, Manual Entry)

Manual Entry

This menu is used to perform the manual entry of the 1/uT (multiplier).

Temp Reference Menu

(This menu is ONLY used if the **Hardware Menu, Proc Temp** value is set for 0-10 volts or 4-20 ma.)
This menu is used to perform the process temperature reference procedure. It contains the following items:

ITEM	FUNCTION
Temp LoRef	This invokes a method that performs the low temp reference.
Temp HighCal	This invokes a method that performs the high temp calibration.
Temp Cal Low	Temperature value during the Temp Lo Ref procedure.
Temp Cal High	Temperature value during the Temp High Cal procedure.
Temp Cap Low	Shows the raw captured temperature counts during the low temp reference.
Temp Cap High	Shows the raw captured temperature counts during the high temp calibration.
RTD Slope	Factory value for RTD Slope.
RTD Offset	Factory value for RTD Offset.

Pressure Reference Menu

This menu is used to perform the process pressure reference procedure. You will be asked to provide real or simulated pressure input conditions, and then enter the pressures relating to these conditions. It contains the following items:

ITEM	FUNCTION
Pressure Ref	This item invokes a method that performs the two-point process pressure reference procedure.
Pres Cap Low	Shows the raw captured pressure counts for the first calibration point.
Pres Cap High	Shows the raw captured pressure counts for the second calibration point.

Loop Config Menu

This menu is used to access the primary 4-20ma loop calibration procedures. It contains the following items:

ITEM	FUNCTION
PV	Shows and allows the user to set the variable assigned to the primary 4-20ma current loop
Loop test	This invokes a method that performs a test on the primary 4-20ma current loop
Damping	Shows and allows the user to set the damping constant for the primary 4-20ma current loop
D/A trim	This invokes a method that performs the D/A trimming of the primary 4-20ma current loop

The PV menu allows you to select one of the following:

ITEM	MEANING
D1	Density represented in units that are used locally
D2	Density represented in alternate units
Proc Temp	Process temperature
Pressure	Process pressure (if available)
Head Temp	Head temperature (if available)
Not Assigned	Blank line

Aux Loop Cfg Menu

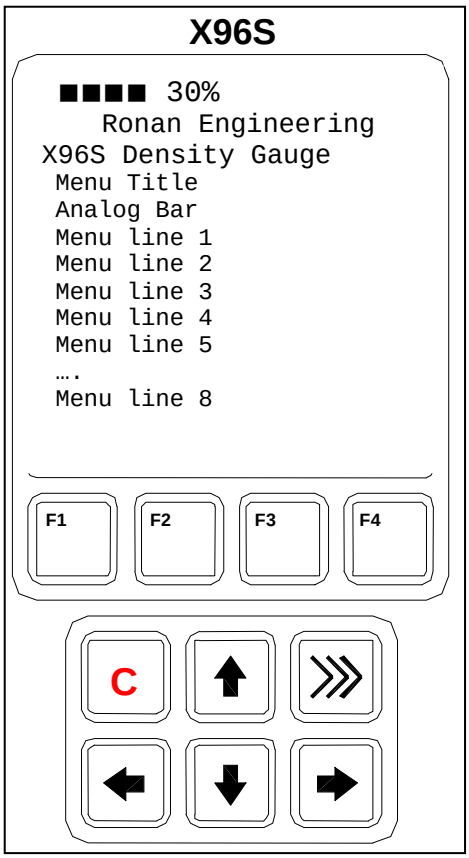
This menu is used to access the secondary 4-20ma loop calibration procedures. It contains the following items:

ITEM	FUNCTION
SV is	Shows and allows the user to set the variable assigned to the SV (secondary variable) 4-20ma current loop
Aux 1 Test	This invokes a method that performs a test on the secondary 4-20ma current loop
Aux 1 Trim	This invokes a method that performs the D/A trimming of the secondary 4-20ma current loop
TV is	Shows and allows the user to set the variable assigned to the TV (the Third Variable) 4-20ma current loop
Aux 2 Test	This invokes a method that performs a test on the TV 4-20ma current loop
Aux 2 Trim	This invokes a method that performs the D/A trimming of the TV 4-20ma current loop

Diagnostics

ITEM	FUNCTION
Raw Counts	Non-filtered counts from the detector
Filt Counts	X96S filtered counts from the detector
Raw Dens.	Displays the real time raw density value
Current	Displays the real time 4-20ma value
Ref/Cal Data	Displays the information on the reference/calibration data
Alarms	Information available for trouble shooting the alarms

X96S Local Display



The X96S Local Display consists of 8 lines by 21-character display and a 10-key keypad. The top line of the display is reserved for the analog bar, if enabled. The next line is used for the Ronan logo. Line #3 shows the device model line. Line #4 displays the specific screen title. That title is typically a screen description or required action. The remainder of lines, with the exception of the last line, is screen or action dependent. The last line displays the active function keys labels.

Directly beneath the display is a keypad. The keypad is divided into two parts:

- a 4 key function key section and
- a 6 key (2 rows of 3 keys) cursor control section

Navigating Menus

The menu and the display screen are one or more lines, each consisting of a line label (name of the entry) and optional value and units. In most cases the menu navigation is exactly following the Rosemount 475 Configurator's user interface.

The first column is reserved for direction keys if the number of lines does not fit the physical display. The second column will show a right arrow character when the cursor is on this line and there is sub-menu or some other screen or action assigned to this line. If the menu is not at the top level, the end of the menu title line will show left arrow to indicate it, and to remind that the user could 'go back' to the previous menu by pressing left arrow.

If the line length is longer than the physical display, a right arrow will be displayed, and if the right arrow key is pressed, the value will be displayed in a screen, similar to the editing one, but with editing disabled.

Depending on the type of the function assigned to the line a different screen will be shown when the user presses the right arrow key.

If this line is a sub-menu, another menu opens.

Editing Values

The editing of different types of values is designed around the use of the four direction keys and up to 4 function keys. The left and right arrow keys are used to position the cursor to the letter/digit to be edited, and up and down arrow keys are used to scroll between the possible values for this position.

In all editing functions, the edited value is displayed below the current value.

Editing Fixed Point Numbers

Using left and right arrow keys, position the cursor at the desired position and scroll the digit at this position using up and down arrow keys. When the value rolls up or down a carry/borrow occurs from the next/previous digits. When done, press F4. To discard changes and abort, press F3.

Editing Floating Point Numbers

Using left and right arrow keys, position the cursor at the desired position and scroll the digit at this position using up and down arrow keys. When the value rolls up or down a carry/borrow occurs from the next/previous digits. When done, press F4. To discard changes and abort, press F3.

The difference to the fixed-point editing is that the decimal point is automatically skipped when moving the cursor left or right.

Editing Text Strings

Using left and right arrow keys position the cursor at the desired position and scroll the character at this position using up and down arrow keys. The characters are rotated between blank and ‘z’. When done, press F4. To discard changes and abort, press F3.
When the string value is a password, it always starts with * for every character to avoid seeing the password.

Editing Enumerated Values

The enumerated values are displayed as menu items below the current value. The up and down arrow keys are used to select the desired choice, and F4 is used to confirm it. F3 is used to abort the editing and leave the value unchanged.

X96S Local Display Vs 475 Calibrator

The local display user interface is very similar to the 475 Calibrator, but there are some differences. One of the major ones is the fact that the X96S local display lacks a numeric keypad. This automatically means that the shortcuts are not supported, as also the value editing is done using only the cursor keys.

Another difference is the fact that all values in the local display are immediately updated, and there is no need to use SEND action whenever a value is changed. Also, the flashing ‘heart’ character indicating that the configurator is exchanging data through HART communication is not needed and thus not presented on the local display.

When there is a value to be displayed and the line length doesn’t fit the display, the 475 Configurator displays the label only and lets the user see the value using the right arrow key. X96S local display will display whatever could fit the display, thus indicating to the user that there is more to be displayed and the right arrow sign is not indicating a new menu.

Installation

Caution

Ronan's Density Gauge uses a sealed radioactive cesium (Cs-137) or cobalt (CO-60) source which is safe if handled properly.

Specific License

(SA or GS Series)

If your gauge is equipped with the SA or GS series source holder, you are required to obtain a specific license. Your company's specific license will name a Radiation Safety Officer (RSO) or Radiation Protection Officer (RPO). The RSO for your company must be notified immediately upon receipt of the gauge. DO NOT proceed with unpacking, storage, or installation without the RSO's authorization.

General License

(RLL Source Holder)

If your gauge is equipped with the RLL series source holder, you are not required to obtain a specific license. Your company should assign a responsible party to maintain records and supervise the installation and commission of the source holder.

Ronan's field service personnel are available for advice or assistance. (859) 342-8500.

Unpacking

All equipment manufactured by Ronan is carefully packaged to prevent shipping damage. Unpack the equipment in a clean, dry area.

Examine the contents and compare them to the packing list. Immediately report any discrepancy or damage to Ronan, the company's RSO, and the carrier. File a claim with the carrier.

Storage

If it is necessary to store this equipment before mounting, the RSO or responsible party will assign a safe and secure location with no personnel access.

During storage avoid temperatures below freezing, and areas with excessive humidity, moisture, or dirt.

INSPECTION

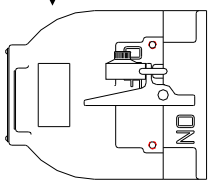
The source holder is equipped with an ON/OFF Mechanism. During shipment and storage, the mechanism MUST BE SECURED in the OFF position with a padlock.

If the padlock is damaged, broken, or missing, contact the RSO immediately.

