

Instructions
and
Operating Manual

X99
**MOTORIZED DENSITY
MONITOR SYSTEMS**



RONAN ENGINEERING COMPANY – MEASUREMENTS DIVISION

8050 Production Drive • Florence, KY 41042

Phone: (859) 342-8500 • Fax: (859) 342-6426 • Website: www.ronan.com • E-mail: ronan@ronanmeasure.com

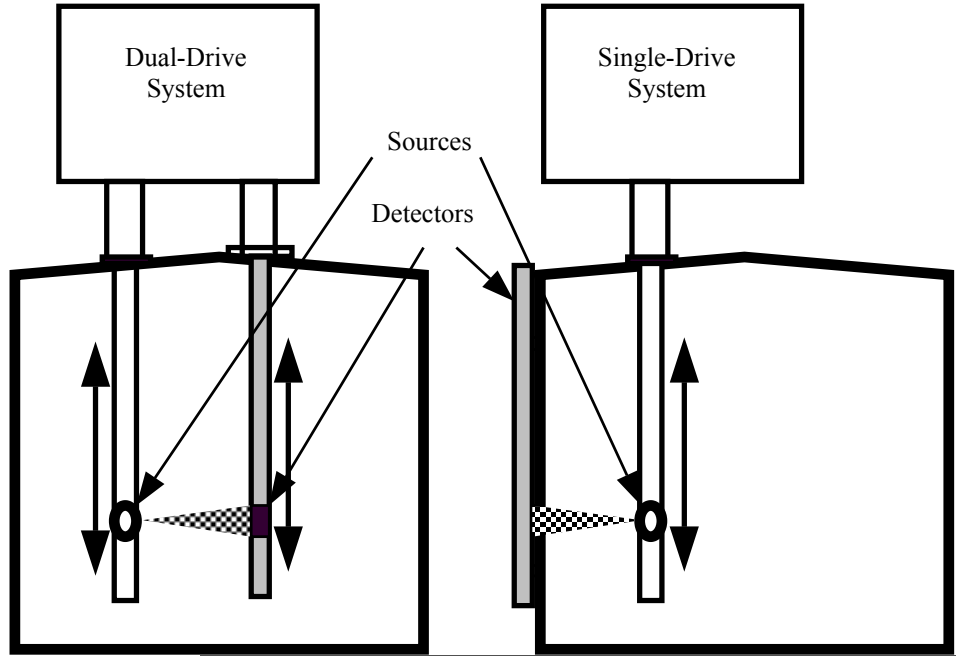
Table of Contents

1. System Description	1.1
2. Theory	2.1
3. Install/Startup	3.1
4. Microprocessor Software Operations.....	4.1
5. Calibration.....	5.1
6. Technical Scintillator	6.1
7. Electronics.....	7.1
8. Accessories/Options.....	8.1
9. Regulation and Safety	9.1
10. Motor Drive Specifications.....	10.1
Appendix B	
Appendix C	
Appendix E	
Drawings	

System Configurations

The user's application determines the system configuration requirements.

Shown here are typical examples of Motorized Density Gage Configurations.



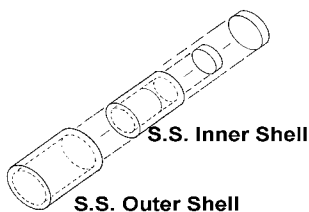
System Components

Many system configurations are available for a number of different applications. However, in all cases there are at least five major components included with each Motorized Density Gage System:

- Motor/Control cabinets
- Source Holder with enclosed source capsule
- Detector
- X99 Microprocessor
- Interconnect Cables

Source Capsule

A radioactive cesium (Cs-137) source is sized to fit the needs of each application. The source material is encapsulated inside a welded stainless steel cylinder and shielded by a lead-filled source holder.

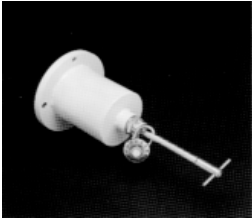


Cesium emits gamma radiation which has several advantages. Gamma radiation does not make material radioactive, nor does it change or affect the material as it is absorbed.

Source Holder

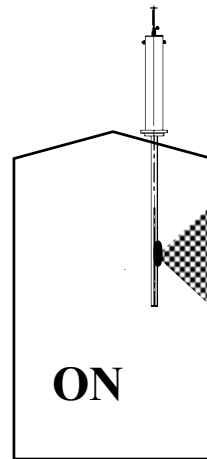
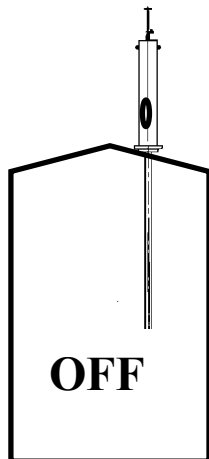
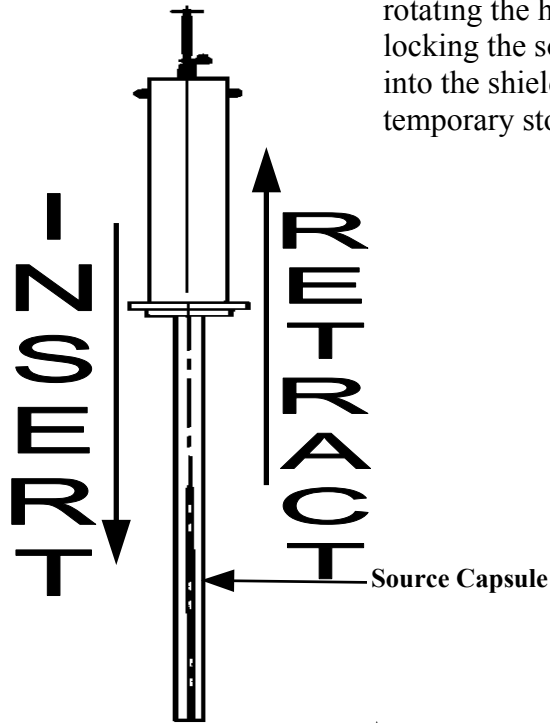
An internal well-type source holder is available when vessel geometry or process conditions require its use.

The well-type source holder is mounted so that the source can be lowered into a well or dip tube inside the process vessel. Its shielded holder is used as a safety container during shipping and storage.



The ON/OFF mechanism in this instance amounts to retracting the source out of the well or dip tube, rotating the handle, and locking the source back into the shielded holder for temporary storage.

ON/OFF Mechanism



Detector

The detector, which may be either an ion chamber or scintillator, is mounted in a protective housing. When radiation from the source strikes the "active" length of the detector a signal is generated.

The active length of the elongated detector corresponds to the full measurement range of interest, and is designated by bands of tape at the top and bottom of the detector housing.

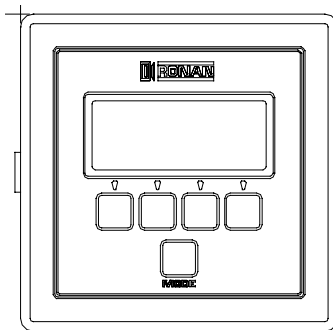
The *ion chamber* detector produces a picoampere current that is converted into a voltage signal, amplified, and sent to the microprocessor.

The *scintillation* detector produces a light pulse that is detected by a phototube, converted into an electrical pulse, amplified, and sent to the microprocessor.

Chapter 6 contains more information about the detector.

X99 Microprocessor

Ronan's X99 Microprocessor electronically manipulates the detector output signal and displays the results in a useful format.



With just four push buttons, a liquid crystal display screen, and pre-programmed menus, the process level and density are continuously monitored with minimal operator effort.

Chapter 7 contains details about the hardware used in the X99, and Chapter 4 explains the software used for motorized density applications.

Interconnect Cable

The interconnect cables provides a signal from the motor cabinet and detector to the X99 Microprocessor.

**Extended Features
and Optional
Accessories**

Ronan's Motorized Density Gage Systems offer a number of options and special features. Among the features available are:

Alarms
Multiple Operating Modes
Local/Remote Mode control
User-defined traversing speeds

Alarms

High and low level alarm outputs are available.
Detector temperature alarm is available
Detector failure alarm is available

**Multiple Operating
Modes**

The system has 4 selectable operating modes:

Continuous Scan
Density Seeking
Rag-Layer Interface Tracking
Manual

**Local/Remote Mode
Control**

The operating modes can be selected via the panel-mounted programmer, by wired switch selection, or via a DCS or PLC.

**User-defined Traversing
Speeds**

The user can select traversing speeds up to 32 fpm. Traversing speed for measurements can be different than 'move-to-start-position' speeds.

System Description

Well Source

System Description

Chapter 1 provides a general overview of the Ronan Motorized Density Gage System and its individual components.

The section on "Options" explains features that may or may not be included in each system depending upon user's specific needs and applications.

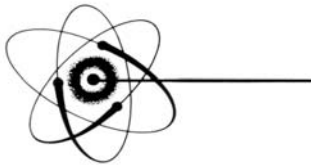
REV NO.	DATE	PAGE NO.	DESCRIPTION
0	07/15/02	ALL	ISSUED

Theory of Radiation Gaging

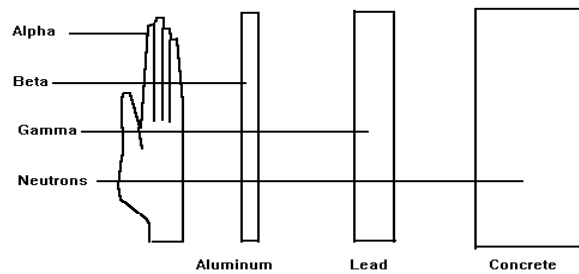
Radiation gages operate on the principle of radiation absorption and transmission.

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

Some amount of radiation is *absorbed* by the material through which it passes, and some of the radiation is *transmitted* to the surface of the detector.

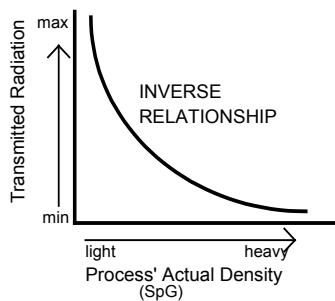


Absorption / Transmission



Gamma's advantages:

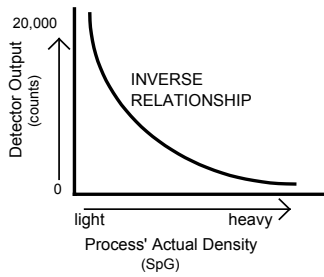
- Passes through process material
- Does not make material radioactive
- Does not change the material
- Can be shielded by lead



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.**

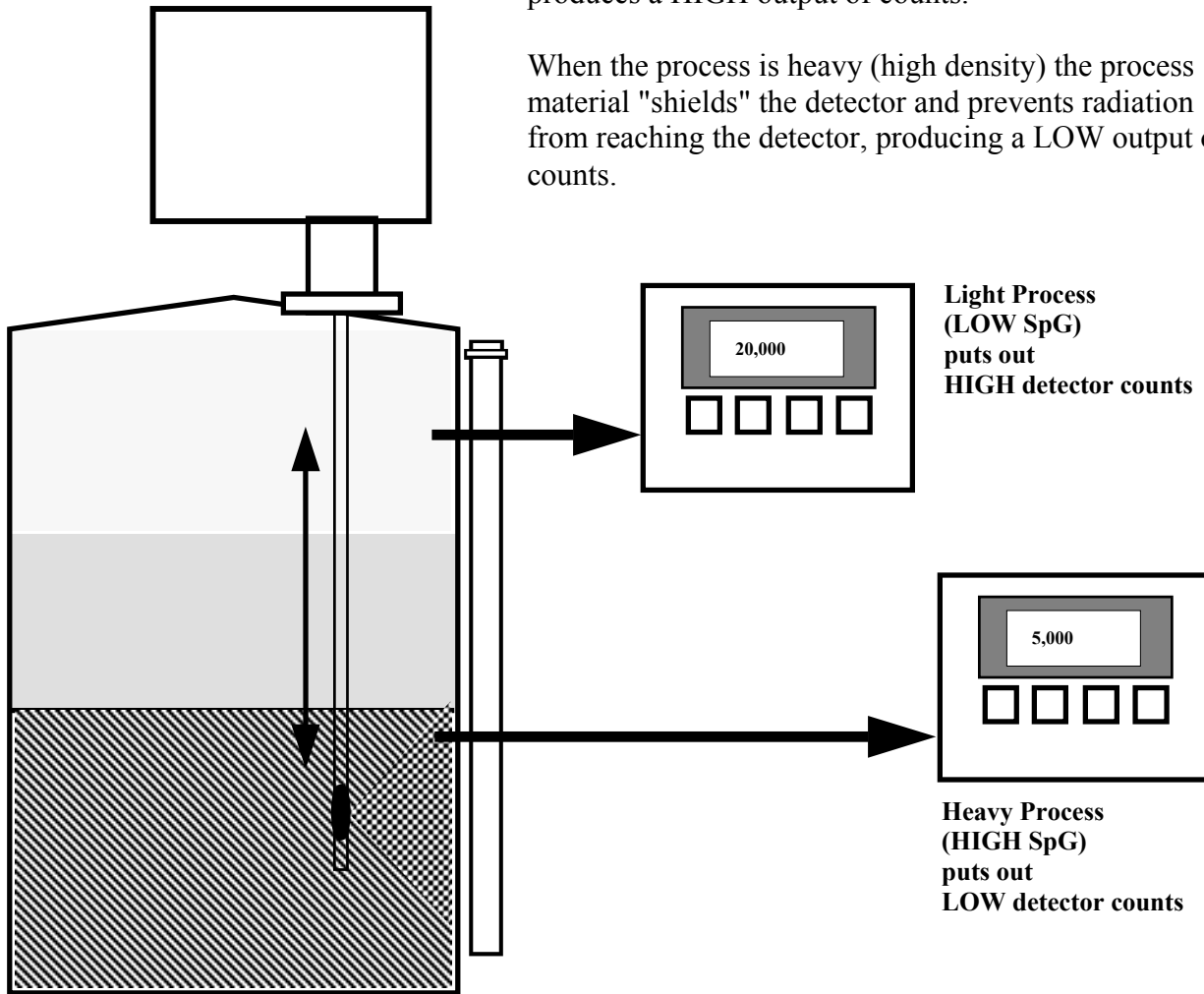


Since the radiation that's not being *absorbed* is being *transmitted*, the process density can be inferred by measuring the amount of radiation reaching the detector at any point in time.

The detector's output signal, in counts, also *varies inversely* to the process density. Shown here is a typical response curve for a density application.

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.



Ronan's Motorized Density Gage is used to replace the lab sampling process since the gage output, when accurately calibrated, will correlate to the density values of process taken from samples at various levels in the vessel.

Principles of Operation

The detector's raw output signal is processed through several stages of software in the X99 computer.

Some of the more significant stages of signal processing are:

- Signal Averaging
- Source Decay Compensation
- Measurement Range
- Calibration (Referencing)

Signal Averaging

The detector signal is averaged for each reading to reduce process and statistical noise for more accurate readings.

Source Decay Compensation

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.

Measurement Range

For both level and density, the "zero" of the measurement range represents the lowest level/density of interest, while the "span" of the measurement range represents the highest level/density of interest.

Calibration

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

Calibration Constant

The density algorithm (or curve) used by the X99 software is an exponential function. That is, the relationship between the detector output and the process density is mathematically expressed as:

$$I_d = I_o e^{-\lambda t(d-d_o)}$$

Transmission/Absorption Table

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

Where:

I_d = detector signal with process density (d)

I_o = detector signal with process density (d_o) in pipe

u = the absorption coefficient

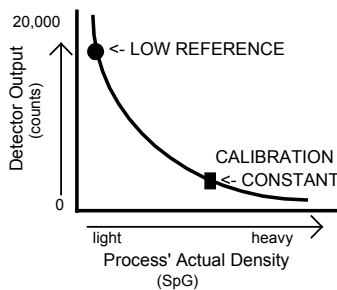
t = pipe internal diameter

d = density usually expressed in SpG

d_o = reference density

The "calibration constant" (1/ut) is used by the X99 software to calculate process density. Shown here is a table of 1/ut values.

**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.

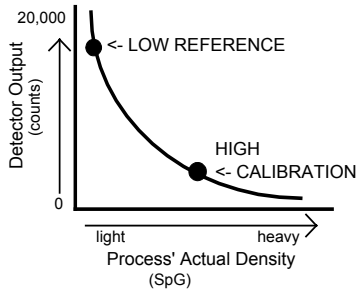
The conveniently drawn process sample is analyzed in the lab so the known density value can be entered into the X99 as the *Low Reference Value* (d_o).

Next, the manually calculated calibration constant (1/ut) value, from a table like the one above, is entered into the X99 software as the *Transmission Constant*.

These two values, the reference density (d_o) and the calibration constant (1/ut), are used by the X99 algorithm to calculate process density (d).

**High Calibration
(Dual Point Calibration)**

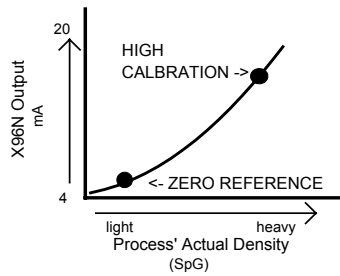
An alternate calibration technique is the "Dual Point Calibration" where samples of TWO different process densities (d_{01} and d_{02}) are drawn , analyzed, and entered into X99 software.



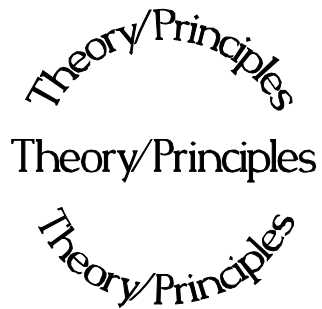
With the addition of a second reference density (d_{02}) the X99 software can now compute very accurately the value of $1/ut$ which it uses to determine the process density.

Calibration Curve

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 X99's display screen indicates an increase in user units from minimum to maximum - (example: 1.1 SpG to 1.25 SpG.)