Radiation Label

General License Label
(if applicable)

SA1



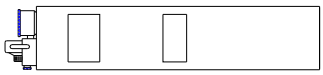
Handle Padlocked OFF

Radiation Label

General License Label
(if applicable)

GS-200

Plunger Padlocked OFF

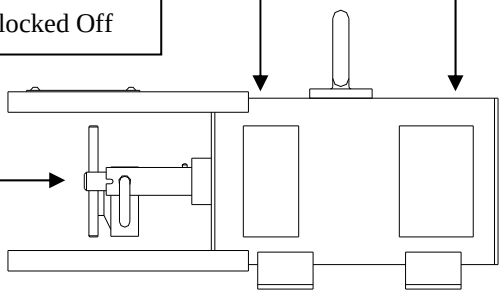


General License Label
(if applicable)

Radiation Label

Handle Padlocked Off

GS-400



RONAN ENGINEERING COMPANY – MEASUREMENTS DIVISION

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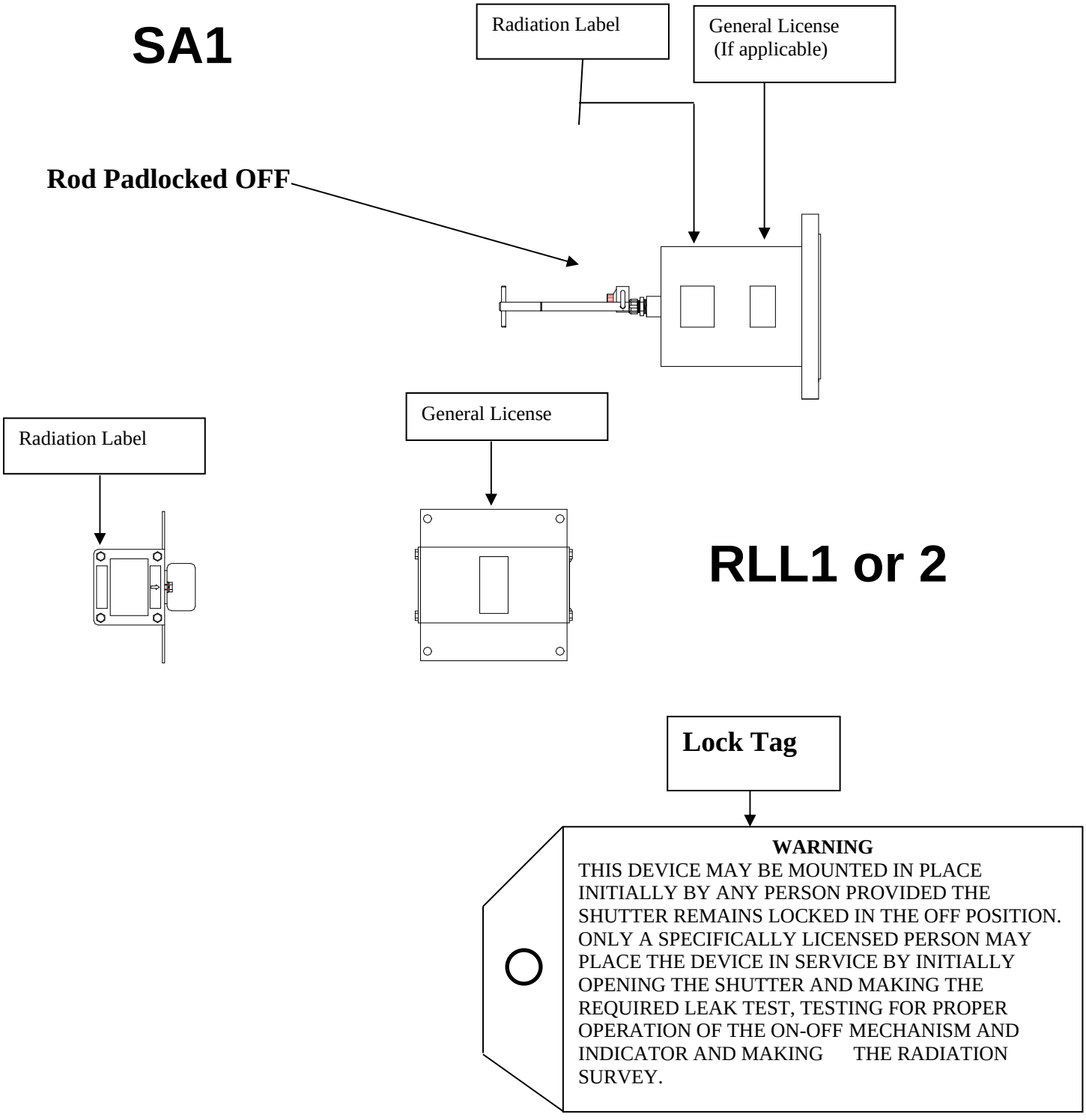
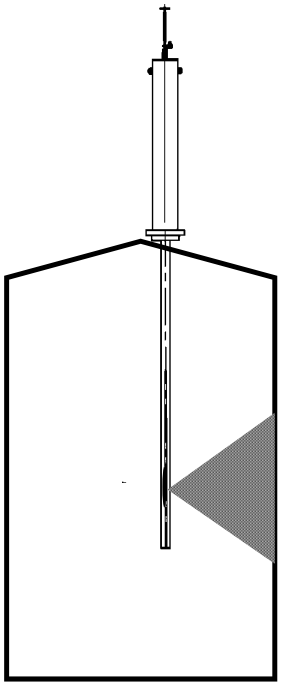
Updated June 8, 2021

SA1


Radiation Label
General License
(If applicable)
Rod Padlocked OFF
General License
Radiation Label
RLL1 or 2
Lock Tag
WARNING
THIS DEVICE MAY BE MOUNTED IN PLACE INITIALLY BY ANY PERSON PROVIDED THE SHUTTER REMAINS LOCKED IN THE OFF POSITION. ONLY A SPECIFICALLY LICENSED PERSON MAY PLACE THE DEVICE IN SERVICE BY INITIALLY OPENING THE SHUTTER AND MAKING THE REQUIRED LEAK TEST, TESTING FOR PROPER OPERATION OF THE ON-OFF MECHANISM AND INDICATOR AND MAKING THE RADIATION SURVEY.

Safety Precautions

During installation the RSO will provide guidelines to assure safety. Consider the information presented in the Regulation/Safety Chapter of this manual, as well as the following general guidelines:



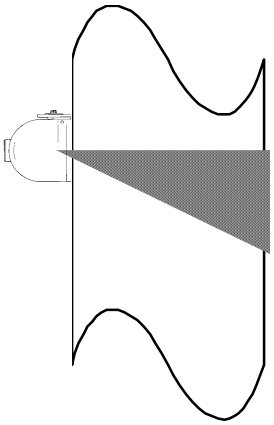
The source holder must remain padlocked in the OFF position until installation is complete.

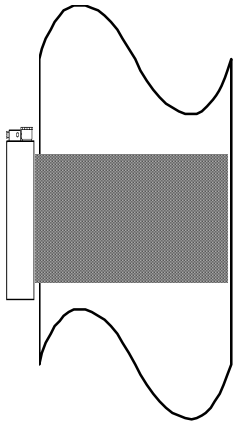
Take all necessary precautions to assure that the source holder is not dropped or damaged.

A specifically licensed individual MUST inspect the installation prior to placing the source holder in the ON position.

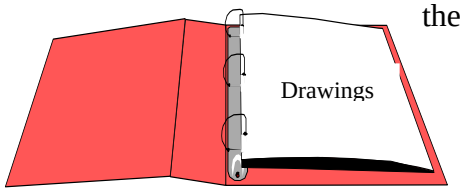
Always turn the source holder to the OFF position when working around it, the detector, or the area between these two components which is referred to as the "measuring gap."

When the source holder is placed in the ON position, avoid the "active beam."





Mechanical Mounting



Drawings:
Configuration
Installation

Review the Configuration Drawing, which is included in the Drawing Chapter of this manual.

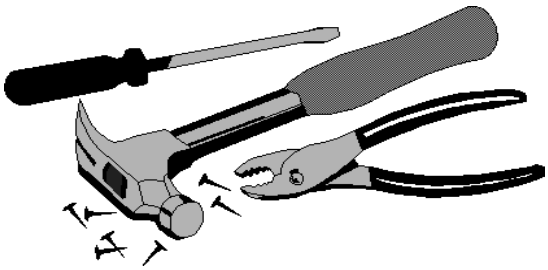
Please reference the dimensional drawings located in the Drawing Chapter of this manual when installing the equipment.

Consider the following general guidelines when mounting the sensor and detector:

Avoid internal vessel obstructions such as baffles, agitators, man-ways, heater/cooler tubes, etc. which could interfere with the transmission through the vessel of the radiation's "active beam."

The source and detector must be rigidly mounted so they do not move with respect to each other. Such movement will destroy the system's calibration and/or its measurement.

Insulation must be used at the point of installation IF:
- the temperature of the process pipes at that spot exceeds 120°F (50°C), or
- the voltage transmission through the pipe could interfere with the signal transmission from the source to the detector.



Location for Ronan Density Gauge

The ideal location for the Ronan Density gauge is where there is no entrained air**, the process is** well mixed**, the flow has a** uniformed cross-sectional area, **the** flow direction is upward **and where a representative sample of the process can be accessed.**

The best location for the density gauge is on a straight vertical pipe that has a constant inner diameter. The pipe should be a straight section of 8 to 12 feet of pipe above the outlet of the pump. The gauge should be mounted in the middle of this pipe. A sample port should also be located within 10 feet of the density gauge. If there is any obstruction in the process pipe (such as flow meters, temperature probes or valves) the gauge should be located upstream to avoid entrained air caused by these devices.

If a gauge can only be mounted on a horizontal pipe, the gauge should be mounted in a 3 o'clock to 9 o'clock manner or a 5 o'clock to 11 o'clock manner. This will help avoid solids that lay on the bottom of the pipe and entrained air that gets trapped at the top of the pipe. The pipe should have an upward and/or vertical section that is downstream from the measurement to ensure there is plenty of head pressure to compress or avoid the possibility of entrained air.

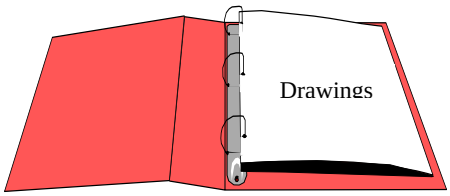
If you have a pipe where the diameter changes, you want to try and have the gauge mounted away from this section as far as possible to avoid entrained air.

If you want to mount the density gauge near a pipe-bend on the downstream side, as a general rule you should mount the gauge at least 4 diameters of the pipe id or further away.