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



Chapter 2 gives a simplified explanation of how radiation gages work.

The "Theory of Radiation Gaging" Section reviews the concepts of radiation transmission and absorption.

The "Principles of Operation" Section explains signal processing and the reference/calibration procedure.

Caution



Ronan's Monitor Systems use a sealed radioactive cesium (Cs-137) source which is safe if handled properly.

Specific License

Most Level Monitors are mounted to large vessels. Installations on vessels that permit personnel access require 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 gage. DO NOT proceed with unpacking, storage, or installation without the RSO's authorization.

General License

Other monitor systems, such as Density Monitors, are mounted to small-diameter process pipes. Those applications do not require a specifically licensed person to unpack or mount the equipment, as long as the source holder remains padlocked in the OFF position. Only a specifically licensed individual is permitted to remove the padlock and turn the source holder to the ON position.

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 will assign a safe and secure location with no personnel access.

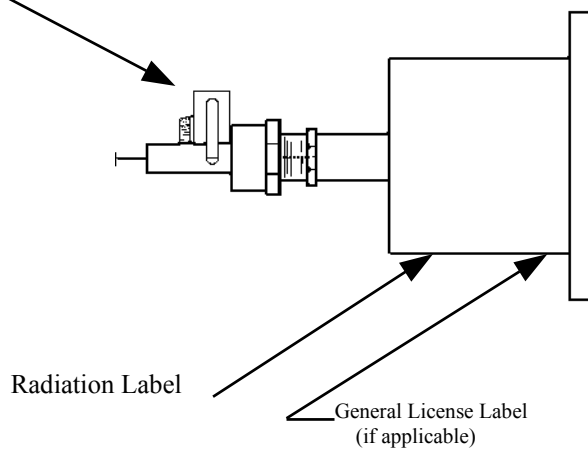
During storage avoid temperatures below freezing, and areas with excessive humidity, moisture, or dirt.

Inspection

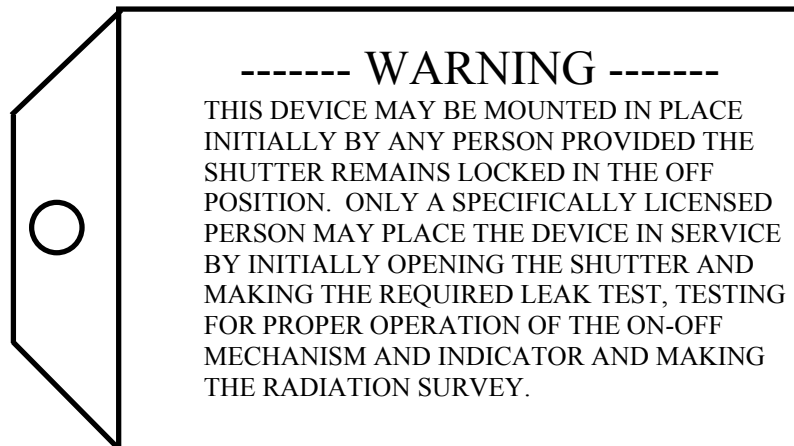
The source holder is equipped with an ON/OFF mechanism. During shipment and storage the mechanism **MUST BE SECURED** in the OFF position with a padlock.

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

Rod Padlocked OFF



Lock Tag



**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:

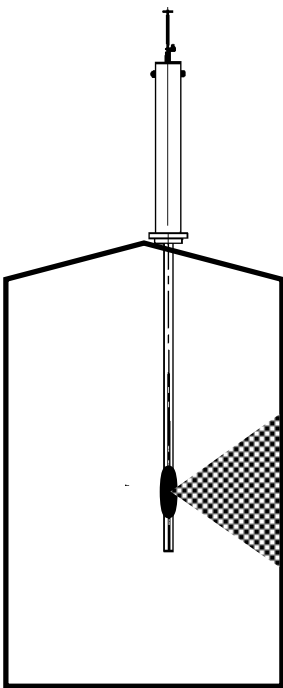
The source holder must remain padlocked in the OFF position until installation is complete.

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

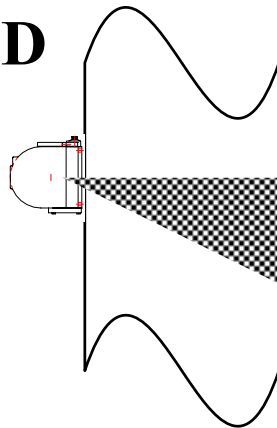
A specifically licensed individual MUST inspect the installation prior to placing the source holder in the ON position.

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."

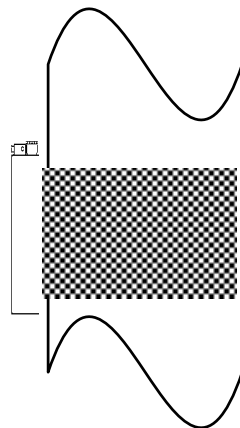
When the source holder is placed in the ON position, avoid the "active beam."



**A
V
O
I
D**



**A
C
T
I
V
E**



**B
E
A
M**

Mechanical Mounting

Please reference the dimensional drawings located in Chapter 10 when installing the equipment.

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



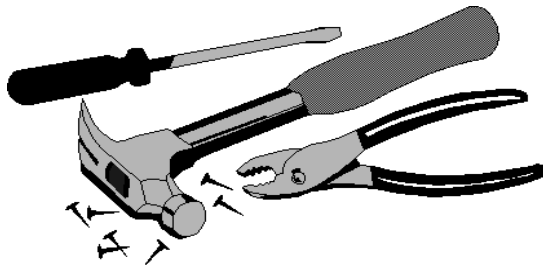
Drawings:
Configuration
Installation

Avoid internal vessel obstructions such as baffles, agitators, manways, 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:

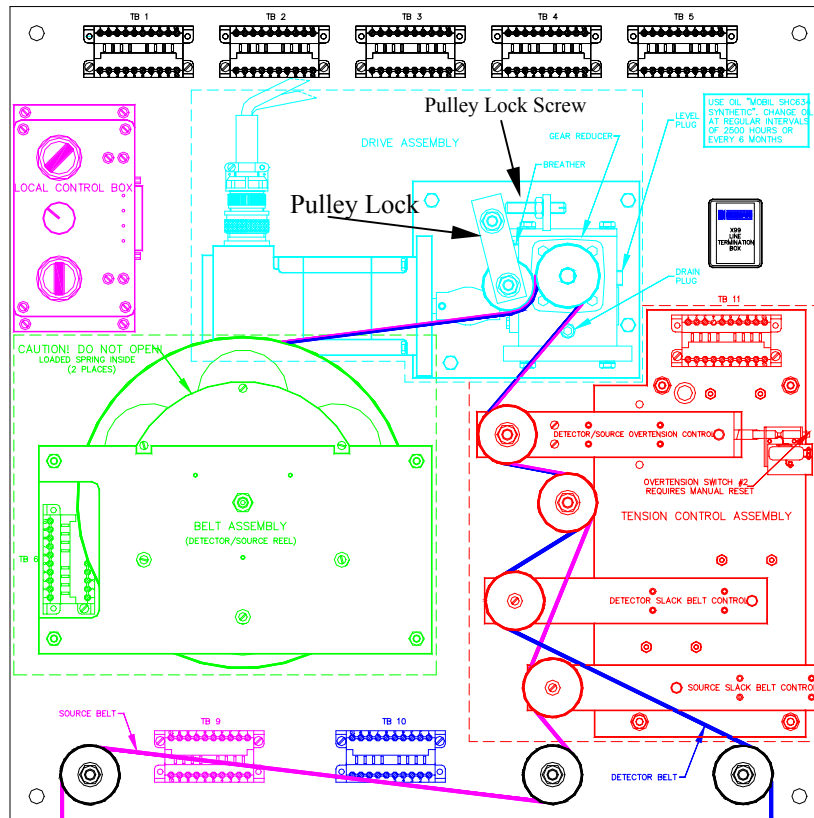
- the temperature of the process pipe at that spot exceeds 131°F (55°C), or
- the voltage transmission through the pipe could interfere with the signal transmission from the source to the detector.



System Installation

After the Motor Panel is mounted to the source/detector housings, ensure that the breather cap is installed in the top of the gear reducer. Untape the drive belt(s), being careful not to allow the reels to unwind. Pull enough belt from the reels to reach into the housing(s). Wrap the belts(s) over the drive pulley, and tighten the lock-down wheel(s) against the drive pulley(s) to prevent the reels from unwinding. Wind the belts(s) around the other pulleys as in Figure 1 - Motor Panel. Drop the belt(s) through the appropriate holes to the attached housing(s). Attach the drive belts(s) to the source and detector, following drawing B-18405-K. The detector belt also serves as a signal carrier. Follow the picture on the bottom of drawing B-18405-K and connect the wires to the detector.

Attach the interconnect cables to each panel, and power up the Control Panel. Switch to local mode at the Motor Panel, set the speed pot to about 10% of speed, and raise the source/detector to the Home position. NOTE: you may have to hold the Slack Belt slides in the compressed position until the belts can hold them in. If only one of the units' home LED comes on, adjust the Slack-Belt tensioner of the other until its home LED is on also. Tighten the tensioner and switch back to remote mode.



To
Source
Housing

To
Detector
Housing

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 Chapter of this manual.

Follow local and national electrical codes for all interconnections.

Consider the following guidelines before making any electrical connections:



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 cables in a separate conduit.

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

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.

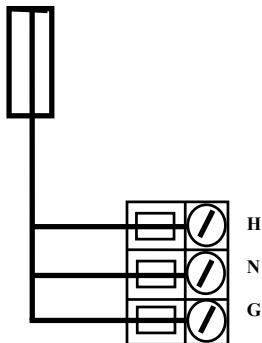


**Local Code
National Code**

WITH POWER OFF - - -

Attach interconnect cables to each panel. Connect ribbon cable to detector.

After aligning source and detector immediately replace lid on detector housing and source housing to keep out water and dirt out each well.



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

Install/StartUp

Install/StartUp

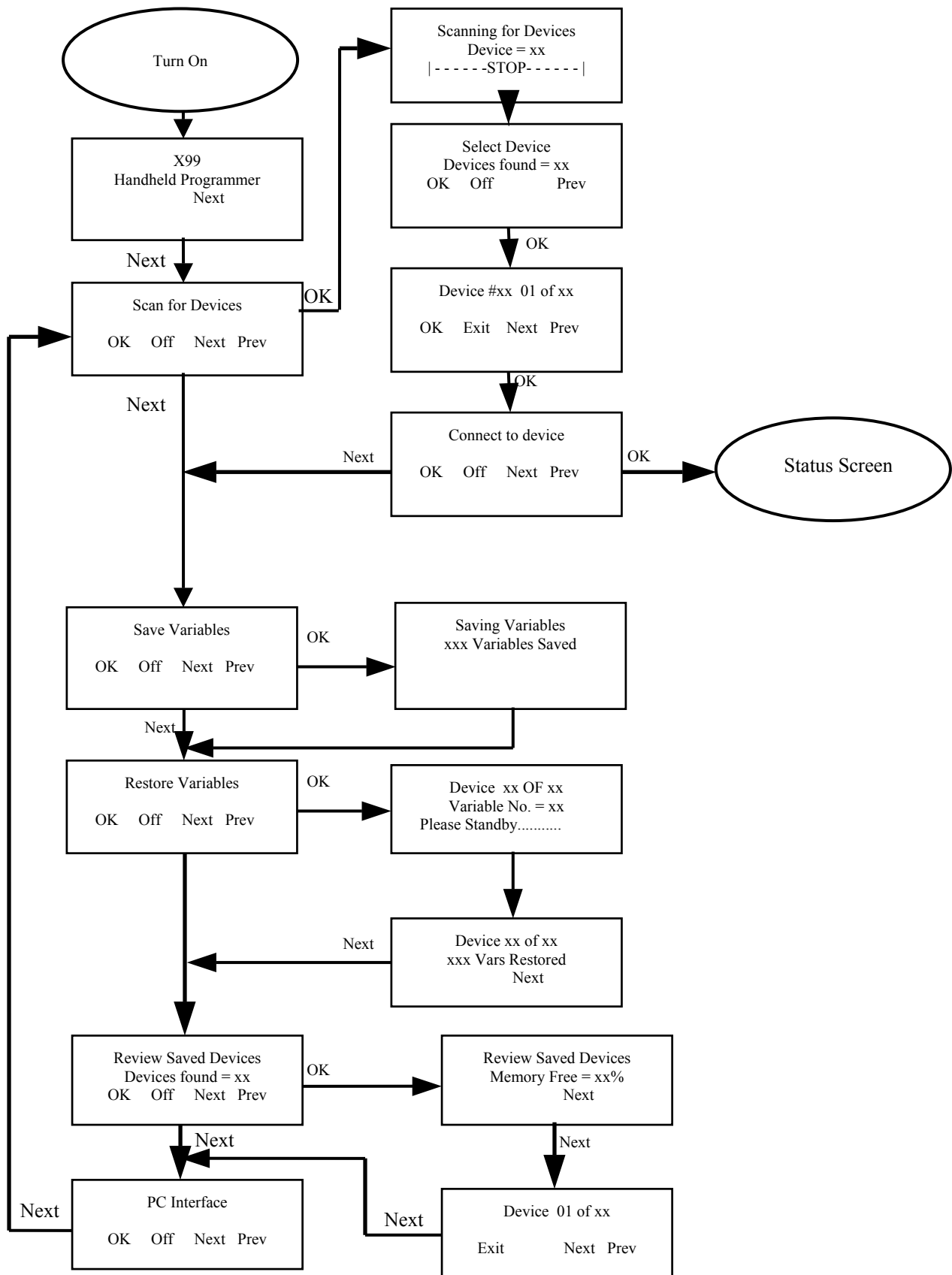
Install/StartUP

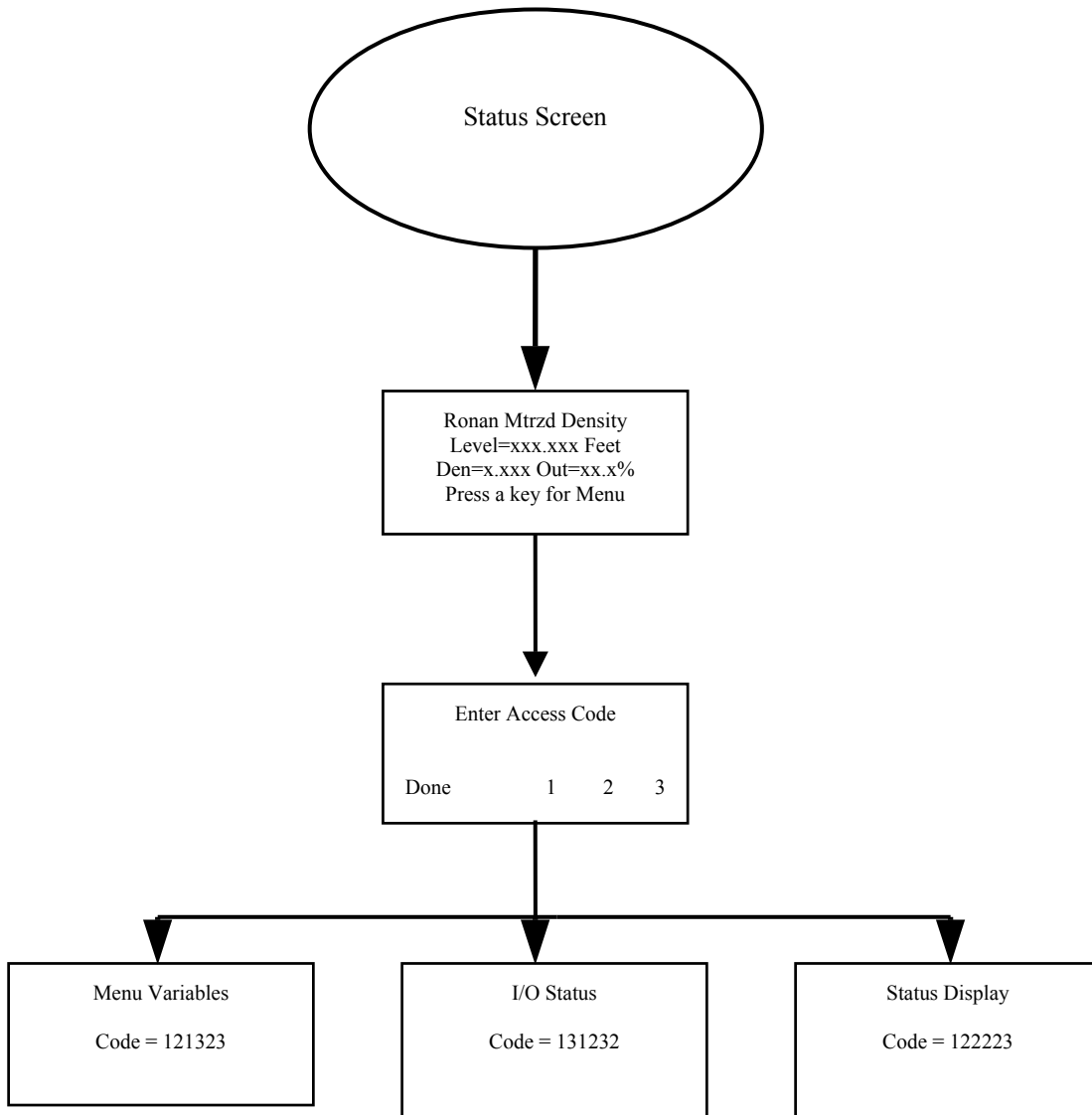
Chapter 3 covers preliminary information that will help prepare for equipment installation and power-up.