Avoid locating the gauge on the inlet side of the pump or on pipe sections where the flow is downward. There have been some successful gauges that work in these locations but they are rare and difficult to achieve. It usually requires modifications to ensure that these sections do not have entrained air.

Once again, when selecting a location for the Ronan Density gauge, you will want to find a location where there is **no entrained air**, the process is **well mixed**, the flow has a **uniformed cross-sectional area,** the **flow direction is upward** and where a representative sample of the process can be accessed.

Electrical Installation of Interconnect Wiring



DO NOT APPLY POWER until wiring is carefully checked.

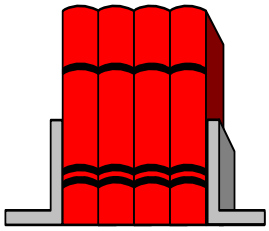
Wire the equipment according to the detailed interconnect drawing which is included in the drawing section of your packet.

Follow local and national electrical codes for all interconnections.

Consider the following guidelines before making any electrical connection:

Use continuous conduit runs and protect housing junction boxes from dripping of condensed moisture off of conduit.

Plug unused conduit holes to prevent entry of dirt and moisture.

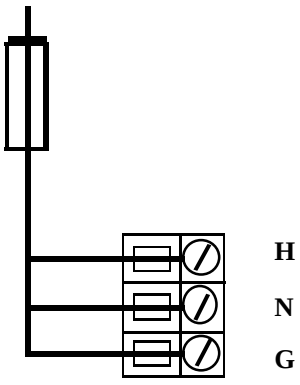


Run the interconnect cable in a separate conduit. Feed the cable through the conduit starting at the detector end and terminate at the microprocessor end.

DO NOT run AC power cable in the same conduit with any of the low-level cables (detector signal, mV, mA, etc.)

LOCAL CODE
NATIONAL CODE

Maintain transient-free AC power sources between 105-130 VAC for the microprocessor. DO NOT use a line that is connected to a large motor, welding equipment, solenoids, etc.



POWER INPUT

WITH POWER OFF - - -
Connect cable pre-wired MS connector to detector.

Immediately replace lid of detector housing to keep out water and dirt.

Check connections at microprocessor chassis terminals. Verify that all wires are fully inserted in terminal sockets and the screws firmly tightened.

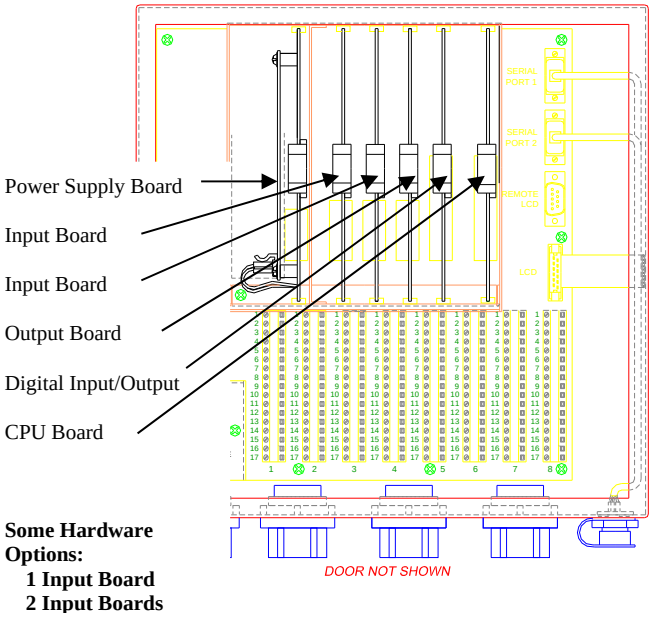
Heater Blanket:

If the gauge utilizes a heater blanket, it must be powered for 5 continuous hours before calibrating and utilizing the gauge. The blanket must have continuous power supplied at all times.

Microprocessor Verification

Rotate latch clockwise to open the enclosure door. Next, remove the computer front cover by sliding the black tabs down. Check each board to see if they are fully seated into the motherboard. Identify the CPU and other major boards from the drawing below. **Optional configurations are possible.**

NOTE:
These boards are not interchangeable in the frame's slots.

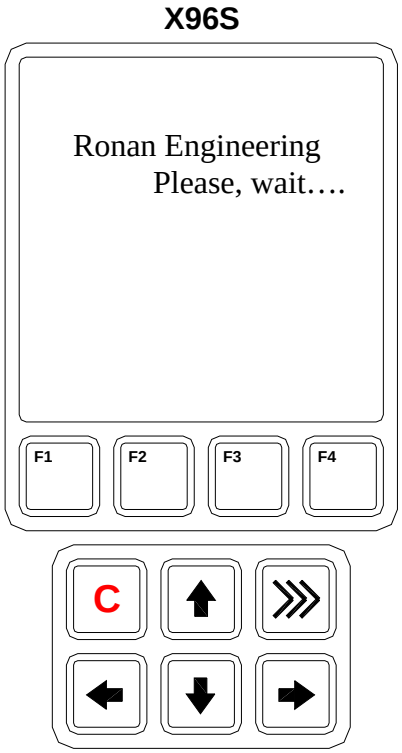


Some Hardware Options:
1 Input Board
2 Input Boards

Identification/ Documentation

The Ronan X96S Microprocessor can be programmed for a variety of applications and configurations. ***The specific application supplied with each system is determined by the combination of software and the unique hardware configuration used to support the software.***

Power-up



Before applying power, ensure all boards are fully seated in frame's slots. Close front door of the X96S and secure the door...

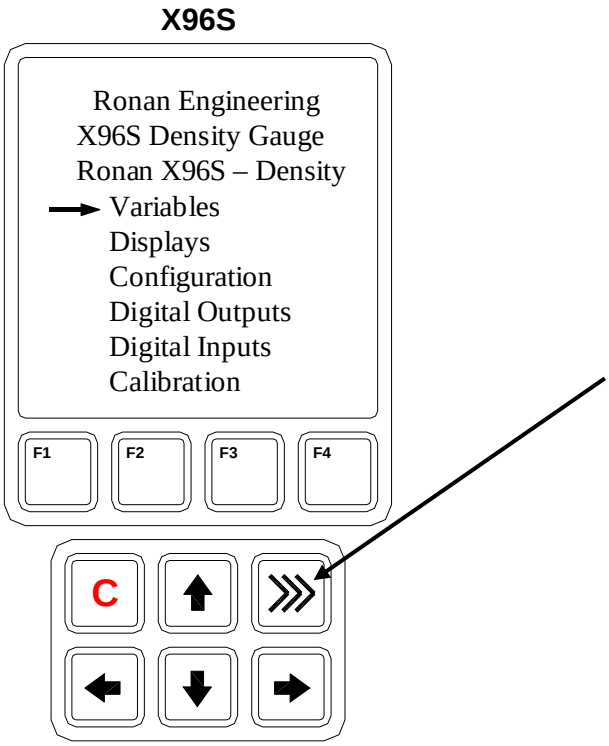
When power is applied the X96S runs a self-diagnostic program.

First display appears for just a second.

To adjust the contrast on the LCD display:

Press the "C" button to adjust the contrast on the LCD display. You can make adjustments by pushing the up and down arrows.

When finished adjusting, press the "C" button a second to set and complete the procedure.



The main display appears next as shown. From this screen you can navigate through your system's configuration. To view the status screen, you can press the Hot Key >>> on the keypad.

Password

Notice:

To access the Programming Menu, the Password is **101010**.

Step 1: Power Up – You should now be on the Status Screen.

Step 2: Press F3 to go back.

Step 3: Now enter the password. (All digits are set at 000000 at this point.)

Press  to get the digit to be # one

Press  2 times (The third digit should be highlighted.)

Press  to get the digit to be # one

Press  2 times (The fifth digit should be highlighted.)

Press  to get the digit to be # one

Press F4 (enter)

Note: If the wrong password was entered, press **F1 (ALL0)** to set all the digits to the number 0 and you can begin re-entering the password from the beginning. Pressing **F2 (RST0)** will set the individual digit that is highlighted back to the number 0.

Note: For security reasons, each digit will always be displayed as an asterisk.

Quick Start Reference – Calibrating Density

What type of calibration is needed?

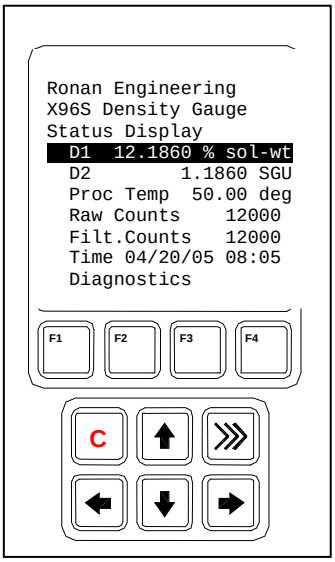
Two types of calibration are available for Ronan's density gauge.

1. Single-point calibration
This requires an accurate laboratory analysis of a truly representative sample of one process density. Single-Point Calibration is used as an alternative method when it is not physically or economically practical to vary the process density. In these cases, a second point is estimated based on the mathematical formula for radiation transmission/absorption.

2. Dual-point calibration
This requires an accurate laboratory analysis of truly representative samples of two process densities. Dual-Point Calibration is preferred when the process can be varied to obtain two process densities (one at each end of the measurement range).

Important facts to remember –

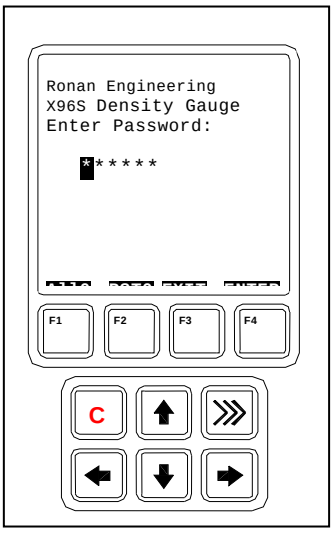
- Equipment should be running at normal environmental conditions – temperature, pressure, process flow, etc.
- Final gauge measurements can only be as accurate as your sampling and analysis technique.
- Remember to document all changes made to the factory parameters that are active in your system.
- The heater blanket must have continuous power at all times.



Step 1 Start at the Status Display

From the Status Display Screen, Press the **F3 Key** to display the Password Screen (or the Main Menus if the password is disabled).

Step 2 Password Menu



With the left most character * highlighted (All digits are set at 000000 at this point), enter in the password '101010'.
Press the ↑ **key 1** time to make the left most character equal to 1.
Press the → **key 2** times to move to the third character.
Press the ↑ **key 1** time to make the third character equal to 1.
Press the → **key 2** times to move to the fifth character.
Press the ↑ **key 1** time to make the fifth character equal to 1.
Press the **F4 key** (enter) to accept the password.
This will take you to the Main Menu.

Note: If the wrong password was entered, press the F1 (All0) to set all the characters back to a value of 000000. You can begin to re-enter the password from the beginning. Pressing the F2 (RST0) will set the individual character that is highlighted back to the value 0.

Note: For security reasons, each character will always be displayed as an asterisk *.

Quick Start Reference – Calibrating Density

(For Completion of a Single Point Reference)

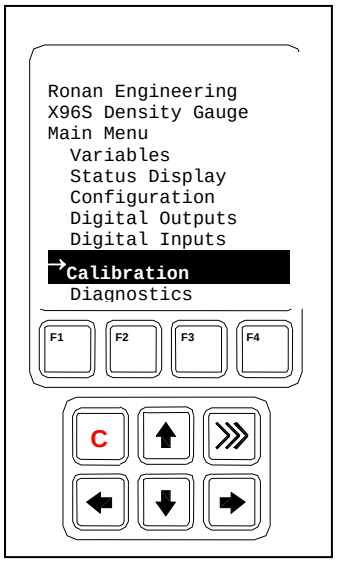
Step 3 'Low Reference Density' Calibration
(Have the process ready filled with water)

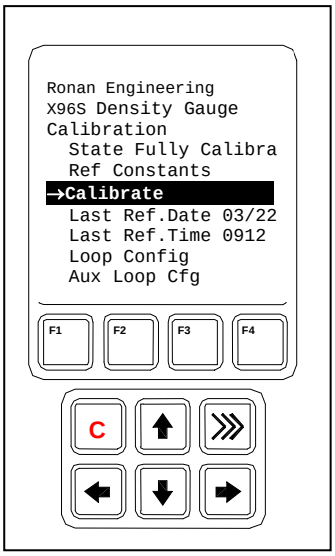
Scroll down ↓ to "Calibration" Press → to enter menu
Scroll down ↓ to "Calibrate" Press the → to enter menu
Scroll down ↓ to **"Low Reference"** Press the → to enter menu
Select **"Reference"** press → to enter menu

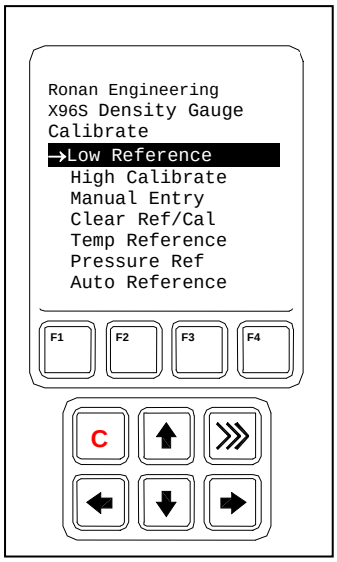
Read the next 3 screens carefully and acknowledge each screen by pressing the **F4 Key** until you see the reference procedure was a success. (This may take several minutes) Press the **F4 Key** again.

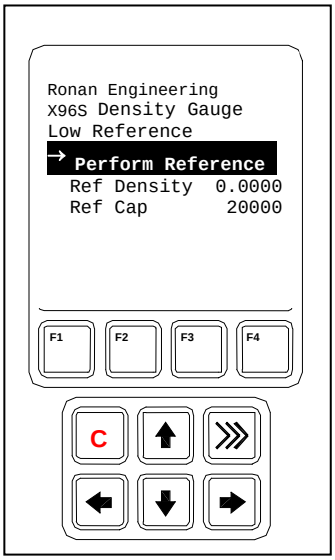
Scroll down ↓ to **"Ref Density"** Press → to enter menu
Notice the value that is displayed.
Use ← **Key** and → **Key** to toggle back and forth between digits.
Change the value using ↑ or ↓
Enter the value of the process (Example 0.0000 %Solids for water).
Press the **F4 Key** to enter and store the value.

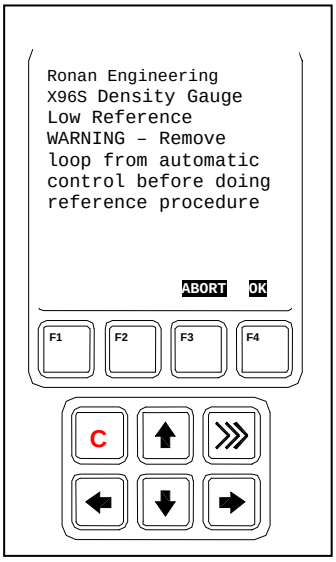
Press the **F3 Key** (Home) to return to the Main Menu.

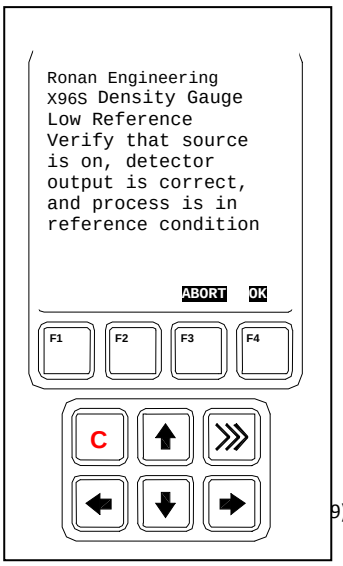


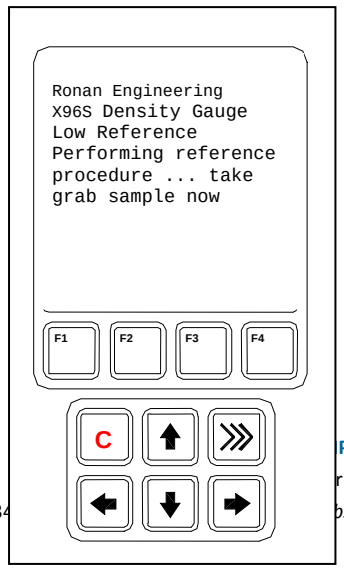


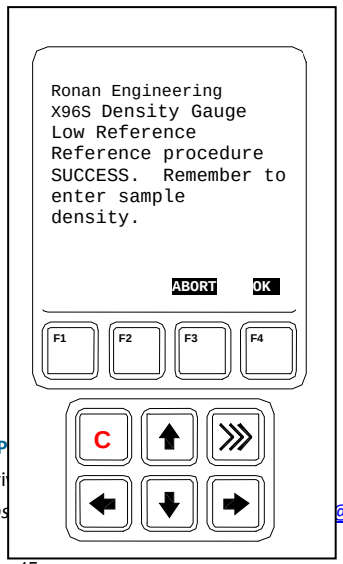


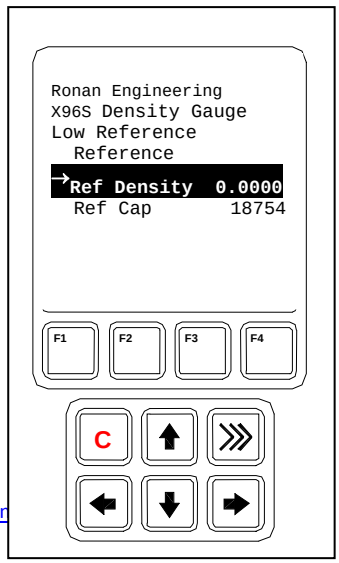












Quick Start Reference – Calibrating Density
(For adjusting the 1/uT or Transmission Constant)

Step 4 High Cal Density Calibration (**Manual Entry**)

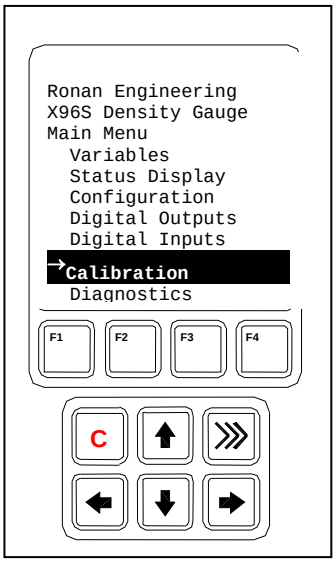
Scroll down ↓ to **"Calibration"** Press → to enter menu
Scroll down ↓ to **"Calibrate" Press** → to enter menu
Scroll down ↓ to **"Manual Entry"** Press → to enter menu
Select **"1/uT"** press → to enter menu
Notice a value is displayed.