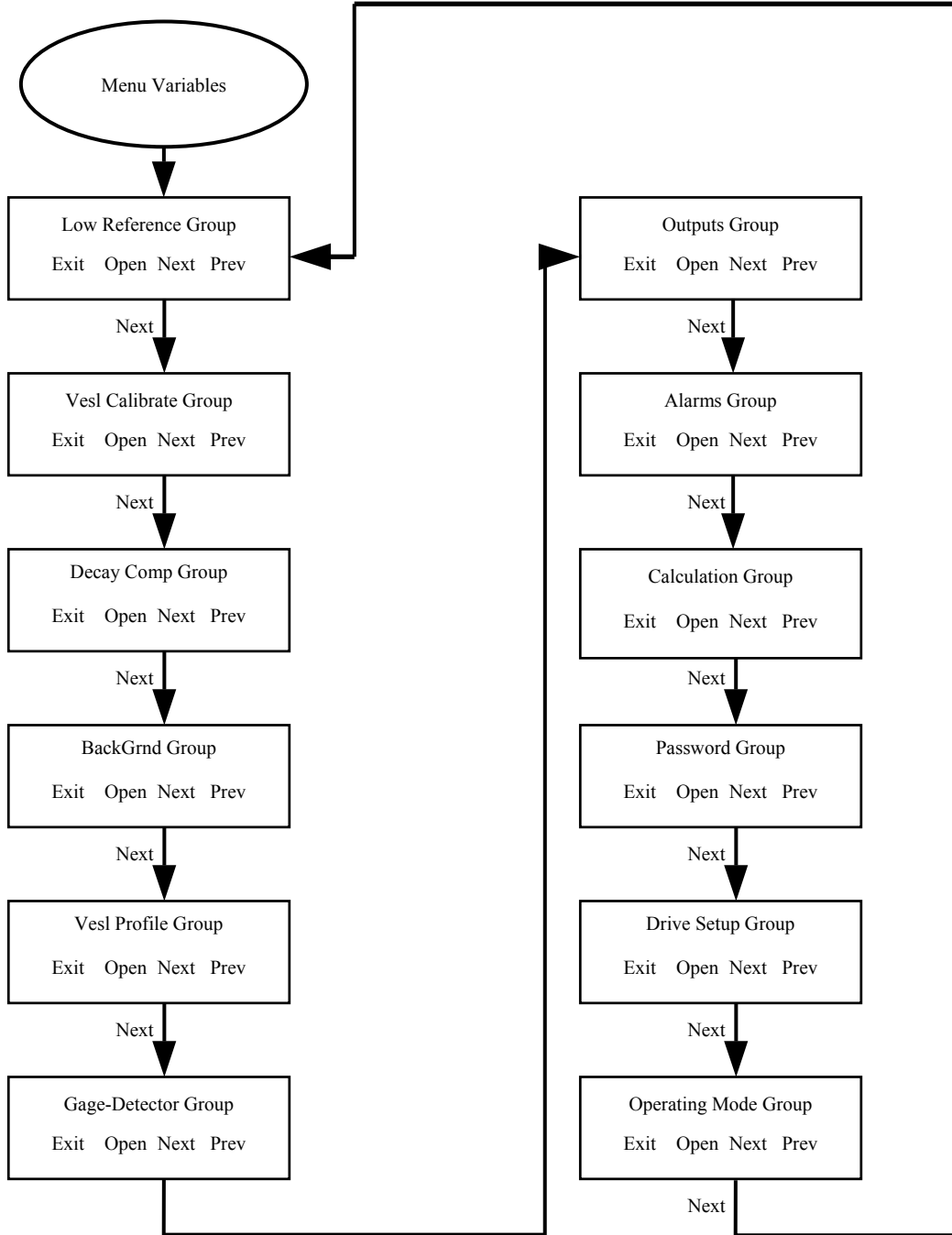
Read the section on "Safety Precautions" before beginning to unpack or install the equipment.

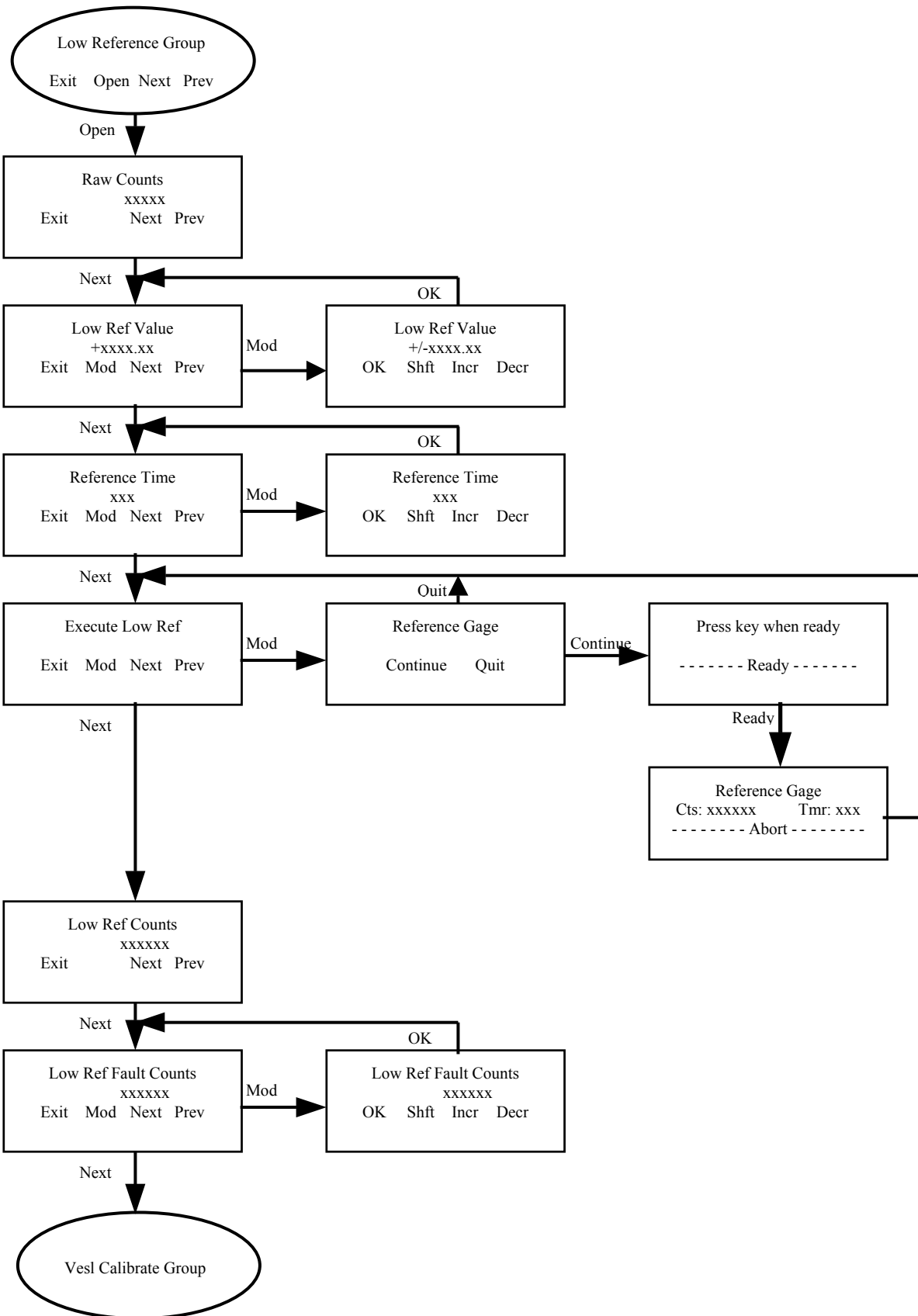
The specific and detailed installation instructions are provided on the Installation Drawings which are included in Chapter 10 of this manual.

REV NO.	DATE	PAGE NO.	DESCRIPTION
0	07/15/02	ALL	ISSUED









Low Reference Group

This group contains the menus for performing a low reference on the gage. The Low Reference here refers to the Density reading only. The level reading is determined by the motor and electronics, but is set up in the Drive Setup Group.

Raw Counts – this menu displays the normalized raw counts from the detector. The value displayed represents counts/second.

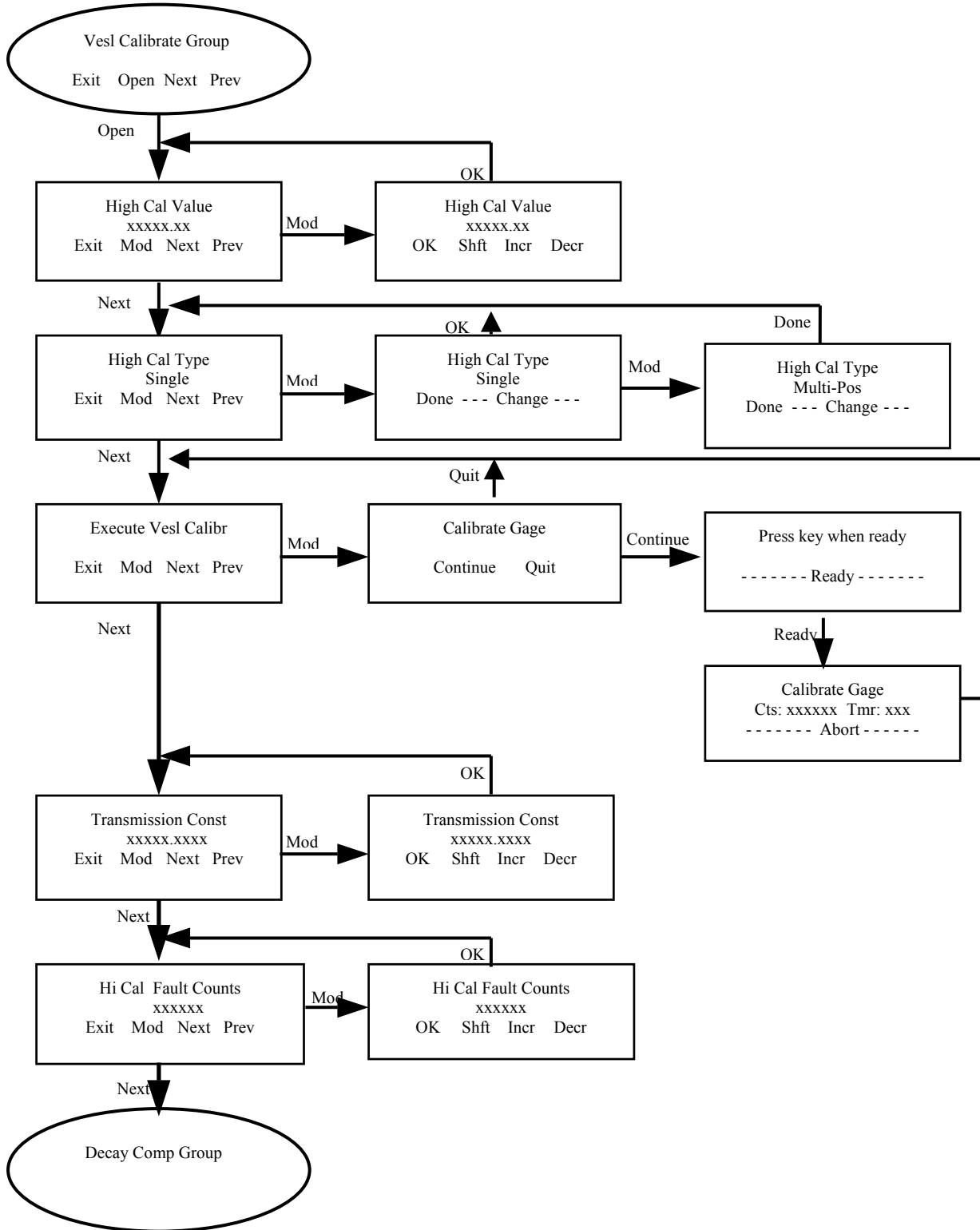
Low Ref Value – this value is the reference density value. The value usually represents a lab-verified sample of the product taken at reference time.

Reference Time – this is the amount of time the reference function will spend averaging the signal from the detector. The time is in seconds.

Execute Low Ref – perform the low reference function. This function establishes the first point of a single or dual point calibration.

Low Ref Counts – displays the final averaged counts captured after the reference function completes.

Low Ref Fault Counts – during a reference function, raw counts falling below this value causes the reference function to abort.



Vesl Calibrate Group

This group contains the menus to perform the second point of a two-point calibration.

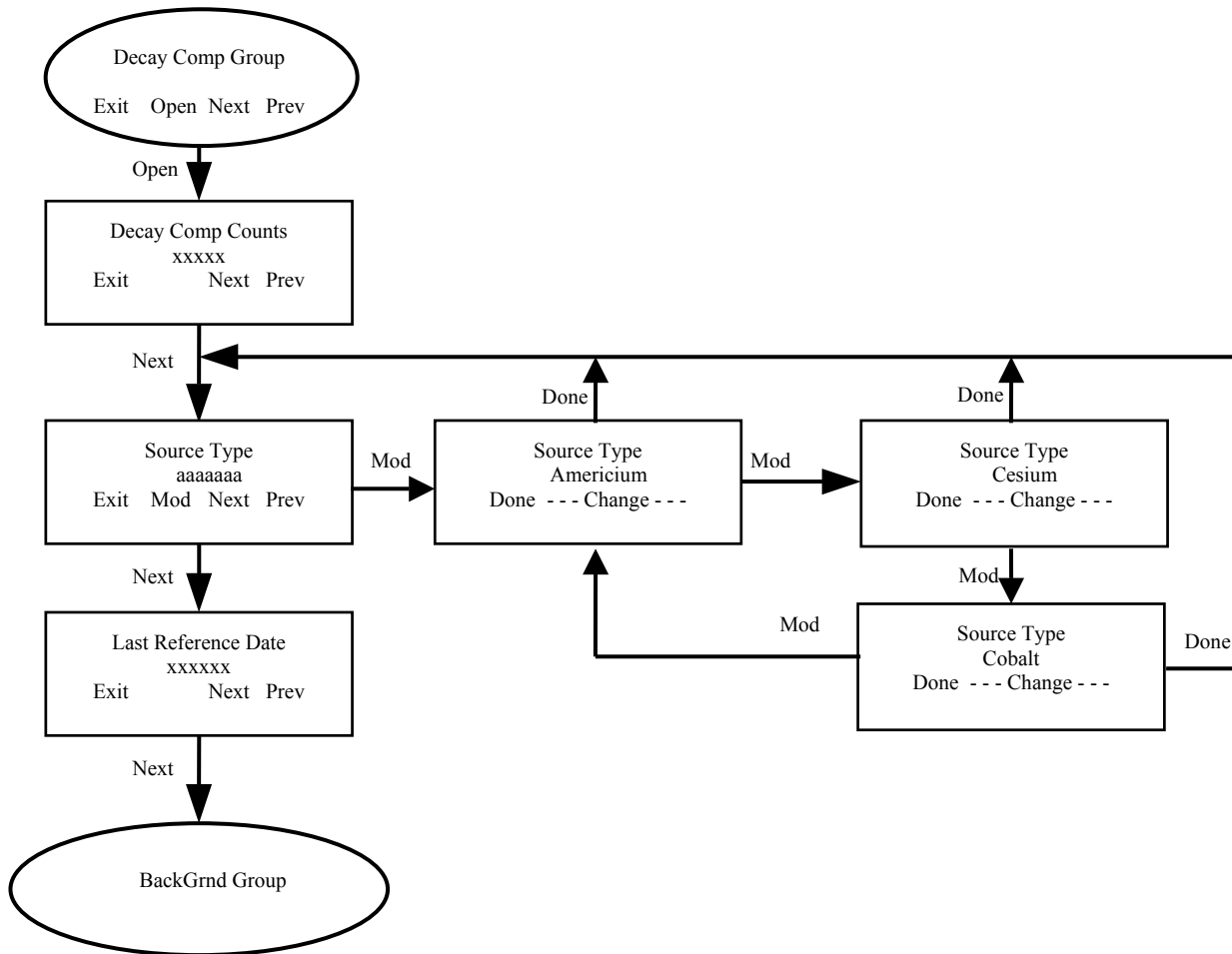
High Cal Value – this is the value entered by the user that represents the density value to be calibrated against. This density value is usually higher than the Low Ref Value.

High Cal Type – the system can use a single transmission constant throughout the measurement range assuming that the distance between the source and detector are relatively consistent. In certain installations, a transmission constant can be stored for each interval traveled.

Execute Vesl Calibrate – performs the calibration function. The calibration duration is set by the Reference Time in the Low Reference Group.

Transmission Const – the transmission constant is the result of the calibration and is used in the density calculation. It represents the transmissivity of the density.

Hi Cal Fault Counts – during calibration, raw counts above this value will cause the calibration function to abort.



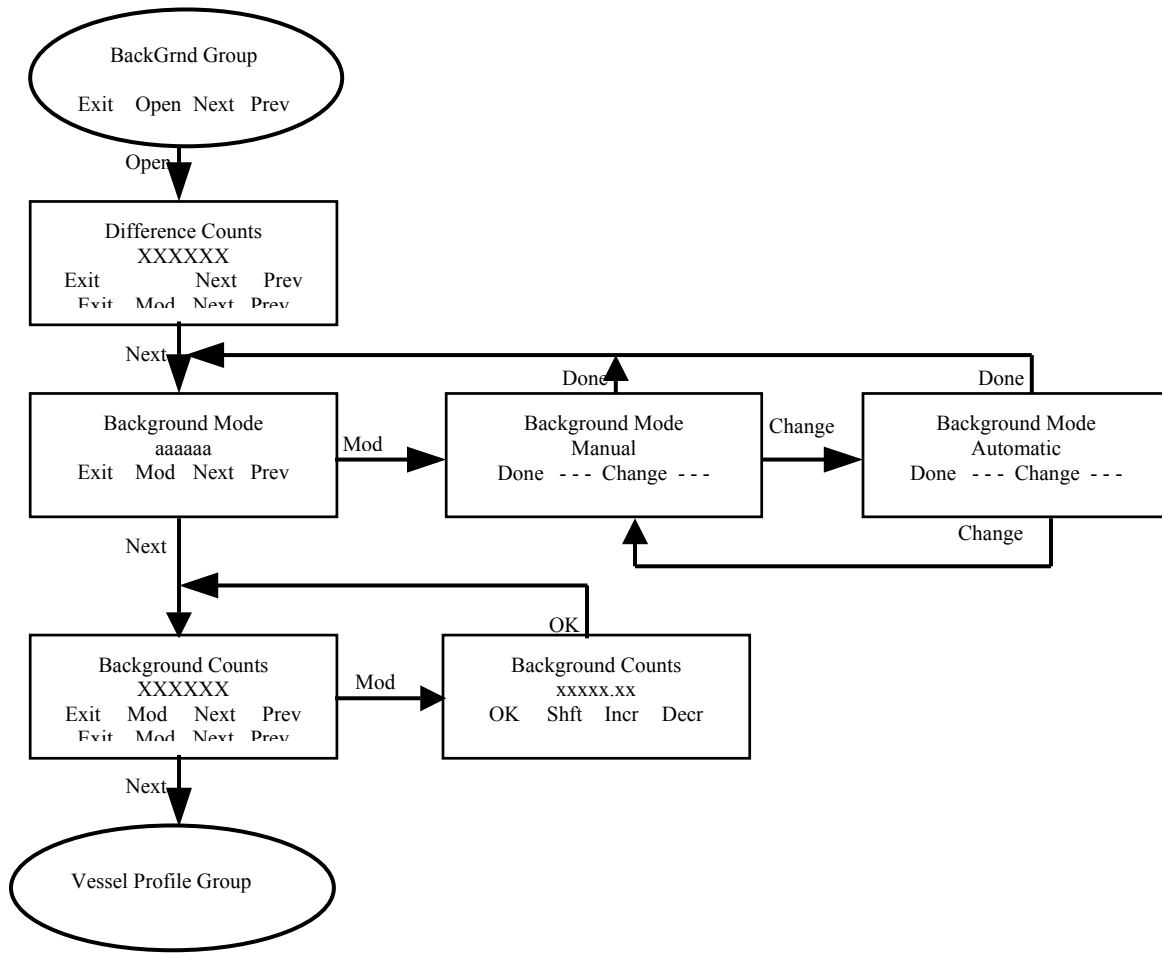
Decay Comp Group

Decay Comp automatically adjusts the detector counts for the loss in radioactivity from the source due to natural isotope decay. The decay comp function is reset by a Low Reference.

Decay Comp Counts – displays the resultant counts after decay compensation.

Source Type – lets the user select the source type being used with the measurement.
Possibilities are: Americium, Cesium, Cobalt.

Last Reference Date – displays the date the last reference was executed.



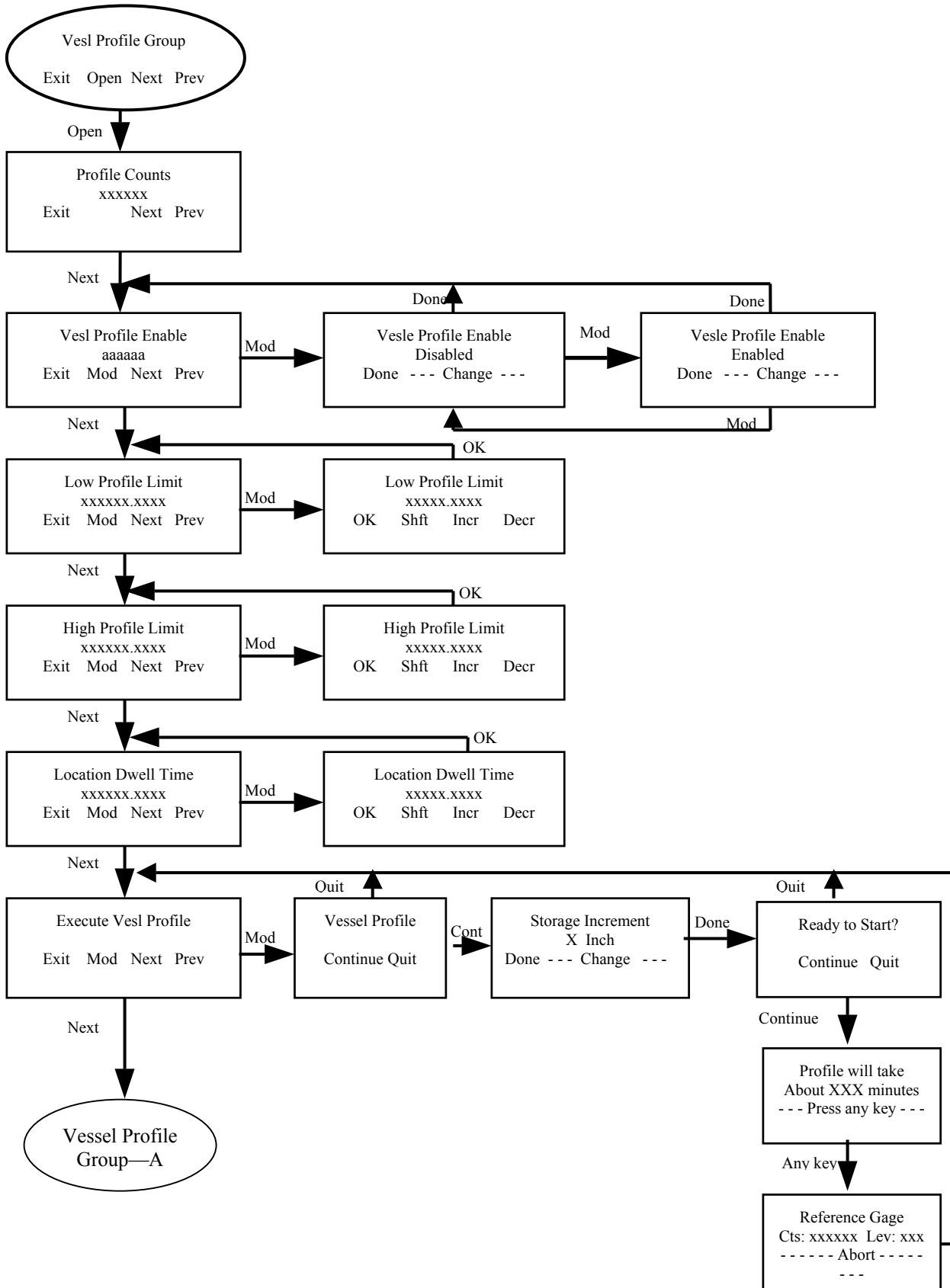
Backgrnd Mode Group

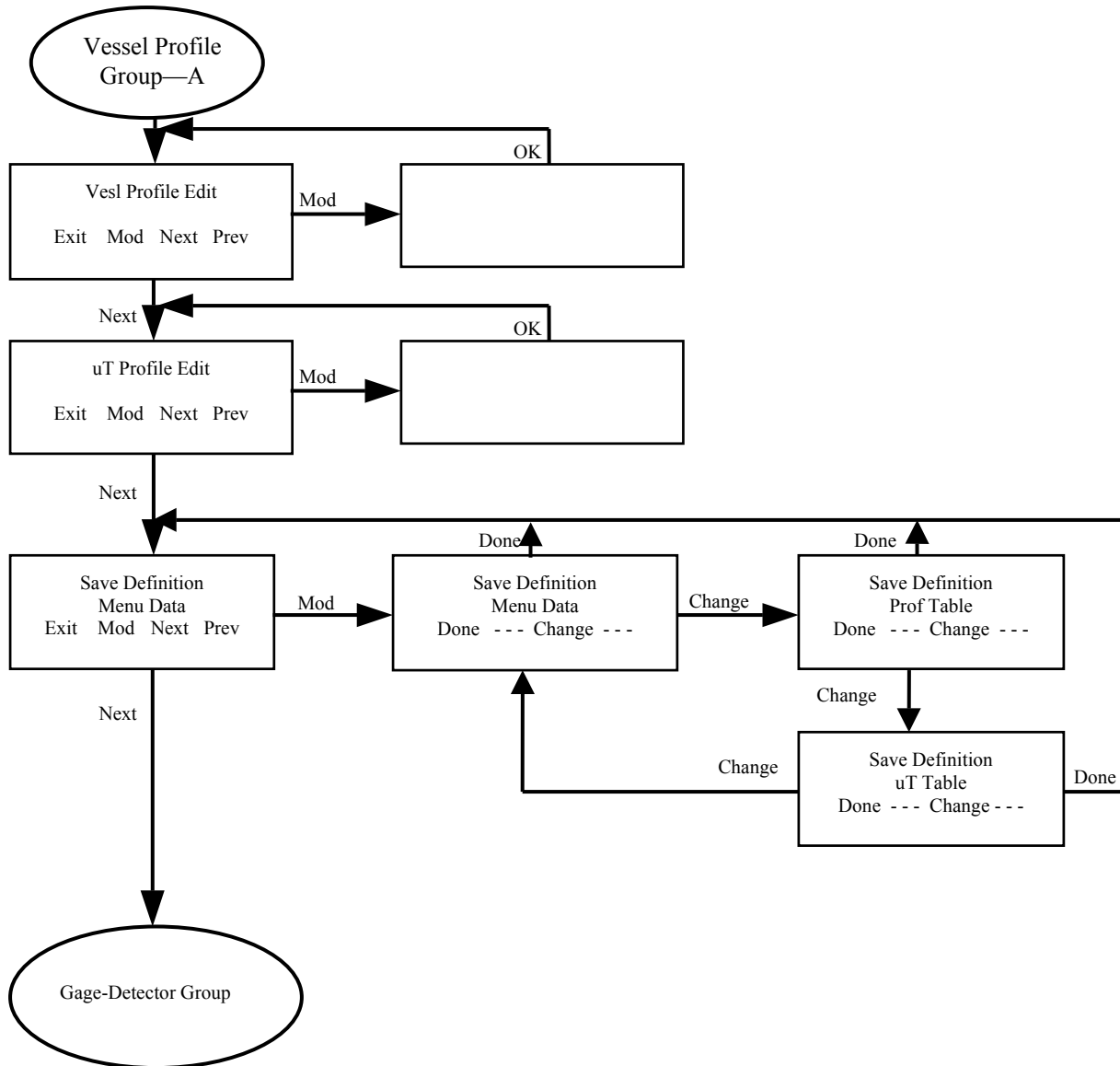
This group allows a more sensitive measurement in some installations. The background radiation can be removed from the density conversions.

Difference Counts – the raw counts after subtracting the background counts.

Background Mode – When Automatic is selected, the Background Counts will be accumulated whenever the source is in the Home position. When Manual is selected, the user can enter the Background Counts in the next menu.

Background Counts – the counts gathered Automatically or Manually to be subtracted from the raw counts.





Vesl Profile Group

These menus pertain to the vessel profile. This is done at startup to compensate for any non-linearity in the wells or minor obstructions in the path. During Profile, the gage will stop at each interval and get a count sample. This sample is compared with a common sample at the bottom position. A multiplier is calculated and stored for each interval to compensate for the non-linearity.

Profile Counts – the resultant counts from Decay Comp manipulated with the multiplier stored at each interval.

Vesl Profile Enable – if disabled, a multiplier of 1.0 is substituted at each interval. When enabled, the stored multiplier for each interval is used.

Low Profile Limit – lower limit of profile multiplier storage.

High Profile Limit – upper limit of profile multiplier storage. Levels above this limit or below the Low Profile Limit use a multiplier of 1.0.

Location Dwell Time – the duration at each interval to accumulate the detector counts and compute a multiplier value.

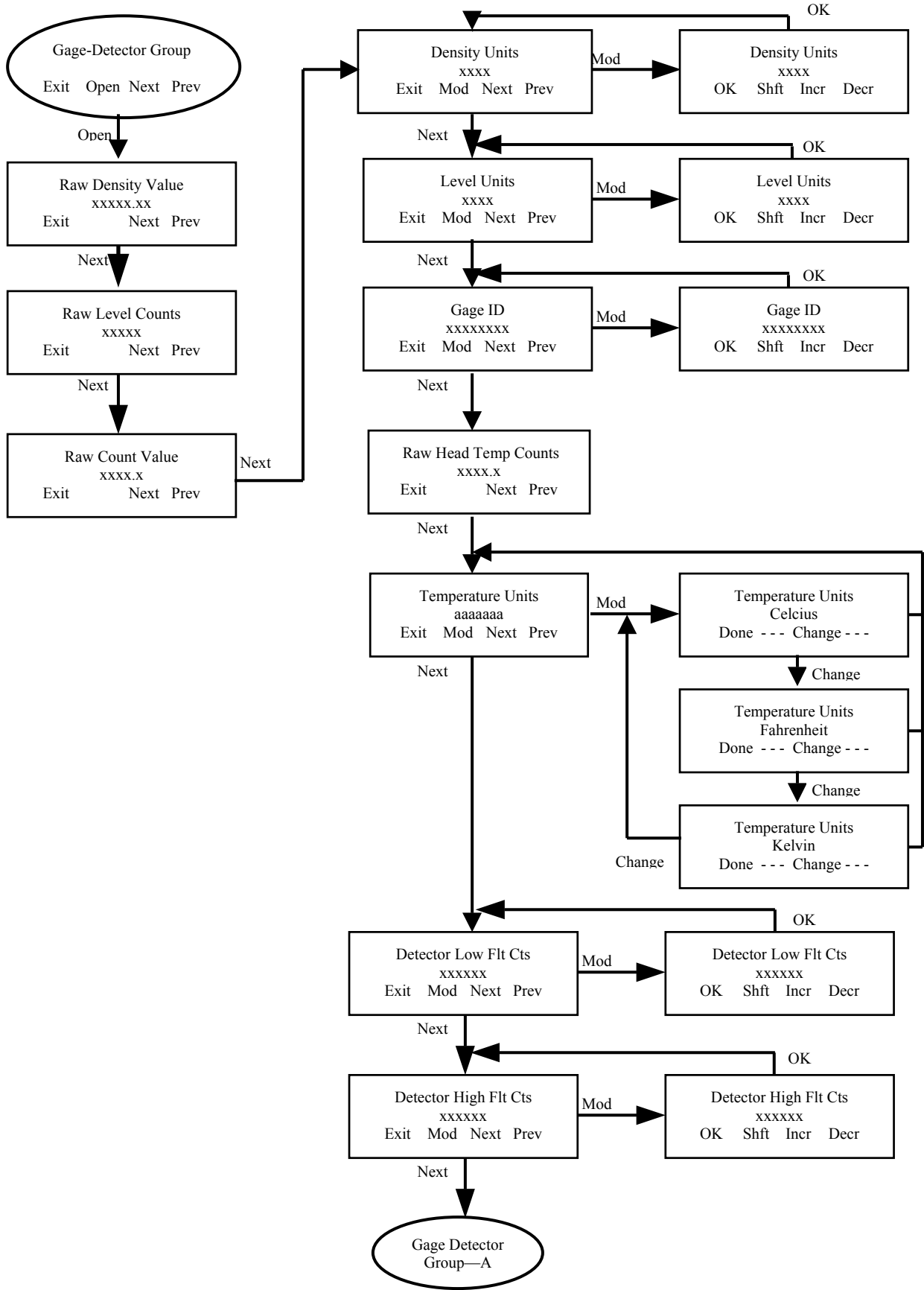
Execute Vesl Profile – perform the Profile. The system will move to the Low Profile Limit, average the counts for the Location Dwell Time, then move to each interval, average the counts for the Location Dwell Time, calculate a multiplier, store it, then move to the next interval. The interval is defined in the Drive Setup Group, the Move Increment menu.

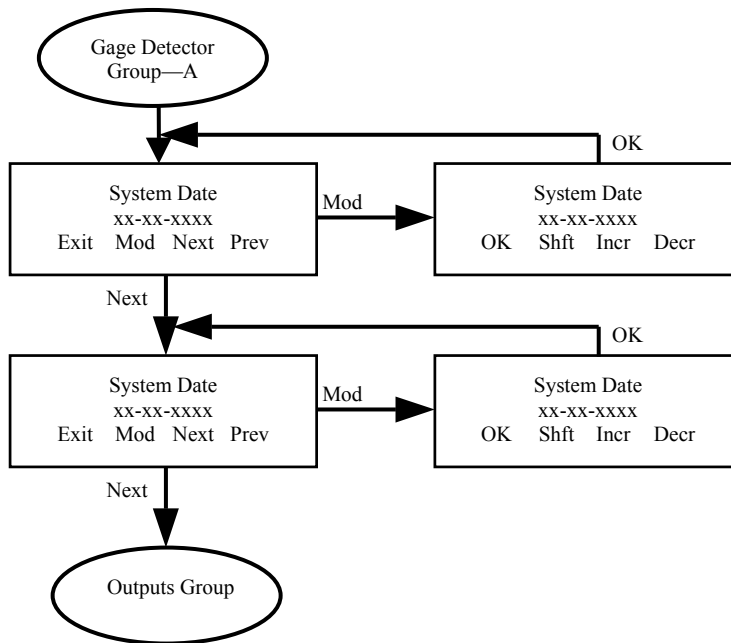
Vesl Profile Edit – allows the user to edit individual multipliers stored in the table. Putting a 0.0000 in a location effectively eliminates that interval from use. The gage will skip over that entry if the Vesl Profile is Enabled.

UT Profile Edit – allows the user to edit individual Transmission Constants stored at each interval if the High Cal Type were set to Multi-Pos when the Execute Vesl Calibrate was performed.

Save Definition – When saving the setup parameters into the X99 handheld programmer, the user can select to save the Profile Table, the uT Table, or the standard Menu data with this menu.

Ronan Motorized Density Monitor	Microprocessor Software Operations
--	---





Gage Detector Group

This group contains menus primarily used for displaying the density, level, and detector failure count levels.

Raw Density Value – displays the calculated density.

Raw Level Value – displays the level.

Raw Count Value – displays the count value used to calculate the density.

Density Units – displays the user's units data. The system does not use the contents of this display since the X99 gages are designed to be unit-less.

Level Units – displays the user's units data. The system does not use the contents of this display since the X99 gages are designed to be unit-less.

Gage ID – user's 8 character ID. This ID will be displayed when the handheld scans for attached devices. It is otherwise not used by the system.

Raw Head Temp Counts – the raw counts from the Head Temp I/O module.