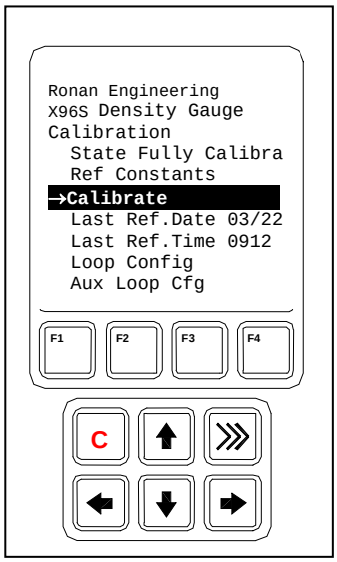
The transmission constant can be manually calculated and entered using the following formula: 1/uT
Where: u = absorption coefficient = 0.16 (using RLL Sourceholder)
T = pipe diameter in inches

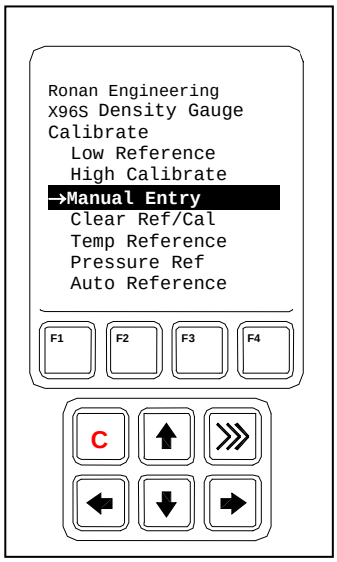
Example: 6" pipe $\frac{1}{(.16)\ (6)} = 1.041666$

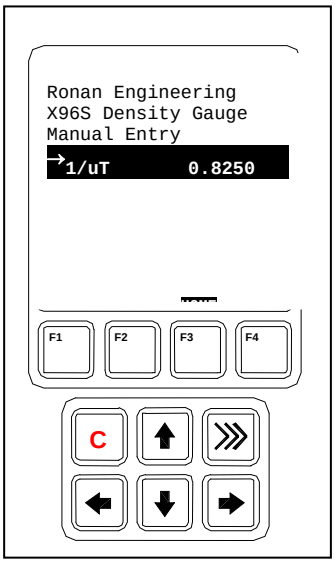
Use ← **Key** and → **Key** to toggle back and forth between digits.
Change the value using ↑ or ↓
Enter the calculated 1/uT value - (example above 1/uT = 1.041666)
Press the **F4 Key** to enter and store the value.

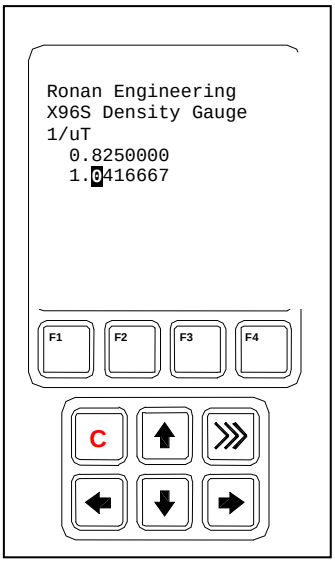
Now press the >>> **Key** to show your status display.











The quick start calibration is now complete. For further help and instructions with calibration please refer to the calibration section or troubleshooting guide in you manual.

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Updated June 8, 2021

Quick Start Reference – Calibrating Density
(For Completing a Dual-Point Calibration)

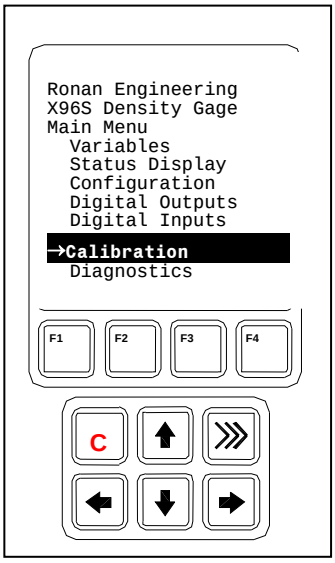
Step 4 'High Density' Calibration

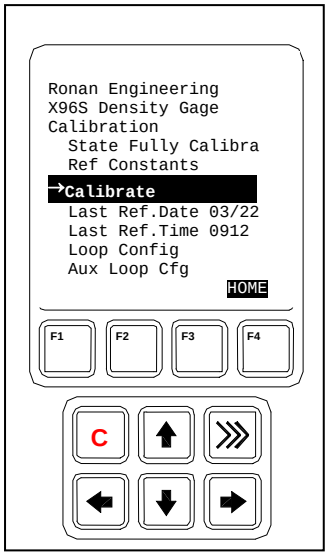
(Have the process ready in the calibrate condition)

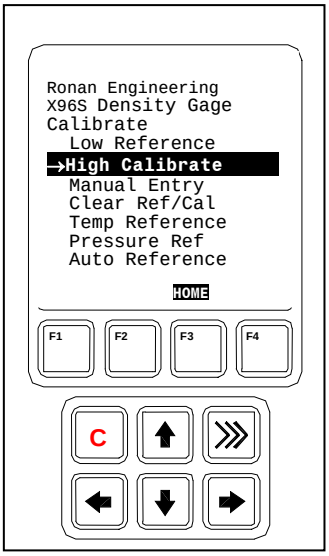
Scroll down ↓ to **"Calibration"** Press → to enter menu
Scroll down ↓ to **"Calibrate"** Press → to enter menu
Scroll down ↓ to **"High Calibrate"** Press → to enter menu
Select **"Calibrate"** Press → to enter menu

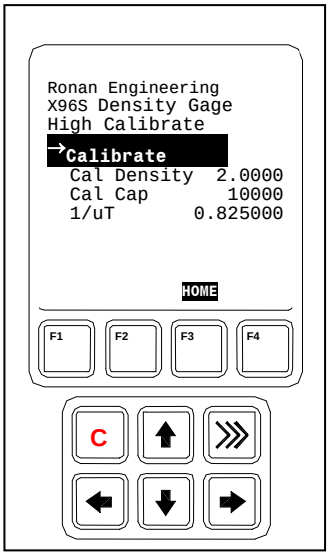
Read the next 3 screens carefully and acknowledge each screen by pressing the **F4 Key** until you see the calibrate measurement taken. (This may take several minutes)
Press the **F4 Key** again.
Scroll down ↓ to **"Cal Density" Press** → to enter menu
Notice the value that is displayed.
Use ← **Key** and → **Key** to toggle back and forth between digits.
Change the value using ↑ or ↓
Enter the value of the process (Example 1.1000 SG).
Press the **F4 Key** to enter and store the value.

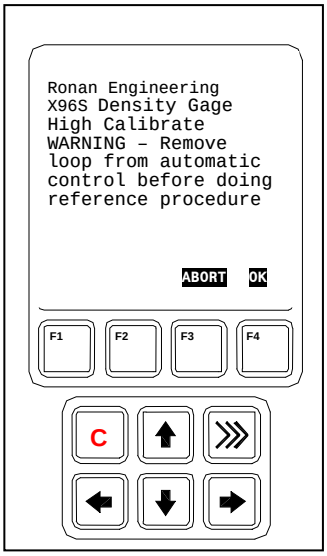
Press ←Key TWO TIMES to get back to the Calibration Menu.

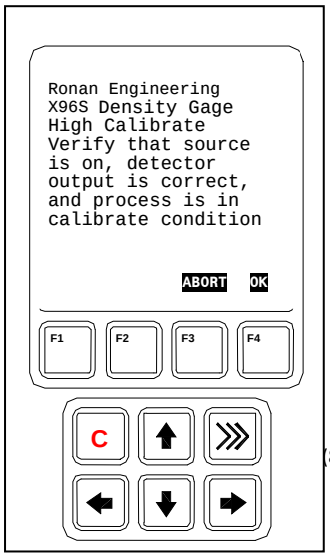


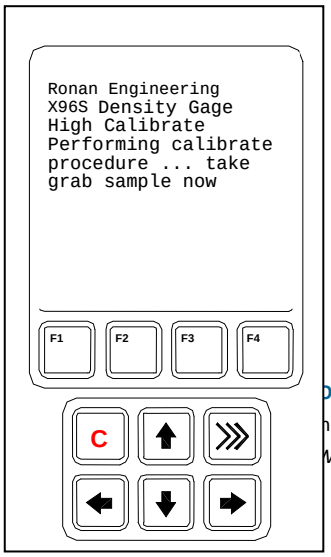


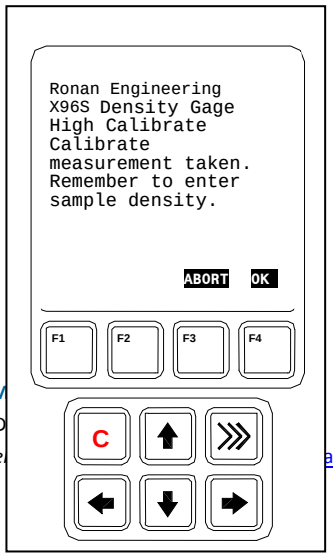


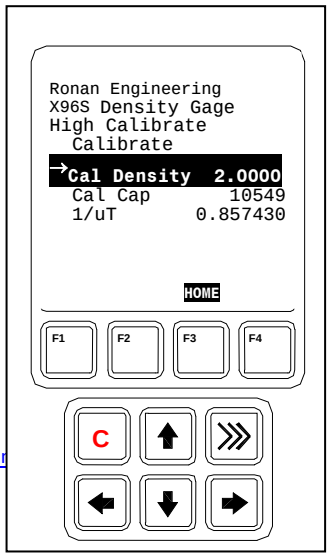












Calibration

Calibration correlates the X96S's output to your actual process density. It instructs the microprocessor to read and store the detector counts for a low and high density of process. Once the system is conditioned to recognize the low and high density, it will provide a 4-20 mA output over the entire range of interest.

Reference Modes

One of your first tasks will be to calibrate the system. The first step in the calibration procedure is to "reference" the gauge on some known value. The steps involved in the referencing procedure will vary slightly depending upon the *mode* selected as the constant.

One of these four REFERENCE MODES will be active on your system:

- Referencing EMPTY (SpG = 0)
- Referencing with WATER (SpG = 1)
- Referencing with PROCESS OF KNOWN DENSITY
- Referencing with ABSORBER

Most applications use the "Reference with Water" or the "Reference with Process" Mode.

Types of Calibration

Two types of Calibration are available for Ronan's Density Monitor.

> **Dual-Point Calibration** requires an accurate laboratory analysis of truly representative samples of **two** process densities. Dual-Point Calibration is preferred when the process can be varied to obtain two process densities (one at each end of the measurement range).
>
> **Single-Point Calibration** requires an accurate laboratory analysis of a truly representative sample of **one** process density. Single-Point Calibration is used as an alternative method when it is not physically or economically practical to vary the process density. In these cases, a second point is estimated based on the mathematical formula for radiation transmission/absorption.

Calibration

Low Reference (Single Point Calibration)

The simplest calibration technique is the "Single Point Calibration" where ONE reference sample is taken from a convenient or easily obtained process condition. This initial reference sample can be any process density in the range of interest.