Head Temperature – displays the temperature of the detector electronics.

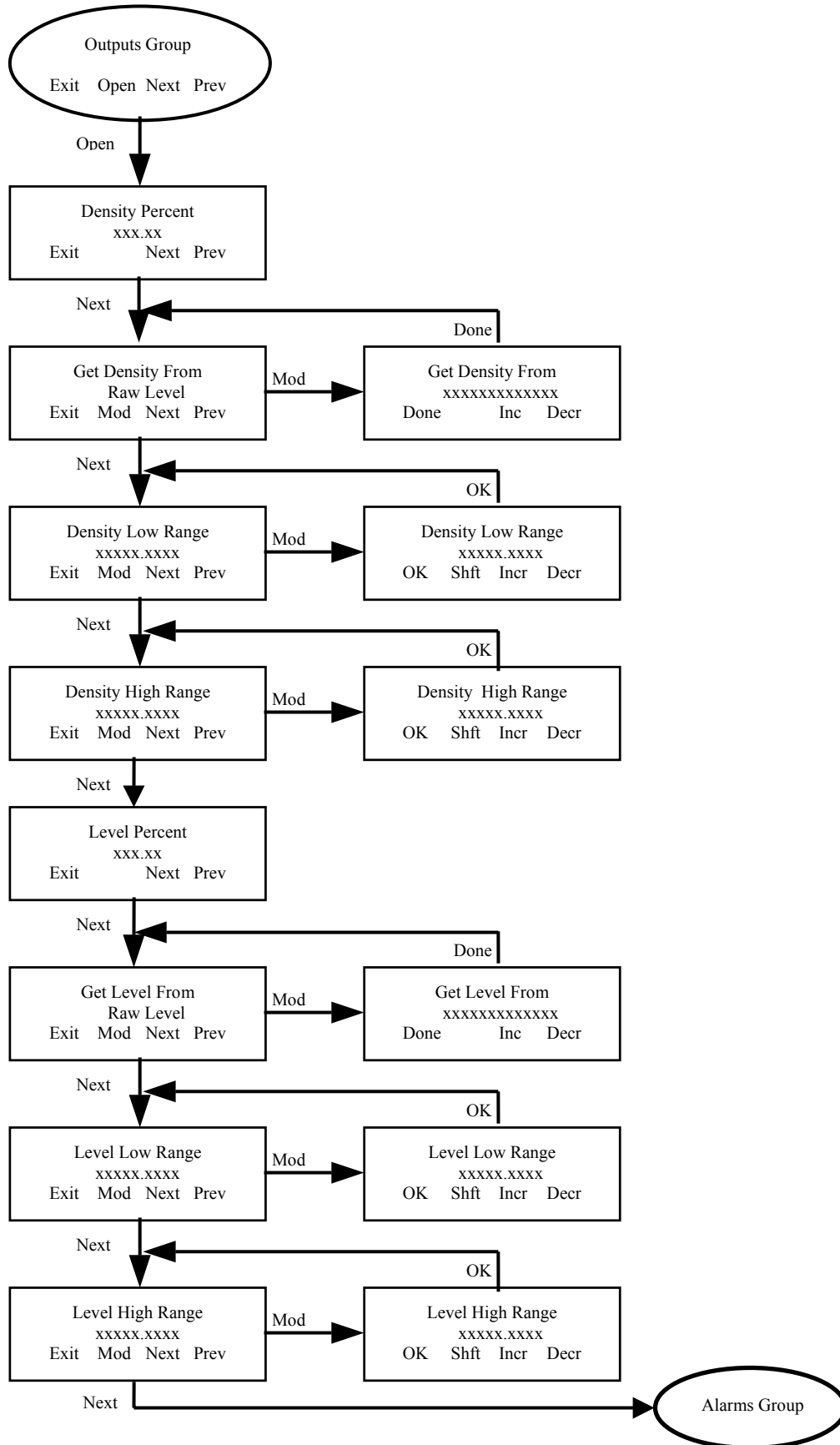
Temperature Units – displays the Head Temperature in the selected units.

Detector Low Flt Counts – allows the user to set the minimum counts a detector should receive. This value is usually set close to the background count value.

Detector Hi Flt Counts – allows the user to set the maximum counts a detector should receive. This value is usually just above the counts received when the vessel is empty.

System Date – current date. This value is used in the Decay Compensation algorithm.

System Time – current time.



Outputs Group

This group contains the menus for setting up the 4-20 ma outputs for the level and density.

Density Percent – the percent (0-100) of range between the Density Low Range and the Density High Range.

Get Density From – allows the user to select which menu to get the density signal from; usually the Raw Density Value menu.

Density Low Range – sets the lower end of the 4-20 mA (or 0 – 10V) range for the density output.

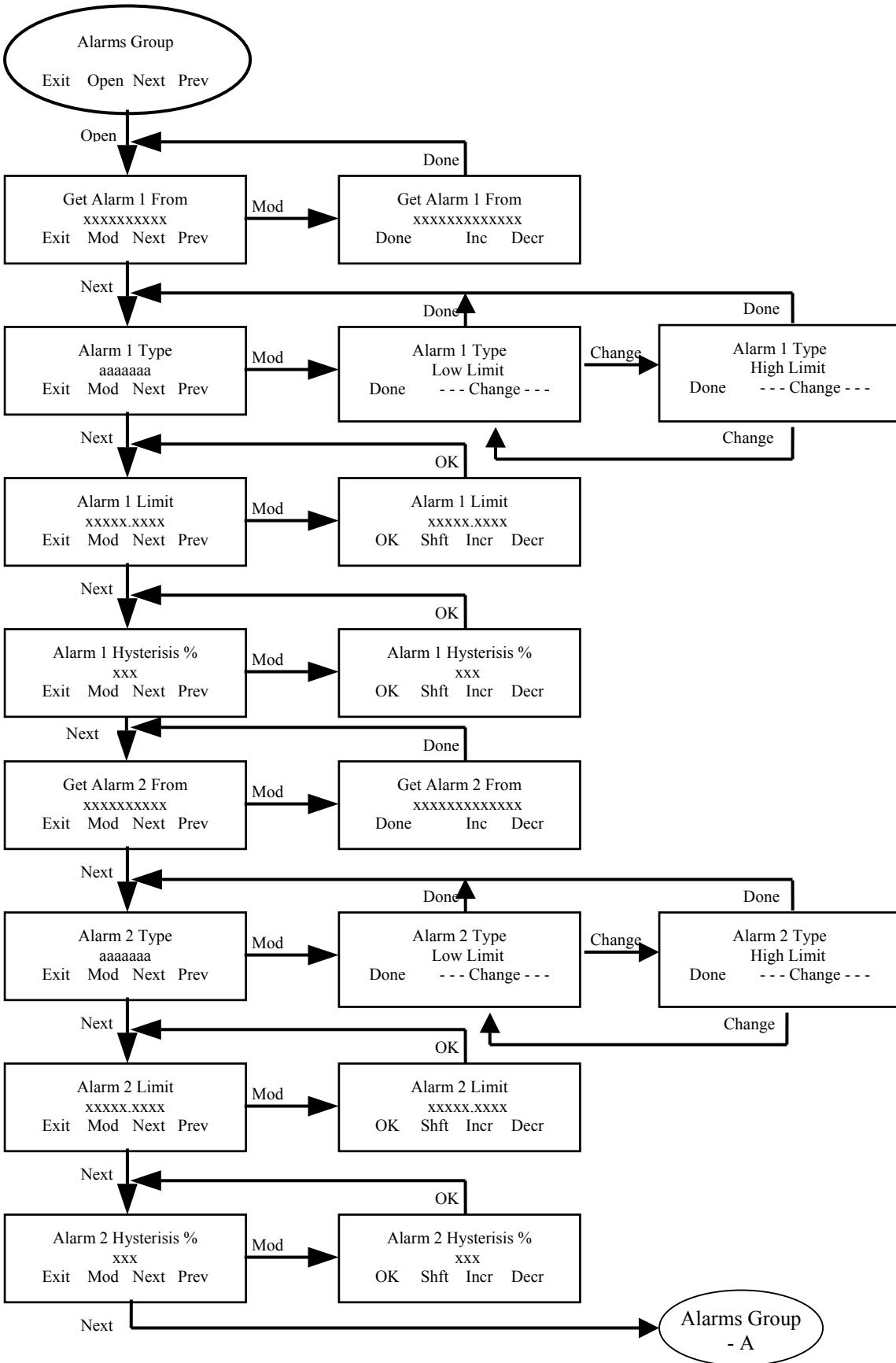
Density High Range – sets the upper end of the 4-20 mA (or 0-10V) range for the density output.

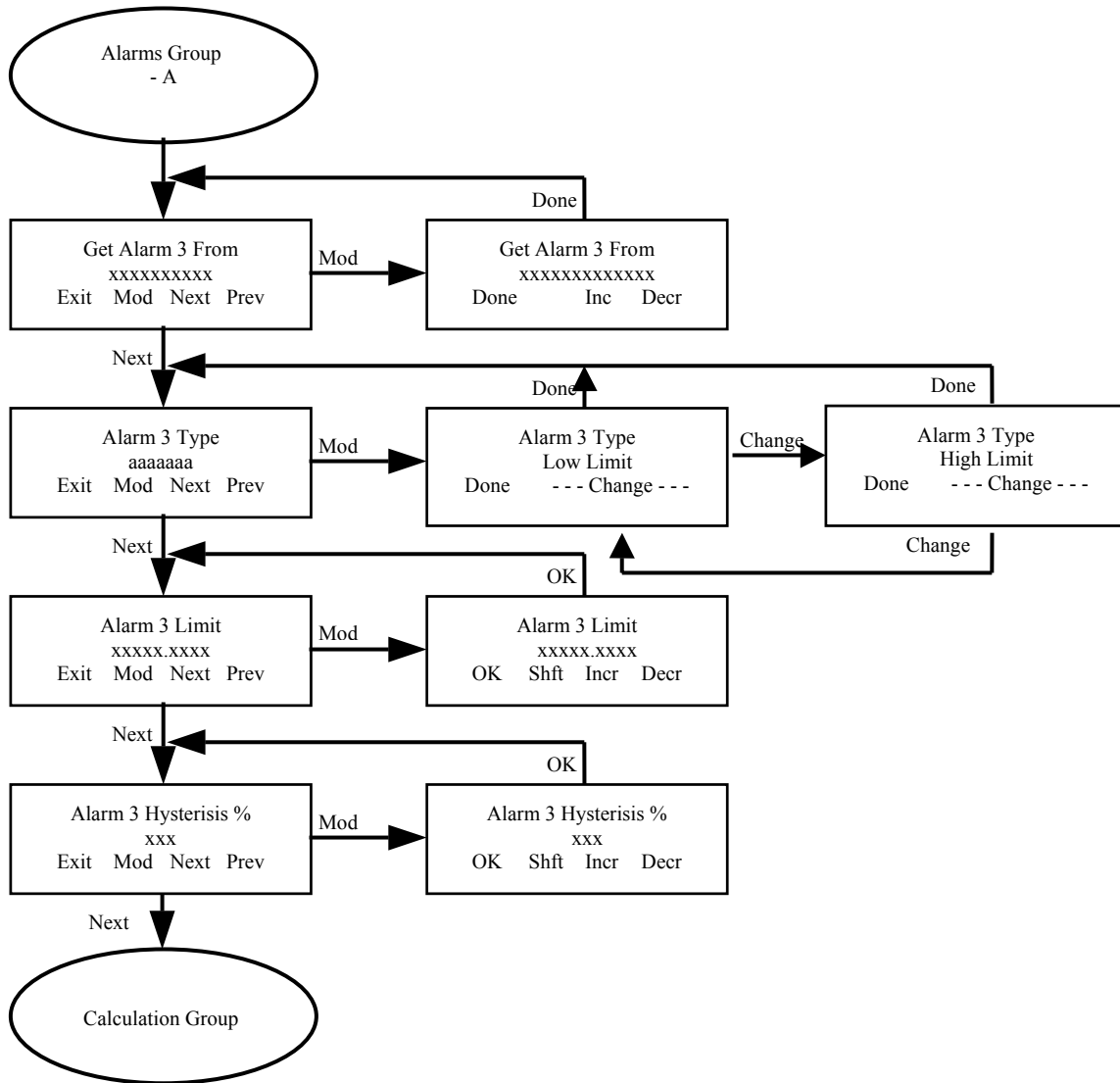
Level Percent – the percent (0-100) of range between the Level Low Range and the Level High Range.

Get Level From – allows the user to select which menu to get the level signal from; usually the Raw Level Value menu.

Level Low Range – sets the lower end of the 4-20 mA (or 0 – 10V) range for the level output.

Level High Range – sets the upper end of the 4-20 mA (or 0-10V) range for the level output.





Alarms Group

This group allows the user to set up to 3 alarms. The alarms can be selected from any available menu, allowing a density limit, level limit, head temperature limit, count limit, etc.

Get Alarm 1 From – select the menu to get the alarm signal from. This is usually a dynamic value (density, level, etc.).

Alarm 1 Type – allows the selection of Low or High Limit.

Alarm 1 Limit – sets the limit value. Low limit type values below this limit activates the alarm; high limit type values above this limit activates the alarm.

Alarm 1 Hysteresis % - allows the user to set the percent of the Limit for hysteresis. Once an alarm activates, it must exit the hysteresis band, and re-enter to re-activate an alarm.

Get Alarm 2 From – select the menu to get the alarm signal from. This is usually a dynamic value (density, level, etc.).

Alarm 2 Type – allows the selection of Low or High Limit.

Alarm 2 Limit – sets the limit value. Low limit type values below this limit activates the alarm; high limit type values above this limit activates the alarm.

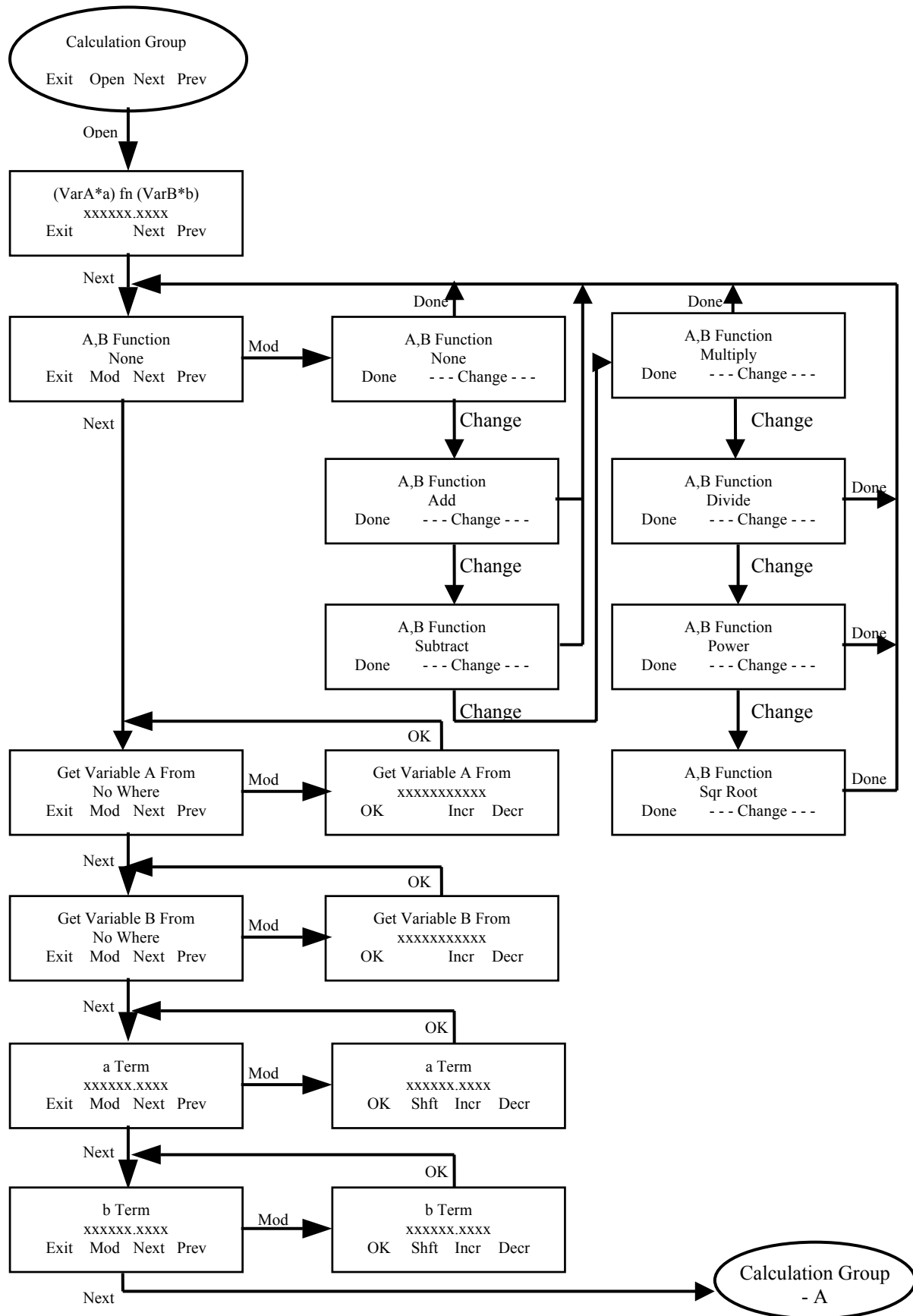
Alarm 2 Hysteresis % - allows the user to set the percent of the Limit for hysteresis. Once an alarm activates, it must exit the hysteresis band, and re-enter to re-activate an alarm.

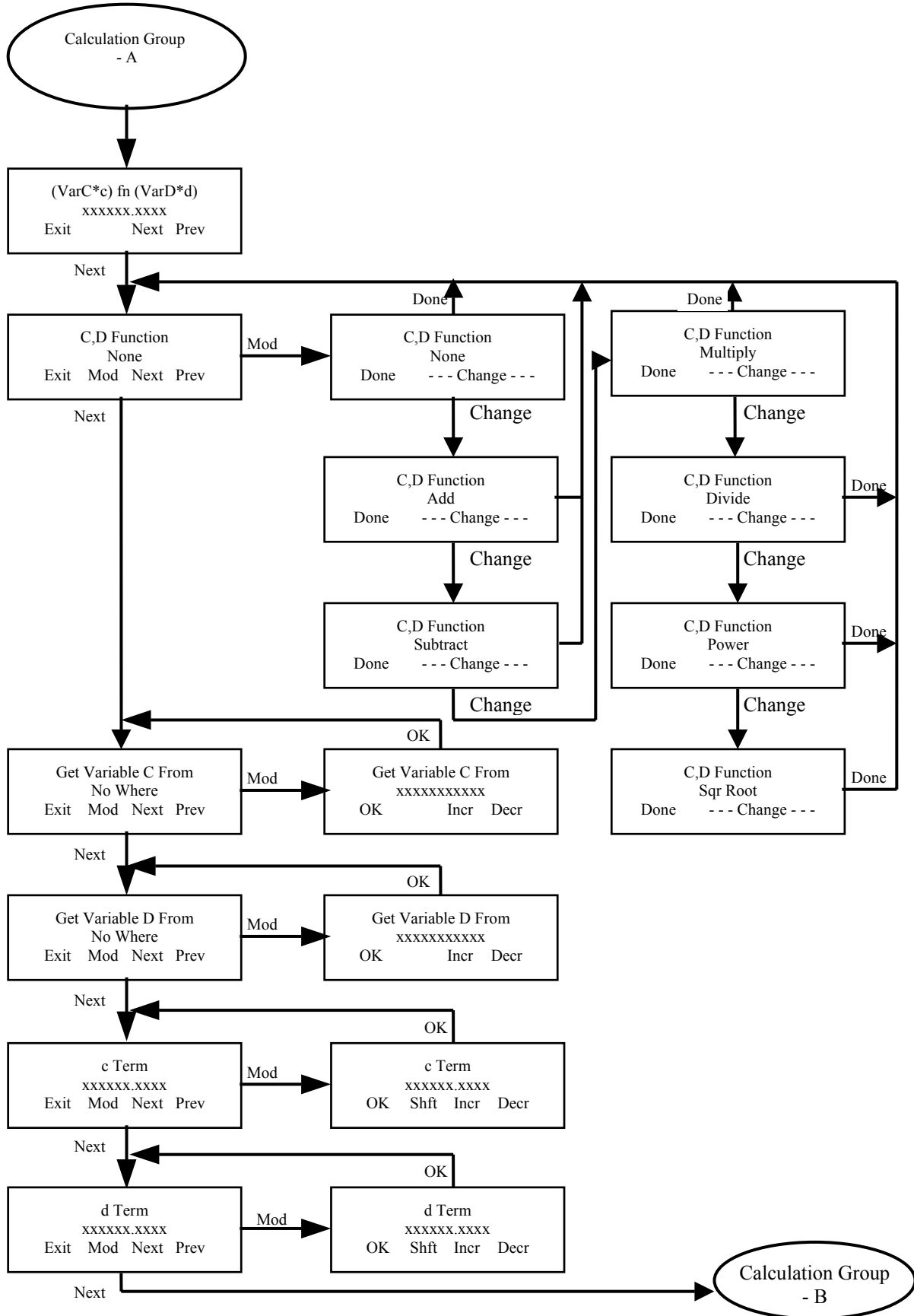
Get Alarm 3 From – select the menu to get the alarm signal from. This is usually a dynamic value (density, level, etc.).

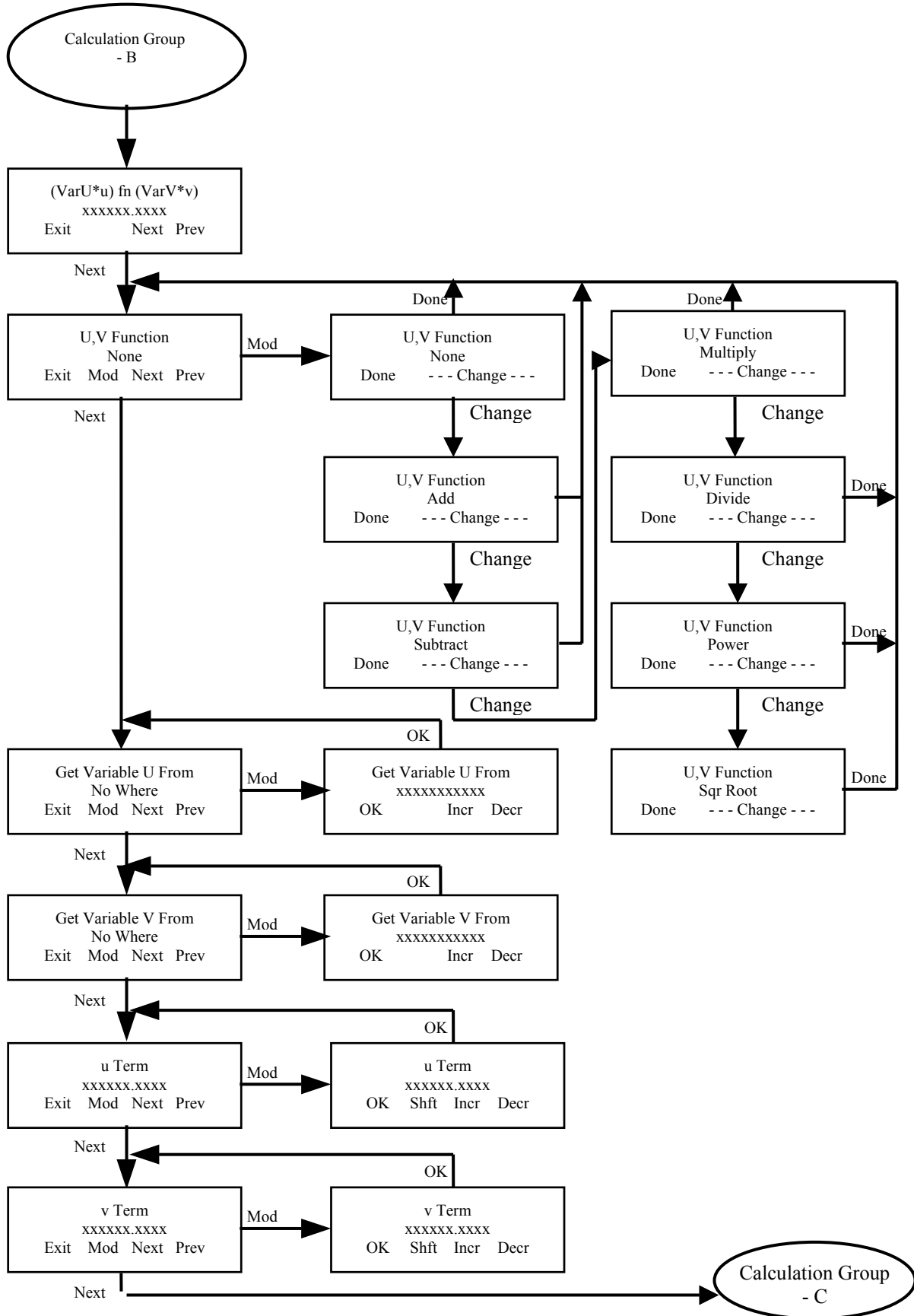
Alarm 3 Type – allows the selection of Low or High Limit.

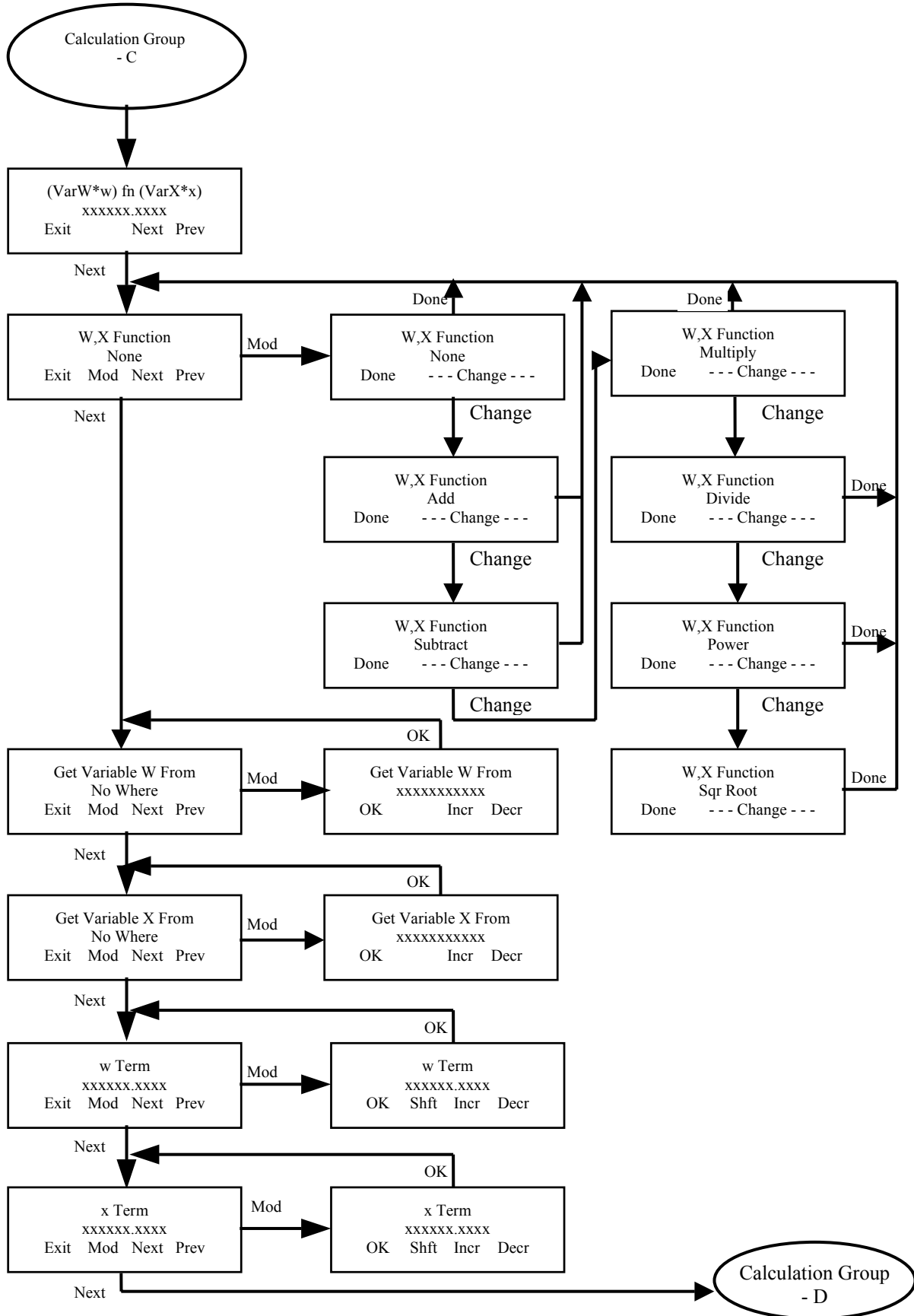
Alarm 3 Limit – sets the limit value. Low limit type values below this limit activates the alarm; high limit type values above this limit activates the alarm.

Alarm 3 Hysteresis % - allows the user to set the percent of the Limit for hysteresis. Once an alarm activates, it must exit the hysteresis band, and re-enter to re-activate an alarm.









1**Start-Up Procedures for Ronan Motorized Density Gages**

NOTE: The following must be completed before configuring the software:

- The source must be installed and connected to the drive belt.
- The detector must be installed, wired, and connected to the drive belt (if a dual-drive system is being installed).
- If a dual-drive system is being installed, the source and detector must be aligned in the Home position.
- Make sure the local panel (inside the Motor Panel) is in the Remote Mode position.

Set up the software for Home Positioning Values.

Access the Operating Mode Group and the Operating Mode menu and set the mode to Manual Mode.

In the Drive Setup Group, set the Home Position Level to the Level at the bottom of the source/detector housings. Set the Bottom Position Level to the proper value (usually 0.000). Next set the Move Increment to the increment you plan to use.

Finally, access the Set Home Position menu and Modify to start the Set Home Position procedure.

2**Perform an Empty Vessel Profile**

- From the X99 microprocessor, access the Background Group. The access code is: “1 3 1 2 3 2”
- Verify that the Background Mode (in the Background Group) and the Background Counts are correct. Note that most applications will use ‘Manual’ mode and set the Background Counts manually.
- Next, access the Vessel Profile Group.
- Enable the Vessel Profile.
- Verify that the Low Profile Limit is correct and equal to or greater than the Bottom Position Limit in the Drive Setup Group.
- Verify that the High Profile Limit is at the highest level the gage will operate at and less than the Home Position Limit in the Drive Setup Group.
- Check the Location Dwell Time. This is the time the gage will dwell at each increment averaging the detector signal. The longer the dwell time, the more stable the multipliers in the Vessel Profile Table will be.
- Move to the Execute Vessel Profile menu and press the ‘Modify’ key.
- Set the Storage Increment value to the same as the Move Increment menu in the Drive Setup Group.
- Follow the remaining prompts to perform a Vessel Profile.
- After the function completes, change the Operating Mode (in the Operating Mode Group) to Continuous Scan Mode.
- Allow the gage to traverse completely through the whole operating range while trending the Density and Level outputs. **SAVE THIS TREND FOR FUTURE USE!** This trend will give both you and the factory the necessary data for troubleshooting later if needed.

3**Reference the gage on a known density.**

1. From the X99 microprocessor, access the menus. The access code is '1 3 1 2 3 2'
2. Change the Operating Mode in the Operating Mode Group to Manual Mode. Position the source to the level of the known density.
3. Open the Low Reference Group and set the Low Reference Value to the known density value.
4. Set the Reference Time to the same time as the Dwell Time you used during the Empty Vessel Profile (Location Dwell Time menu).
5. Execute the Low Reference.
6. During referencing, the gage will average the counts for the Reference Time. Once the averaging is finished, the X99 will store the counts.
7. You should next perform a Calibration.

4

Gage Calibration. Three methods exist for calibration:

- Manual 1/uT entry.
- Calculated Single-position 1/uT. **Recommended.**
- Calculated Multiple-position 1/uT.

Manual 1/uT Entry.

This method is useful as a temporary measure to get started when time is critical. It is much more accurate to perform a Calculated Single – position 1/uT .

1. Calculate the 1/uT transmission constant:
u = absorption constant (.2 for Cesium source)
T = process path length (in inches)

Example:

Distance between source and detector well = 10”

Transmission Constant = $1/(.2 \times 10) = .5$

2. Access the menus via the code “1 3 1 2 3 2”
3. Open the Vessel Calibrate Group and access the Transmission Constant menu.
4. Set the value here to the value you calculated from above.

Calculated Single-position 1/uT.

This is the recommended method for calibration unless you have source and detector wells that are non-parallel due to vessel configuration.

1. The calibration density must be known. You will need to move the source/detector to a position in the vessel where the known density is in the process path. Leave the gage parked at this position until the calibration is complete.
2. Access the menus via the code “1 3 1 2 3 2”
3. Open the Vessel Calibrate Group and access the High Cal Value menu and enter the value of the density that is in the process path.
4. Access the High Cal Type and set it to ‘Single’.
5. Next access the Execute Vessel Calibrate menu and follow the prompts to complete the calibration. The calibration duration is defined by the Reference Time in the Low Reference Group.
6. The Transmission Constant calculated will appear in the Transmission Constant menu.

Calculated Multiple-position 1/uT.

This is the recommended method for non-parallel wells due to vessel configuration. It permits a different 1/uT value for each Move Increment due to differing path lengths.

The vessel must be filled with a consistent density for perform the multiple-position 1/ut function.

Access the menus via the code "1 3 1 2 3 2"

Open the Vessel Calibrate Group and access the High Cal Value menu and enter the value of the density that is in the process path.

Access the High Cal Type and set it to 'Multi-Pos'.

Next access the Execute Vessel Calibrate menu and follow the prompts to complete the calibration. The calibration duration will be the same as in the Empty Vessel Profile.

The Transmission Constant calculated for each increment will appear in the Transmission Constant menu.



Chapter 5 describes calibrating the Ronan Motorized Density Gage System.

The calibration procedure is detailed, with step-by-step instructions.

Careful attention to drawing a representative sample of density for precise laboratory analysis will produce the most accurate measurement results.

Document all changes you make to the factory-default settings* that are active in your system.

* See "Factory Configuration and Inspection Sheets" filed in Chapter 10 with drawings.

REV NO.	DATE	PAGE NO.	DESCRIPTION
0	07/15/02	ALL	ISSUED

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 polyvinyltoluene (PVT) plastic. The crystal produces light pulses which are proportional to the incident radiation events striking it.

Typically mounted in a 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

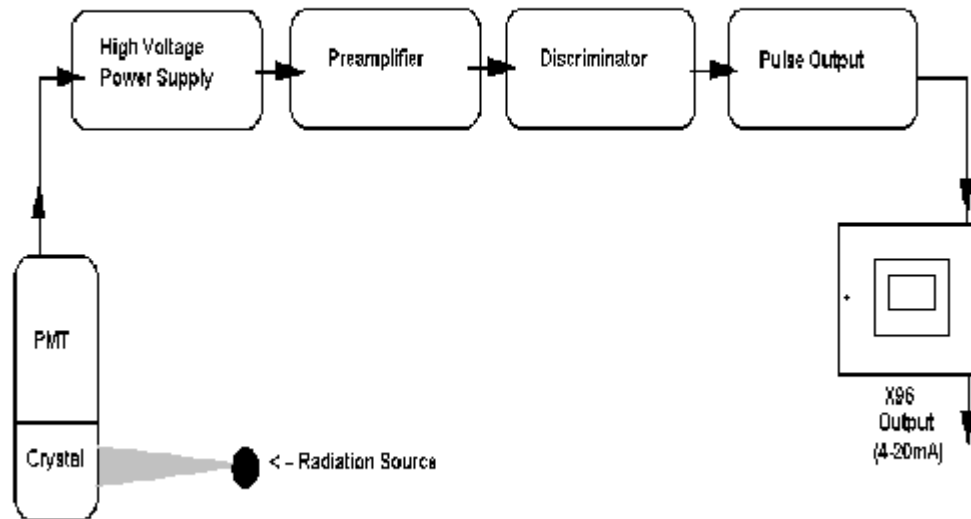
The PMT is a light sensitive vacuum tube with a photosensitive layer that converts the light pulses to an electrical current. Light pulses from the crystal strike the photosensitive layer and release electrons. A high voltage power supply connected to the photosensitive layer accelerates the electrons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

Technical

Scintillator

Technical

Chapter 6 contains technical information and reference drawings for the detector.