The conveniently drawn process sample is analyzed in the lab so the known density value can be entered into the X96S as the

reference density (d_O).

Next, the manually calculated calibration constant (1/ut) value, from a table like the one below, is entered into the X96S software.

Calibration Constant

The two values, the reference density (d_O) and the calibration constant (1/ut), are used by the X96S algorithm to calculate process density (d).

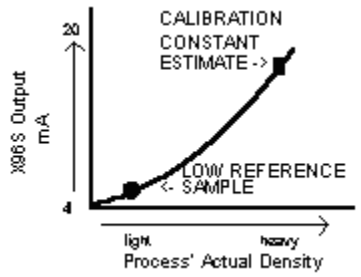
t	ut	1/ut
2"	0.4	2.5
3"	0.6	1.6
4"	0.8	1.25
5"	1.0	1.0
6"	1.2	0.825
8"	1.6	0.625
10"	2.0	0.5

t = mat'l thickness (pipe I.D.)
u = absorption coefficient
= 0.2 for Cs137
1/ut = calibration constant

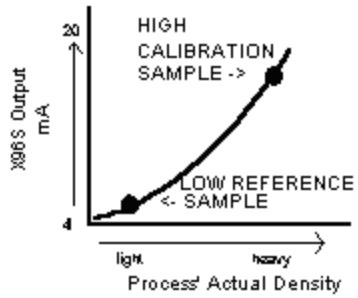
Transmission/Absorption Table

Calibration Curve

The first curve below shows the relationship for a single-point calibration between the Low Reference, the Calibration constant, and the X96S output value.



The calibration curve below depicts a two-point calibration and the relationship between the Low Reference, High Calibrate, and the X96S output value.



High Calibration (Dual Point Calibration)

An alternate calibration technique is the "Dual Point Calibration" where samples of TWO different process densities (d_{o1} and d_{o2}) are drawn, analyzed, and entered into X96S software.

With the addition of a second known density (d_{o2}) the X96S software can now compute very accurately the value of 1/ut, which it uses to determine the process density.

The calibration procedure also reverses the relationship between detector counts and actual process density. Now, a direct relationship exists, so that as the process density changes from light to heavy, the X96S's display screen indicates an increase in user units from minimum to maximum - (example: 1.1 SpG to 1.25 SpG.)

The transmitter output signal also increases from minimum to maximum - (usually 4 to 20 mA).

The exponential algorithm used by the X96S software ensures an accurate measurement and eliminates the need for linearization through a separate stage of signal processing.

Preparation for Calibration

WHAT type of process sample is needed?

Any conveniently obtained process density that is within the range of interest can be used. For example, water-based slurries could use water as the reference sample. Sub-water slurries could use an empty pipe for the reference condition.

WHAT type of sampling procedure is needed?

The sampling procedure will depend upon your own process. You will have to do what is necessary to obtain a truly representative sample of the density(ies) on which you are calibrating. Pull a minimum of three samples of each density. (This means at least three samples of one density for single-point calibration and at least three samples of two densities for dual-point calibration). Take necessary precautions to preserve the integrity of each sample.

WHAT type of laboratory analysis is required?

Precise laboratory analysis will produce the most accurate and useful results. If the results are temperature compensated, you will need to enter the uncompensated values(s) into the X96S software.

Final gauge measurements can be only as accurate as your sampling and analysis technique and level of accuracy.

EQUIPMENT SHOULD BE RUNNING AT NORMAL ENVIRONMENTAL CONDITIONS - TEMPERATURE, PRESSURE, PROCESS FLOW, ETC.

Dual-Point Calibration Procedure

The dual-point calibration uses two separate modules in the X96S software. First you will **REFERENCE** the system at some known low density, and then you will **CALIBRATE** the system at some higher density.

The second part of the dual-point calibration will permit your system to calculate a "calibration constant" (1/uT) for your process. This can be done through the **CALIBRATION** module sequence, which is located in the customer-programmable functions.

Single-Point Calibration Procedure

As an alternative, the single-point calibration can be used. In that case, the results of the first sampling procedure are used in conjunction with a manually- calculated calibration constant where:

$$\frac{1}{\mu T} = \frac{1}{(0.2)\,(\text{pipe I.D.})}.$$

(pipe diameter in inches)

The calculated result is entered into the system through the Calibrate Menu, Manual Entry Menu. In this alternate method, the CALIBRATION module sequence is NOT used.

Temperature Compensation

If temperature compensation is required for your measurement accuracy, you will want to enable that feature before doing the calibration.

WHY is Temperature Compensation Used?

Process temperature variation will cause a change in process density. If the change in density due to temperature variation is significant, the measurement could be influenced. In those cases, temperature compensation is used to offset the influence.

WHEN is Temperature Compensation Needed?

In general, WIDE temperature variations over NARROW measurement spans usually require temperature compensation. For example, a 25ºC change in process temperature over a measurement span of 0.6 SpG would NOT require temperature compensation. However, a 25ºC change in process temperature over a measurement span of 0.1 SpG would require temperature compensation.

As a rule-of-thumb, follow this guideline:

If your change in process temperature (in ºC) is greater than 50 times your density span, you will need to use temperature compensation.

EXAMPLE:

IF: $\Delta T = 25^{\circ}$ C
AND: Density Span = 0.6
THEN: 50 * 0.6= 30 > 25

THEREFORE:
Temp comp IS NOT needed.

HOWEVER:
IF: $\Delta T = 25^{\circ}$ C
AND: Density Span = 0.1
THEN: 50 * 0.1= 5 < 25

THEREFORE:
Temp comp IS needed

Documentation

For future reference, document these items:

(a) Environmental/process conditions (densities, temperatures, etc.) that influence the reference/ calibration. The next time a calibration is performed, you will need to duplicate the conditions, or account for the differences.

(b) All changes made to factory-default settings such as time constant, reference constants, gain, etc.

(c) The information from the status displays. A record of "counts" being received from the detector may assist with future troubleshooting efforts.

Configuration

Ronan ships the Density Monitor System with factory-default software settings. Those settings are responsible for the information that initially appears on the status displays.

After installation at your site, you may need to reconfigure the system to fit your application. The goal is to correlate the X96S output with your lab sampling, so the X96S density monitor can replace the time-consuming task of constant manual lab sampling. The list below summarizes the activities that are detailed in the remainder of this chapter:

- Check the factory-default settings to be sure they are appropriate for your circumstances. IF NOT, make the necessary changes and document those changes for future reference.
- Enable and setup temperature compensation before doing the calibration, if required.
- Perform an initial calibration to correlate the X96S's output to the actual process density as determined by laboratory sampling.
- Document detector output counts at calibrated values to assist in troubleshooting. Also, record changes you make to factory-default settings. Keep this information for future reference.

Detector

Scintillator Detector

Description

The Ronan scintillation detector consists of three main components: The plastic scintillation crystal, the photomultiplier tube (PMT), and the associated electronics.

Scintillation Crystal

The crystal used for the Continuous Level Monitor System is polyvinyl toluene (PVT) plastic. The crystal produces light pulses which are proportional to the incident radiation events striking it.

Typically mounted in s stainless steel shell the entire crystal assembly is sealed against moisture and dirt and is non-repairable. An integral flange serves to mount the crystal to the PMT. A special silicone membrane serves as an optical coupling medium between the crystal and the PMT.

Photomultiplier Tube

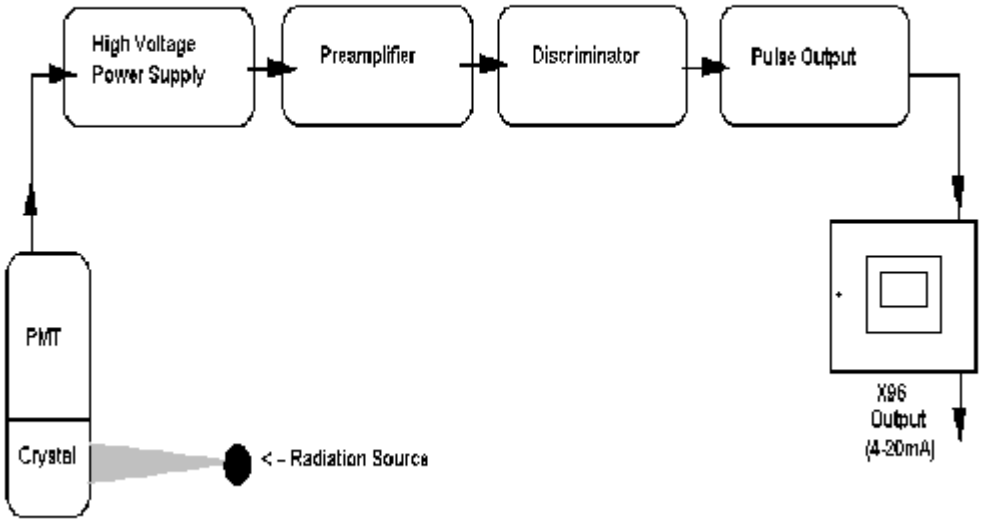
The PMT is a light sensitive vacuum tube with a photosensitive layer that converts the light pulses to an electrical current. Light pulses from the crystal strike the photosensitive layer and release electrons. A high voltage power supply connected to the photosensitive layer accelerates the electrons through stages of current amplification.

The PMT and its associated components are housed in a special magnetic shield. The tube is shock-mounted internally, with an interface plate at the top, which also mounts the electronics and the outer shell.

Electronics

Four boards, housed in a stainless-steel shell, comprise the electronics and their functions.

- High Voltage Power Supply
- Preamplifier
- Discriminator
- Pulse Output



Detector Service

the critical components of the electronic circuit and the PMT/Crystal Assembly are aligned before leaving the factory. If any component of the Scintillation Detector is adjusted or replaced, the performance of the entire system will be adversely affected and will require realignment before continued use is possible.

Therefore, the **scintillation detector IS NOT field serviceable.** Should a problem arise with the detector, the entire Detector Assembly should be returned to Ronan for repair/replacement.