The Scintillation Detector is NOT field servicable.

Instructions are given for replacing the detector.

REV NO.	DATE	PAGE NO.	DESCRIPTION
0	07/15/02	ALL	ISSUED

Scintillator Input Module Description

The Scintillator Input module is the digital pulse detector input to the Ronan Intelligent Detector systems.

The Scintillator Input module supplies +18VDC to the detector for power and receives the digital pulses from the detector that represent the strength of the radiation field applied to the detector. The system can accept a value of 32767 maximum each scan. Normally, the Ronan detectors are well within this limitation.










The module can be calibrated for the Count Period (typically matches the gage's scan time of 400 mS), and Prescale Divider (to divide the counts down - typically set to one).

This module is microprocessor-based with an RS-485 communications interface, and the RNET proprietary protocol. The module's communications address is normally preset at the factory, but is field selectable.

Scintillator Input Module Specifications

Power:	+5 VDC \pm 5%, 75 mA maximum
Communications:	Single RS-485 multi-drop communications channel
Temperature:	-40 to +75 °C
Humidity:	0 - 95% non-condensing
Vibration:	
Input Range:	Digital pulses up to 1MHZ in frequency.
Outputs:	+18VDC for detector power
Resolution:	15 bit (0 - 32767 counts)
Calibration:	Factory Pre-calibrated; Field calibration capable.

Scintillator Input Module Pin Number Description

Green/White	9		Shield to Scintillator
	8		Isolated Ground
Red	7		+18 VDC to Scintillator
Blk	6		Scintillator Signal Common (-)
Wht	5		Scintillator Signal Input (+)
	4		RS-485 -D (from CPU)
	3		RS-485 +D (from CPU)
	2		5 VDC Ground (from Power Supply)
	1		+5 VDC (from Power Supply)

Analog Output Module Description

The Analog Output module is used for voltage or current output from the Ronan Intelligent Detector systems. A switch on the module selects either voltage or current output.

This module produces an isolated voltage of from 0 - 10 VDC, or an isolated current from 0 to 20 mA. The module can be calibrated for any voltage or current within the above limits by setting the Zero and Span in the calibration procedure. Zero and Span values can also be inverted (Zero = maximum input value, Span = minimum input value).

The Analog Output module also incorporates a Failure Mode of operation, where the output from the module can be specified in the event of an I/O communications failure. This mode can be selected during the calibration procedure to be Hold or Specific Value. In the Hold mode, the last valid value received by the module will be maintained until either power is removed from the module, or communications is restored. In Specific Value mode, you select a percent of full scale output to be maintained during communications failure.







The module is microprocessor-based with an RS-485 communications interface, and the RNET proprietary protocol. The module's communications address is normally preset at the factory, but is field selectable.

Analog Output Module Specifications

Power:	+5 VDC \pm 5%, 75 mA maximum
Communications:	Single RS-485 multi-drop communications channel
Temperature:	-40 to +75°C
Humidity:	0 - 95% non-condensing
Vibration:	
Output Range:	Isolated 0 - 20 mADC (switch selectable between mA and V) Isolated 0 - 10 VDC
Max Output Load:	1,000 Ω
Resolution:	12 bit
Accuracy:	\pm 1/2 LSB over full range
Calibration:	Factory Pre-calibrated; Field calibration capable.

Analog Output Module

<u>Pin Numbers</u>	<u>Description</u>
--------------------	--------------------

6	 - Output
5	 + Output
4	 RS-485 -Data (from CPU)
3	 RS-485 +Data (from CPU)
2	 5 VDC ground (from Power Supply)
1	 +5 VDC (from Power Supply)

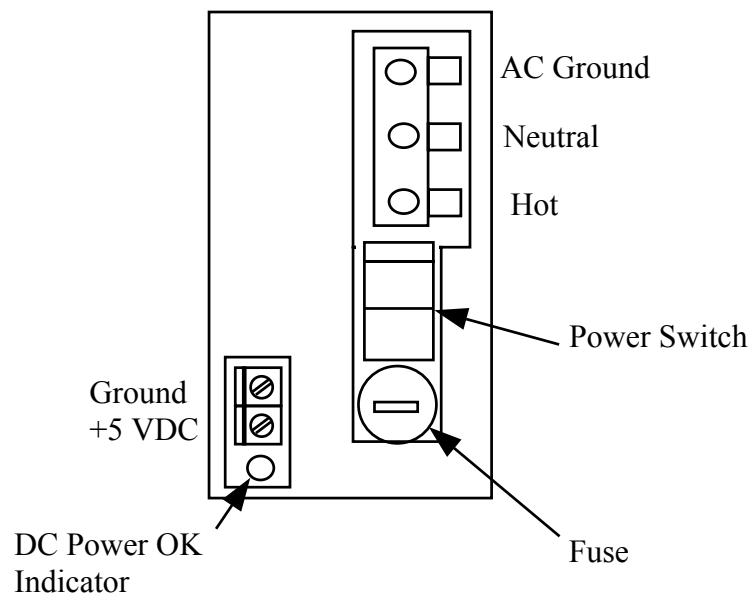
AC Power Supply Module Description

The Power Supply module supplies the +5VDC to the modules housed in the NEMA-4 enclosure attached to the detector.

AC Power Supply Module Specifications

Power Input: 85 - 265 VAC \pm 15%, 15 watts
Power Output: +5VDC, 3A maximum
Temperature: -40 to +75°C
Humidity: 0 - 95% non-condensing
Vibration:
Fuse: 250 Volt, 3.15A, 5x20mm

Power Supply



CPU Module Description

The CPU module is the computer module for the Ronan Intelligent Gage Systems. It incorporates the micro-processor, PROM program memory, non-volatile RAM data memory, and communications.

Two relays provide alarm outputs for the detection of power fail and I/O communications errors. The processor is housed in a NEMA-4 enclosure along with the power supply and I/O modules for a particular gage type.

The gage software for the micro-processor contains the Menu Variable Access package, I/O control and monitoring package, and the gage algorithm package. Two communications ports provide RS-485 communications for the handheld and I/O modules using Ronan's RNET proprietary protocol. One can be switched to RS-232 for special communication option.

The module also contains a switch bank for selecting the address (0-31) on the RS-485 multi-drop communications link to the handheld programmer.

CPU Module Specifications

Power Required:	+5 VDC \pm 5%, 90 mA maximum
Temperature:	-40 to +75°C
Humidity:	0 - 95% non-condensing
Vibration:	
Outputs:	Form A relay output for power fail Form C relay output for I/O communications errors RS-485 communications for I/O modules RS-485 communications for handheld programmer RS-232 communications for Field Addressable Remote Transmitter modem Option +5VDC for handheld programmer power
Processor:	10 MHZ 80188 microprocessor
Memory:	128KB PROM memory 2/4/8KB Non-volatile battery-backed RAM (Minimum 10 year battery life. Battery is used only when system is powered down)
Software:	Gage-type dependent.
Options:	I/O modules (gage-type dependent) Field Addressable Remote Transmitter modem - 9600 Bits/Second

CPU Module

<u>Pin Numbers</u>		<u>Description</u>
14		RS-232 Data Direction
13		RS-232 Data Out
12		RS-232 Data In
		RJ-11 connector for Local RS-485 hookup
11		Power-Fail Common
10		Power-Fail N.C. Contact
9		I/O Comm. Error N.O Contact
8		I/O Comm. Error Common
7		I/O Comm. Error N.C. Contact
6		-Data for Remote RS-485 communications
5		+Data for Remote RS-485 communications
4		-Data to I/O boards
3		+Data to I/O boards
2		5 VDC ground (from Power Supply)
1		+5 VDC (from Power Supply)

Relay Out Module Description

The Digital Output module supplies four Form C contacts to the user.

This module is microprocessor-based with an RS-485 communications interface, and the RONET proprietary protocol. The module's communications address is normally preset at the factory, but is field selectable.

Relay Out Module Specifications

Power:	+5 VDC \pm 5%, 70 mA maximum
Communications:	Single RS-485 multi-drop communications channel
Temperature:	-40 to +75°C
Humidity:	0 - 95% non-condensing
Vibration:	
Input Range:	None
Outputs:	4 Form 'C' contacts
Contact Rating:	1A @ 24 VDC .5A @ 120 VAC
Calibration:	Factory Pre-calibrated; No field calibration required.
Indicators:	Red LED: Off - No Power On Steady - Power OK, No Communications Blinking - Power and Communications OK

Relay Out Module Connections

<u>Pin Numbers</u>	<u>Description</u>
16	Output 4 N.C.
15	Output 4 Com.
14	Output 4 N.O.
13	Output 3 N.C.
12	Output 3 Com.
11	Output 3 N.O.
10	Output 2 N.C.
9	Output 2 Com.
8	Output 2 N.O.
7	Output 1 N.C.
6	Output 1 Com.
5	Output 1 N.O.
4	RS-485 -D (from CPU)
3	RS-485 +D (from CPU)
2	5 VDC Ground (from Power Supply)
1	+5 VDC (from Power Supply)

3-30 VDC In Module Description

The Digital Input module is designed to accept discreet digital inputs and send them to the Ronan Intelligent Detector systems.

This module will accept up to four discreet inputs.

This module is microprocessor-based with an RS-485 communications interface, and the RONET proprietary protocol. The module's communications address is normally preset at the factory, but is field selectable.

3-30 VDC In Module Specifications

Power:	+5 VDC \pm 5%, 50 mA maximum
Communications:	Single RS-485 multi-drop communications channel
Temperature:	-40 to +75°C
Humidity:	0 - 95% non-condensing
Vibration:	
Input Range:	3-30 VDC for DC module (4 inputs)
0 Logic:	Max Input Voltage 0.5 VDC
1 Logic:	Min Input Voltage 3.0 VDC
Outputs:	5VDC @ for input excitation
Calibration:	Factory Pre-calibrated; No field calibration required.
Indicators:	Red LED: Off - No Power On Steady - Power OK, No Communications Blinking - Power and Communications OK

3-30 VDC In Module

<u>Pin Numbers</u>	<u>Description</u>
14	Ground
13	+5 VDC Supply
12	Input 4 -
11	Input 4 +
10	Input 3 -
9	Input 3 +
8	Input 2 -
7	Input 2 +
6	Input 1 -
5	Input 1 +
4	RS-485 -D (from CPU)
3	RS-485 +D (from CPU)
2	5 VDC Ground (from Power Supply)
1	+5 VDC (from Power Supply)

General Troubleshooting Tips

Problem or symptom:

1. The gage will not move and/or movement time is greater than the pre-programmed dwell time.

At the Control Panel

- Check for the input power to the Control Panel. Should be 120 Volts ac on Terminal 7 between pins 1 and 2
- Check the green LED on the X99 Power Supply. Should be on. If not, check fuse. If fuse is okay replace power supply module.
- Check red LEDs on the X99 boards. Should be flashing. If not, check connector is fully seated onto the X99 board. Check connector screws for tightness. Check for possible shorts between the wiring at the connector. If connector and wiring is correct, try cycling power to the X99. If this does not solve it replace the defective X99 board.
- Check all the connectors in the control panel and the terminals on the X99.
- Check the detector and make sure the detector is working. A failed detector will inhibit normal operation. The system can still be moved manually or through the local panel in the Motor Panel but no density measurements are possible except for the level.
- Check for input power to the Pacific Scientific Servo Drive.
- Check the green LED on the Pacific Scientific Servo Drive. Should be on or flashing (green LED is on solid when not moving and flashing when the motor is moving). If not, check fuse. If fuse is okay replace Pacific Scientific Servo Drive.
- Check red LED on the Pacific Scientific Servo Drive. Should be off. If not press the Reset button next to the Pacific Scientific Servo Drive. If this does not solve the problem check wiring between Pacific Scientific Servo Drive to the Servo Motor inside the Motor Panel. If this does not solve the problem contact the factory.
- Check Terminal 8 User Go Home Contact. Should be open. If not check user wiring.
- Check the X99 Operating Mode Group for the proper selection if remote is selected then check the Remote Selector for the proper mode selection. If wrong operating mode is selected change to the correct operating mode.

At the Motor Panel

- Check Local Control Panel Selector is in the Remote position. If not change Local Control Panel Selector to the Remote position.
- Check Slack Belt LED. Should be off. If not change the Local Control Panel to Local position. Manually move the Detector and/or Source Slack Belt Control arms to the right until the Slack Belt LED is off while at the same time raising the source and detector from the Local Control Panel. Once the slack belt is taken up. Change the X99 Operating Mode to Manual/Stop. Perform a Drive Setup to reset the encoder. Return the X99 back to its normal operating mode.
- Check Over Tension LED. Should be off. If not, determine cause for the over tension. Move the source and detector to the home position. Verify the Source and detector Home LED turn on. If not, check the source and detector alignments in their respective housings. If they are out of alignment adjust belt at the gear reducer. After alignment, ensure the pulley lock screws are tight and the pulley locks are tight against the pulleys to the belts from slipping. If the detector and source were correct then check wiring and home position switch. Correct wiring or replace switch.
- Check Detector Home LED. The LED should be off if the detector is not in the home position. If not then check wiring and home position switch. Correct wiring or replace switch.
- Check Source Home LED. The LED should be off if the source is not in the home position. If not then check wiring and home position switch. Correct wiring or replace switch.

2. The gage movement or location is off position.

At the Control Panel:

- Access the Drive Setup Group on the X99. Go to Set Home Position menu and press the Modify key. Follow the prompts to reset the Home position. Return to the normal operations and verify the gage operation. If the gage movement is still off position proceed to the checks “At the Motor Panel”

At the Motor Panel:

- Move the source and detector to the Home position. Verify the Source and detector Home LED turn on. If not, check the source and detector alignments in their respective housings. If they are out of alignment adjust belt at the gear reducer. After alignment, ensure the pulley lock screws are tight and the pulley locks are tight against the pulleys to keep the belts from slipping. Access the Drive Setup Group on the X99. Go to Set Home Position menu and press the Modify key. Follow the prompts to reset the Home position. Return the gage to the normal operations and verify the gage operation.

3. The density indication is below the “Density Low Range” or above the “Density High Range”.

At the Vessel

- Check the process condition. Through lab samples determine the actual process density at the current vessel operating condition.
- Check and see if the vessel is full or empty.
- Check detector well temperature for over heating.

At the Control Panel

- Check that X99 display agrees with the user display (example: DCS display screen). If not verify the X99 Density and Level ranges match the DCS display ranges. If ranges agree then verify X99 output board is setup correctly. See Analog Output Module Setup Procedure.
- Check the Reference and Calibration. See the chapter “Calibration” to reference and calibrate the gage.
- Check the detector input board LED. Should be flashing. If not, check connector is fully seated onto the X99 board. Check connector screws for tightness. Check for possible shorts between the wiring at the connector. If connector and wiring is correct, try cycling power to the X99. If this does not solve it replace the defective X99 detector input board. If the LED is flashing next measure the frequency of input from the detector at the input board terminal pulses (detector pulse height 4.5 Vp-p with varying pulse frequency. Typically varying between 10 – 50,000 Hertz). Next access the Low Reference Group. Compare the raw counts with the frequency of input pulses. If there is pulses from the detector but the input board is reading zero verify the input board address is correct. If the address is correct, then replace the defective X99 detector input board. If there is zero pulses from the detector verify wiring from the input board to the detector. If the wiring is okay replace the detector.

4. The Ronan X99 fails to respond through HART®.

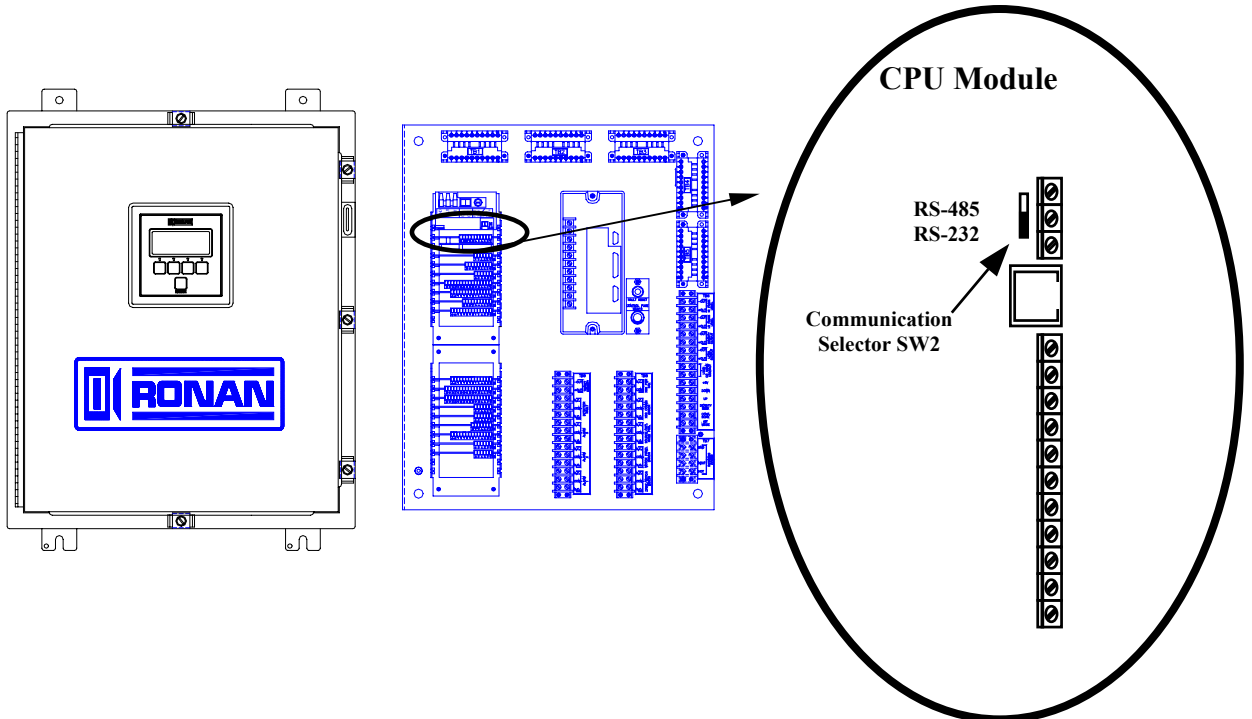
At the Control Panel

- Check the Local RS-232 (HART®) and RS-485 (Ronan Protocol) Communication Selector Switch. For the user to communicate HART® to Ronan Motorized Density Gauge the Communication Selector Switch (SW2) must have RS-232 selected on the CPU Board.