ION Chamber

Detector/Amplifier Assembly

(DET-7471-XXX)

Ronan's ion chamber detector is filled with an inert high-pressure gas. It uses low-voltage (-15VDC) bias and generates a low-level current proportional to the gamma radiation incident on the detector. The current generated is on the order of 10 A, so an electrometer amplifier is required to convert the current to a low-impedance, high-level voltage signal. The signal is then measured by the X96S Microprocessor, which converts the voltage signal to a level (or density) output of 4-20mA for a specified measuring range.

Circuit Description

The current (I), generated by the ion chamber, is fed into the inverting input terminal of the electrometer amplifier, (IC1). The electrometer amplifier output is filtered by R2C4 (a microphonic, low-pass filter) and fed into a follower amplifier. The output of IC2 is proportionally fed back to the inverting terminal to provide a closed-loop gain based on the value of the gain resistance potentiometer (R2) on the X96S input board.

The detector's gain is adjusted whenever the signal output of the detector is too high and may saturate the input of the X96S, which is approximately 3.5VDC. The output must be less than 3.0VDC with an empty vessel.

An offset zero control (R6), used to null the offset voltage of the electrometer amplifier, is factory adjusted and Gyptal coated. R6 is adjusted to make the output, (TP1), zero with Rf shorted. (TP2 is circuit common.)

The most important components of the amplifier are the operational amplifier (IC1), feedback resistor (Rf), and feedback capacitor (Cf). If these components are substituted, the performance of the system will be adversely affected.

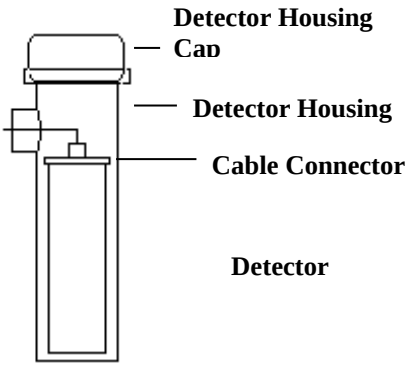
Servicing the Detector

The ion-chamber detector contains pressurized inert gas. The ion chamber itself is not serviceable and must be returned to the factory for service. Instructions follow for "Detector Removal/Replacement."

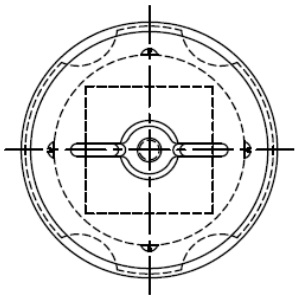
However, a qualified technician can troubleshoot and service the detector's amplifier assembly. Instructions follow for that procedure as well. Some precautions are needed when handling the detector/amplifier assembly.

It is important to keep the interior of the detector/amplifier dry. Moisture on the high-impedance components will cause leakage currents. If the amplifier lid is opened, it is important to see that warm, dry air is introduced into the amplifier before replacing the gasket lid.

Detector Removal/ Replacement



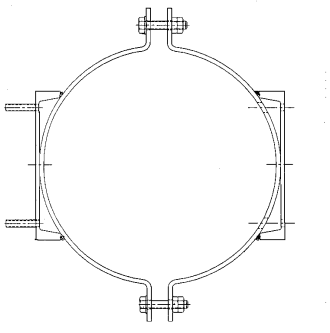
1) Check NOTES below for illustrations and cautions that apply to your specific equipment.
2) Unscrew cap on detector housing.
2) Unscrew connector on top of detector.
3) Remove detector from housing.
4) Carefully install replacement detector in housing.
5) Screw connector back onto detector.
6) Immediately replace detector-housing cap.
7) Follow instruction to REFERENCE or CALIBRATE new detector.



ELONGATED DETECTORS NOTES:

To avoid damage in shipment or installation, the elongated detectors are packaged separate from the housing. Avoid subjecting detectors to mechanical shock. Avoid supporting detector by other lifting devices, for prolonged periods of time.

When detector is properly seated on the bottom of the housing, the hold-down clamp should be tightened until the wing nut no longer turns. Make sure the detector is not subject to vibration.



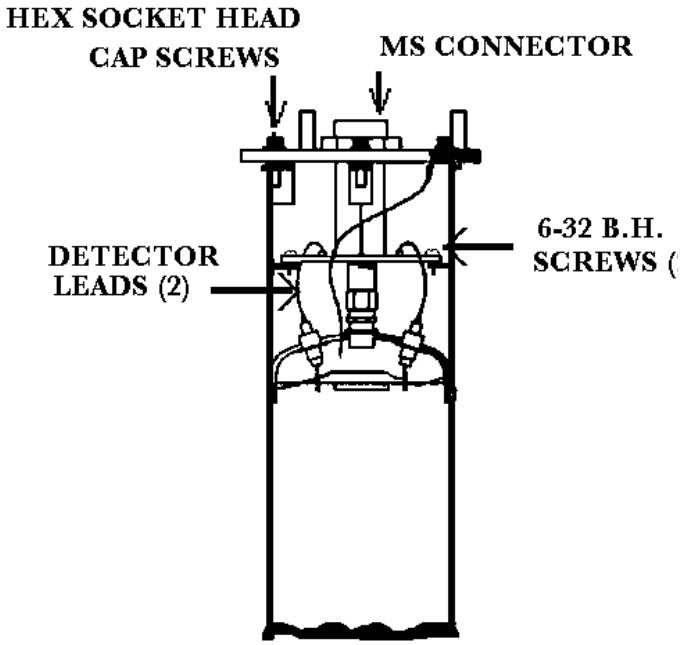
DETECTOR HOUSING/ BRACKET ASSEMBLY NOTES:

Many detectors are shipped inside the housing/bracket assembly. Bolts at the top and bottom of the C-Clamp are used to adjust the assembly around a pipe.

Removing the Detector Amplifier Circuit Board (CBAY-6102)

Follow this procedure to remove the electrometer amplifier circuit board:

1. Remove the amplifier cover by unscrewing the hex socket head cap screws.



2. Remove the MS connector from the amplifier cover.

3. Remove the two 6-32 binding head screws, which secure the amplifier board to the detector.

4. Using a low power (60W) iron unsolder the detector leads to the printed circuit board standoffs.

CAUTION: Excessive twisting or bending can damage the detector leads.

5. Lift the board/ connector assembly from the interior of the detector housing.

CAUTION: DO NOT over heat the detector leads. Using long-nose pliers as a heatsink will avoid melting the solder at the detector feed-through.

Replacing the Detector Circuit Board/Connector Assembly

If installing a new electrometer amplifier board, refer to drawing B-6102-K for internal connector wiring and connections to the detectors.

Be sure the detector leads are straightened to clear the holes in the new circuit board.

Follow this procedure. **CAUTION:** Excessive twisting or bending can damage the detector leads.

1. Carefully straighten the detector leads to clear the holes in the new circuit board.

2. Place the new circuit board/connector assembly in the detector housing.

3. Using the two 6-32 binding head screws with a light coating of gyptal, secure the board to the detector housing.

4. Taking care the detector leads do not touch the printed circuit board, solder the detector leads to the standoffs.

5. Replace the MS connector into the amplifier cover.

6. Ensure the flat gasket in the amplifier cover is in place and undamaged.

7. Using a light coating of glyptal on the hex socket head screws, replace the amplifier cover.

Electronics (Spare Parts)

X96-2001PL-SP
X96-2001PL is the CPU module

X96-2003-01PL
X96-2003-01PL is the Ionization Chamber Input

X96-2003-02PL
X96-2003-02PL is the PCB assembly, analog input, and 0-5 volt on both channels

X96-2003-03PL
X96-2003-03PL is the PCB assembly, analog input, and 0-20mA on both channels

X96-2003-04PL
X96-2003-04PL is the PCB assembly, analog input, and two-wire transmitter

X96-2003-05PL
X96-2003-05PL is the analog input, 0-15 volt on both channels

X96-2004PL
X96-2004PL is the 2-Channel Analog Output Module. This optional module has two isolated analog outputs each of which can be independently configured as a:

- 4-20 mA current loop,
- a source of 0 to 10 volts, or
- a sink of 0 to 20 mA.

X96-2005PL
X96-2005PL is the HART Daughter Module. This module provides both a 4-20 mA current loop and a HART slave interface.

X96-2008PL
X96-2008PL is the Digital Input/Output Module. The module provides a total of 16 bits of digital I/O and wetting/encoder power.

8 isolated digital inputs are provided. These inputs can be configured for use as:

- dry[2] or live[3] contact monitoring,
- quadrature encoder[4], or
- pulse counter.

4 relay (2 Amp capacity) output points are provided. Form “C” outputs are brought out to the connector (three connections per relay).

4 isolated open collector output points are provided. These outputs are capable of switching 4.5 to 30 Volts (externally supplied) at a maximum of 50 mA.

[2] When used with dry contacts, jumpers shall be used on the connector block to provide the wetting voltage. When used in this mode, input to input isolation is not maintained.
[3] When used with live contacts, each input shall be able to accept up to 30 volts DC. Zero volts to 0.8 volts are recognized as a logic zero and 2.5 volts to 20 volts are recognized as logic one.
[4] The interface to the quadrature encoder shall consist of two inputs, 15 volts DC at 200 mA (described in a later section), and common.

The 24 volts DC provided is to be used as a wetting voltage when needed.

An isolated 15-volt DC power supply capable of providing 200 mA is also provided. The primary use of this power supply is to power a quadrature encoder, but can be used for other purposes if it is not required for this purpose.

X96-2009PL1
X96-2009PL1 is the Scintillation Detector Interface Module. This optional[5] module provides:

- 1 isolated scintillation input (pulse counter, max signal 0-12[6] V, threshold 0.6 V)
- 1 head temperature input (1 uA per deg K)
- 1 non-isolated RTD (3-wire) input
- isolated power for the scintillation detector 24 V 40 mA supply[7].

X96-2009PL2
X96-2009PL2 is the Scintillation Board with ch. 2 modified for 0-20 mA input instead of RTD

X96-2009PL3
X96-2009PL3 is the Scintillation Board with ch. 2 modified for 0-10Vdc input instead of RTD

X96-2029PL
X96-2029PL is the Mold Level Module (board) for scintillation detector, with two digital inputs, two analog outputs and two digital outputs (1 relay, 1 TTL).

X96C148-5
X96C148-5 is the 85 to 230 Volt DC power supply module

X96C148-2
X96C148-2 is the 24 Volt DC power supply module

X96C148-3
X96C148-3 is the 85 to 230 Volt power supply module

X96C148-4
X96C148-4 is the 12 Volt DC “in”, 24 Volt DC “out” power supply module

X96C429-1
X96C429-1 is the display keypad module for the X96S Computer

[5] At least one detector interface module is required.
[6] 8.6 V nominal.
[7] The power supply has the ability to control the power to the scintillation detector:

- when commanded by the CPU module,
- when the processor on the module detects a condition that could harm the scintillation detector,
- when the watchdog timer generates a reset.

Options

X96S Mechanical Chassis & LCD Part Numbers

PART NUMBER	DESCRIPTION
CHAS-0511-6	X96S-N4-1, NEMA 4 Enclosure, 6 Position, W/O LCD Display
CHAS-0512-9	X96S-N4-2, NEMA 4 Enclosure, 9 Position, W/O LCD Display
CHAS-0513-6-SS	X96S-N4X, NEMA 4X, 6 Position, W/O LCD Display, Stainless
CHAS-0514-9-SS	X96S-N4X, NEMA 4X, 9 Position, W/O LCD Display, Stainless
CHAS-0515-6-SSW	X96S-N4X, NEMA 4X, 6 Position, W/O LCD Display, With Window
CHAS-0516-9-SSW	X96S-N4X, NEMA 4X, 9 Position, W/O LCD Display, With Window
X96C429-1	LCD Display Assembly “Local” for X96S

X96S Electronic Module Part Numbers

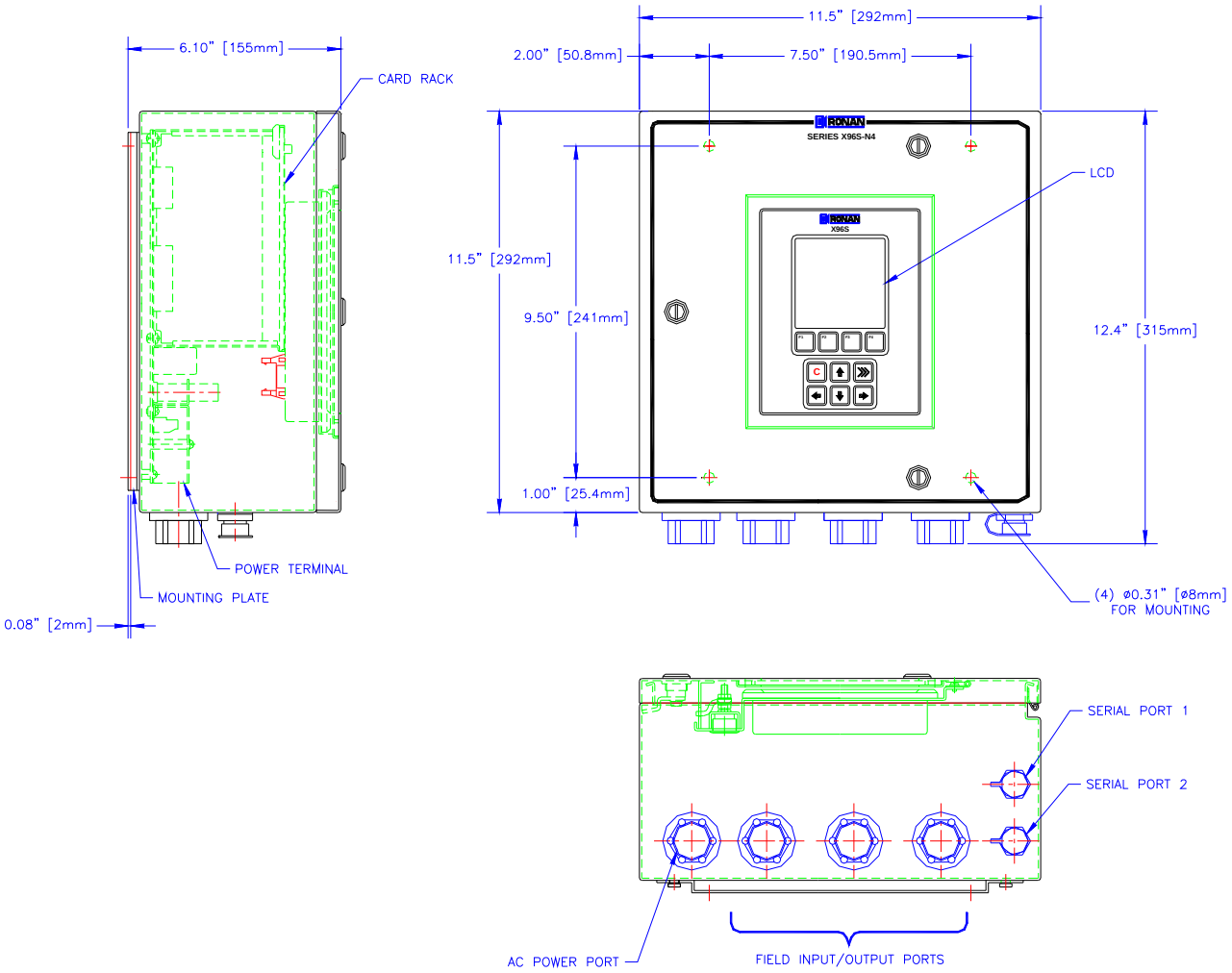
PART NUMBER	DESCRIPTION
X96-2001PL-SP	X96S CPU Module
X96-2003-01PL	X96S Ionization Chamber Input
X96-2003-2PL	PCB Assembly, Analog Input, 0-5 Volt on both channels
X96-2003-3PL	PCB Assembly, Analog Input, 0-20mA on both channels
X96-2003-4PL	PCB Assembly, Analog Input, Two wire transmitter
X96-2003-5PL	PCB Assembly, analog Input, 0-15 volt on both channels
X96-2004PL	X96S 2-Channel 4-20 mA Analog Output Module
X96-2005PL	X96S HART Daughter Module
X96-2008PL	X96S 8-Channel Digital Input Module, 8-Channel Digital Output Module (4 Transistors + 4 Relays)
X96-2009PL1	X96S Scintillation Detector Board with modification (Cap -11004 & 1018)
X96-2009PL2	X96S Scintillation Detector Board modified for 0-20mA input instead of RTD
X96-2009PL3	X96S Scintillation Detector Board modified for 0-10V DC input instead of RTD
X96-2029PL	PCB Board, Mold Level, Input/Output for Scintillation
X96C148	X96S 85V to 230V Power Supply Module
X96C148-2	X96S 24 V DC Power Supply Module
X96C148-4	X96S 12V DC “in”, 24 V DC “out”, 50 watt Power Supply Module

SPECIFICATIONS

Model X96S

Process Computer:	Microprocessor-based unit with a liquid crystal display, push-button interface, HART® Communications, process control output, process condition input, serial communications.
Chassis:	19” Rack Mount, Surface Mount or Panel Mount
Enclosure:	Standard NEMA-4 Stainless Steel NEMA-4X Explosion Proof
Electrical:	Power inputs: 90 to 24 VAC +/- 15%, 50/60 Hz; 24 VDC +/- 15% Usage: 60 watts (standard model), 260 watts (heated model)
Environmental:	Ambient Temperature Range: 14° to 122° F (-10° to 50° C) Humidity: 90% Non-Condensing
Electronics:	Processor: Embedded 80 x 86 Compatible Processor Memory: Flash, Static RAM, battery Backup RAM, Mini SD Card A/D Converters: 16-bit, Dual Slope, Auto-Zeroing Display: Graphic LCD, Fluorescent Back-lit
Inputs: (Optional)	Tachometer: 0-10 VDC, 4-20 mA, or Pulse Rate TTL Load Detector: 0.42-2.4 VDC or Pulse TTL Temperature Compensation: 100 Ohm Pt, 120 Ohm Ni, or 4-20 mA (Mass Flow or Density)
Outputs: (Optional)	Three 4-20 mA; One assigned to each Channel Four Single Set-point SPDT Relays: 3 Amp at 28 VDC or 240 VAC Remote Totalizer Pulse: 20 msec Pulse, Open Collector 50 mA at 24 VDC
Display Units:	(Engineering Units per Gauge) Level: in, ft, mm, cm, or m Density: % Solids; SpG, Baume H, Baume L, API, Brix, Ball, or Twaddell Mass Flow: lb/mn, kg/min, mT/min, mT/hr, sT/min, sT/hr, IT/min or IT/hr Weight: lb/min, kg/min, mT/hr, sT/hr, IT/hr, kg/hr or oz/min
Computer Interface:	HART® and Communications

SAMPLE DRAWINGS



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Updated June 8, 2021

RONAN
ENGINEERING COMPANY
MEASUREMENTS DIVISION

Saving Configuration Data on the MicroSD Card

The microprocesser you purchased has the ability to back up your parameter settings on an SD card. To access this feature, you should follow these steps:

1. Verify your display is Version 2.0. (you should see this image)

Please note, it is only visible for a brief time when the microprocessor is powered up.

2. While viewing the Main Menu screen OR the Status Display screen, press the red "C" on the LCD module keypad. Note that the top line of the LCD will say "Adj.contrast up/down".
2. Next press the Hot Key button. (the button with the three right facing arrow heads ">>>".)
3. The LCD screen will change to read "SD Card Write Configuration Triggered".
4. After just a few seconds the write-to-the-SD Card is complete and the LCD changes back to normal.
5. The Configuration file on the SD Card will have a name *X96V30_.use* The blank _ will indicate the system type. L=level, D=density, W=weight, M=mass flow, X=level with density compensation.

Note!

If this procedure is followed, then on the next power up, the gauge will use what is stored on the SD Card to overwrite the active configuration parameters. In other words, if any config changes were made to the gauge after the write to the SD Card, then on next power-up, those changes will be lost and the config data will revert back to what was stored on the SD Card.

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