5 The Ronan X99 Local Display does not respond.

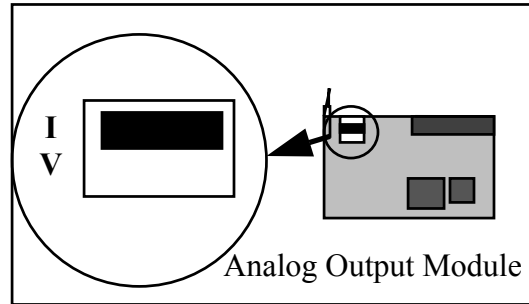
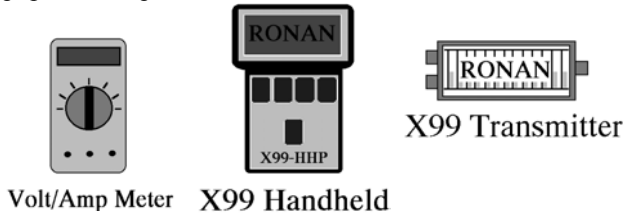
At the Control Panel

- Check the Local RS-232 (HART®) and RS-485 (Ronan Protocol) Communication Selector Switch. For the user to communicate using the Local Display to Ronan Motorized Density Gauge the Communication Selector Switch (SW2) must have RS-485 selected on the CPU board.



Analog Output Module Setup Procedure

Equipment Required:



Before you start, determine whether you are using the Analog Output module as a voltage(V) or current (I) output, and set the switch on the Analog Output module to reflect your choice. The above is shown in the current position.

Access the Analog Output module's Setup function through the gage's I/O Status Menu, and press the 'Next' key (displays the Zero Out Signal frame).

Setup the Zero Signal

This is the minimum output signal this module will produce.

- 1) Press the Modify Key to setup the Zero Signal (displays the Connect Zero Output frame).
- 2) Connect a DC voltage or current meter (depending on the switch selection from above) to pins 5 (positive) and 6 (negative) of the Analog Output module.
- 3) Modify the value on the display up or down (Incr or Decr) until the correct Zero Out value is displayed by your meter.
- 4) When the reading is correct, press the 'Done' key, then the 'Save' key to set the Zero value, or 'Quit' to abandon the setting. Either key returns you to the Zero Output Signal frame.

Setup the Zero Out Units

This value will be displayed as part of the 'module type' in the I/O Status frames.

- 1) Press the 'Next' or 'Prev' key until the Zero Out Represents frame is displayed.
- 2) If the Zero value you set up does not match this displayed value, press the 'Modify' key to change it. The value displayed here is for identification only. It is not used by the system.
- 3) Use the 'Shft', 'Incr', and 'Decr' keys to set the Zero value (00 Volts, 04 mA, etc.). Press 'Done' then either 'Save' to store the value, or 'Quit' to abandon the value.

Setup the Span Signal

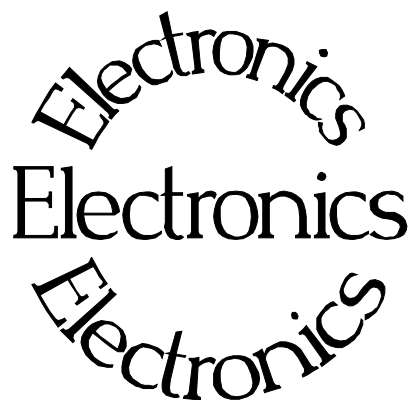
This is the maximum output signal this module will produce.

- 1) Press the 'Next' or 'Prev' key until the Span Output Signal frame is displayed.
- 2) Press the Modify Key to setup the Span Signal (displays the Connect Span Output frame).
- 3) Connect a DC voltage or current meter (depending on the switch selection from above) to pins 5 (positive) and 6 (negative) of the Analog Output module.
- 4) Modify the value on the display up or down (Incr or Decr) until the correct Span Out value is displayed by your meter.
- 5) When the displayed value settles, press the 'Done' key, then the 'Save' key to set the Span value, or 'Quit' to abandon the setting. Either key returns you to the Span Output Signal frame.

Setup the Span Out Units

This value will be displayed as part of the 'module type' in the I/O Status frames.

- 1) Press the 'Next' or 'Prev' key until the Span Out Represents frame is displayed.
- 2) If the Span value you set up does not match the displayed value, press the 'Modify' key to change it. The value displayed here is for identification only. It is not used by the system.
- 3) Use the 'Shft', 'Incr', and 'Decr' keys to set the Span value (10 Volts, 20 mA, etc.). Press 'Done' then either 'Save' to store the value, or 'Quit' to abandon the value.



Chapter 7 contains information about the Electronics used in your Motorized Density Monitor System.

Troubleshooting tips are also included.

Most measurement problems can be isolated to one of four areas:

- Accessory related
- Installation related
- Process related
- Monitor System
- Equipment

HART®

Communications

The Ronan X99 Motorized Density gauge level output provides a 4-20 mA current loop and HART® Field Communications Protocol. 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 variables, parameters, and device configuration 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.

Communications Variables

HART® defines four device variables, PV (Primary Variable), SV (Secondary Variable), TV (Tertiary), and QV (Quaternary). PV is assigned to the primary 4-20 ma loop . HART® is also communicated over this loop.

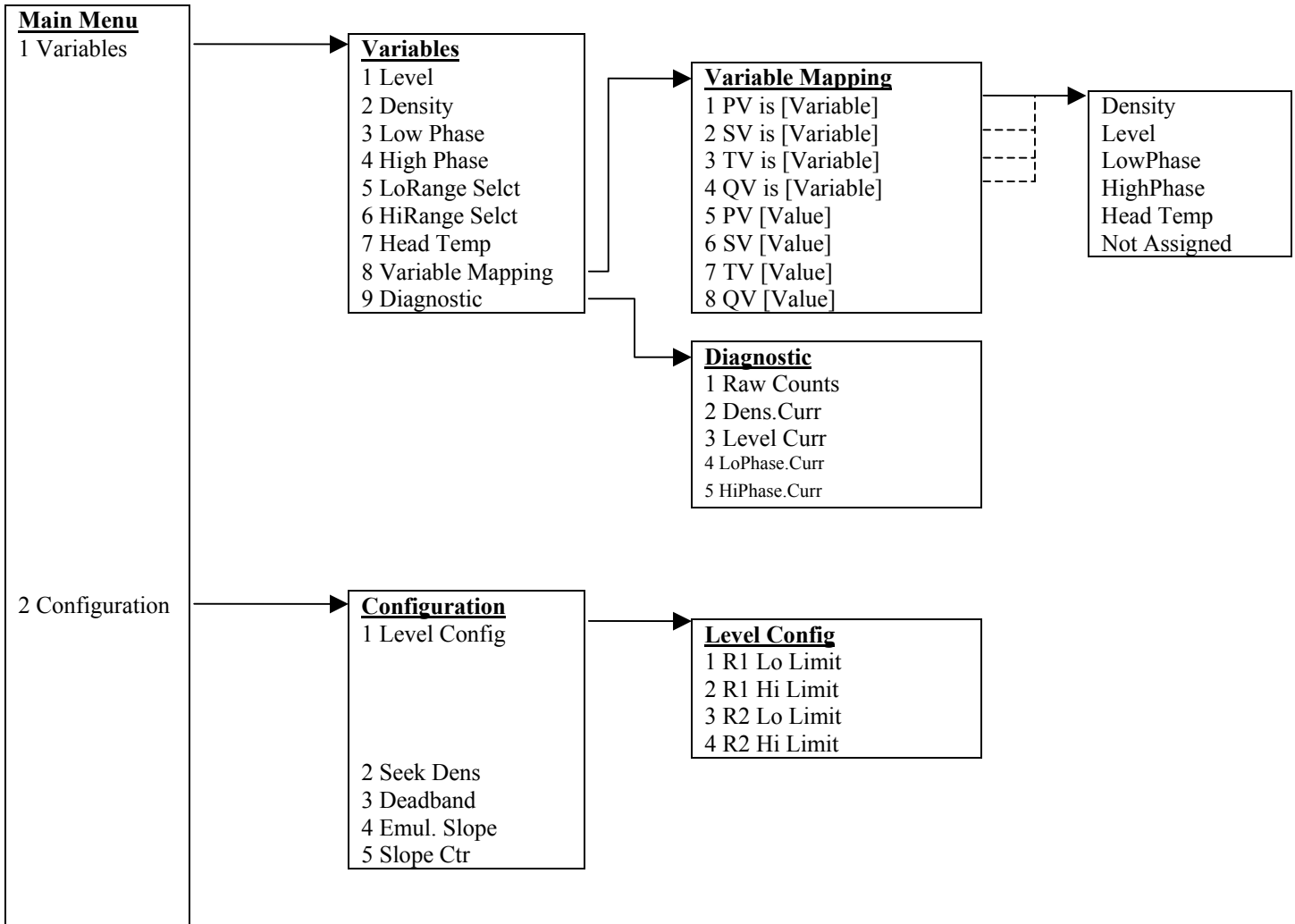
Device Variables

The Ronan X99 Motorized density gauge has five device variables:

Device Variable	Value
Level	Level
Density	Density
Low Phase	Low Phase RIT Level
High Phase	High Phase RIT Level
Head Temp	Head Temperature

HART® Menu Tree

The Ronan X99 Motorized Density Gauge with HART® uses a tree structured menu system.



Root Menu

The root menu is titled “*Ronan X99 – Motordriven Density*”. It contains the follow items:

ITEM	FUNCTION
Variables	Selecting this choice takes the user to the <i>Variables</i> menu
Configuration	Selecting this choice takes the user to the <i>Configuration</i> menu

Variables Menu

The menu titled “*Variables*” contains the following items.

ITEM	FUNCTION
Level	Shows the current value of Level (the Level value)
Density	Shows the current value of Density (the Density value)
Low Phase	Shows the current value of Low Phase RIT (the Low Phase RIT value)
High Phase	Shows the current value of High Phase RIT (the High Phase RIT value)
LoRange Selct	Shows the current value of Selected Range Low (the Selected Range Low value)
HiRange Selct	Shows the current value of Selected Range High (the Selected Range High value)
Head Temp	Shows the current value of Head Temp (the Head Temperature value)
Variable Mapping	Selecting this choice takes the user to the <i>Variable Mapping</i> menu
Diagnostic	Selecting this choice takes the user to the <i>Diagnostics</i> menu

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
PV	Shows the current value for PV
SV	Shows the current value for SV
TV	Shows the current value for TV
QV	Shows the current value for QV

Diagnostic Menu

The “*Diagnostic*” menu allows the user to view the the following values:

ITEM	FUNCTION
Raw Counts	Shows the current value of Detector Counts (the Detector Counts value)
Dens Curr	Shows the current value of Density Current (the Density Current value)
Level Curr	Shows the current value of Level Current (the Level Current value)
Lo Phase.Curr	Shows the current value of Low Phase RIT Current (The Low Phase RIT Current value)
Hi Phase.Curr	Shows the current value of High Phase RIT Current (The High Phase RIT Current value)

Configuration Menu

The *Configuration* menu is used to select and modify the following items:

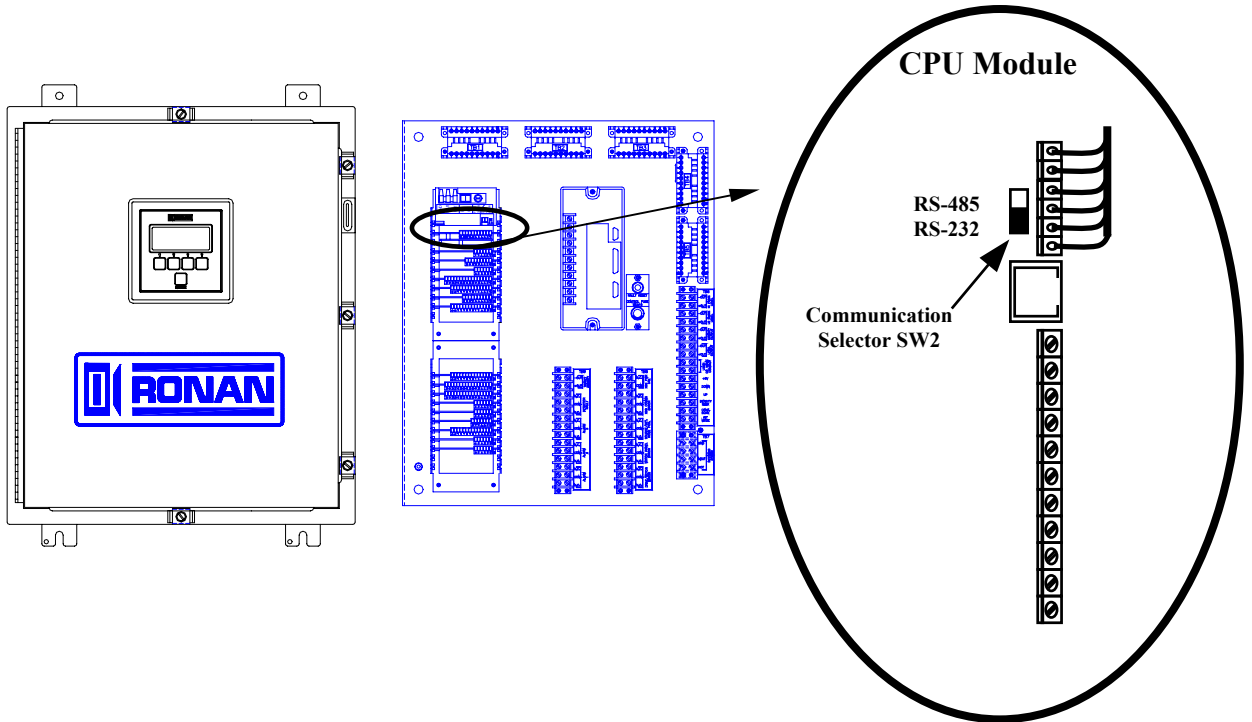
ITEM	FUNCTION
Level Config	Selecting this choice take the user to the <i>Level Config</i> menu
Seek Dens	Allows the user to view and/or change the Density to Seek value
Deadband	Allows the user to view and/or change the Density Dead Band % value
Emul. Slope	Allows the user to view and/or change the Min. Emulsion Slope value
SlopeCtr	Allows the user to view and/or change the Slope Valid Counter value

Level Menu

The *Level* menu is used to select and modify the following items:

ITEM	FUNCTION
R1 Lo Limit	Allows the user to view and/or change the Operating Low Limit R1 value
R1 Hi Limit	Allows the user to view and/or change the Operating High Limit R1 value
R2 Lo Limit	Allows the user to view and/or change the Operating Low Limit R2 value
R2 Hi Limit	Allows the user to view and/or change the Operating High Limit R2 value

For the HART® modulator to operate, the RS-232/RS-485 communication switch (located on the CPU module) must be selected for RS-232. If the user desires to view and/or change the X99 parameters at the local display, the RS-232/RS-485 communication switch must be selected for RS-485.



Accessories/Options

Accessories/Options

Accessories/Options

Chapter 8 includes details about optional features, accessory equipment, and other special items that may be included with your gage.

The information in this chapter applies only to the Motorized Density Monitor Systems that use these options.



Chapter 9 contains a summary of NRC regulations and personnel safety requirements that pertain to radiation gages.

An example is provided for determining radiation field intensity, with Dose Rate, RAD, and REM calculated.

Source holder shutter and leak testing is explained.

- 9.0 Regulation/Safety
(Specific License)
- 9.1 Leak Test
- 9.2 10 CFR Part 19
- 9.3 10 CFR Part 20
- 9.4 10 CFR Part 30
- 9.5 10 CFR Part 31
- 9.6 10 CFR Part 32

Motor Drive Specifications

	Motor Panel	Control Panel
Environmental		
Operating Temperature	-30°C to 80°C	0 to 50°C
Storage Temperature	-40°C to 80°C	-40°C to 80°C
Humidity	0 - 100%	5 - 95% (non-condensing)
Area Classification	Class II, Div 2 with Purge	None
Purge	Recommended for corrosion protection	
Electrical		
Supply Voltage	52 VDC, 3A from Control Panel 12 VDC, .15A from Control Panel	90 - 250 VAC, 50-60 Hz +/- 10%
Power required		150 Watts
Drive	Brushless D.C. motor	
Position Sensor	Motor Resolver	
Output		Level: 0-20mA/0-10V Density: 0-20mA/0-10V
Connections		3-lug terminal block for AC power 2-slot terminal blocks for Level/Density outputs
Cabling (between Motor Panel and Control Panel, tested to 1000 feet)		
1 - 500 feet distance:	16 Ga, 4 Cond w/shield (motor pwr) 18 Ga, 6 Cond w/shield (detector) 22 Ga, 12 Cond w/shielded pairs (resolver feedback) 22 Ga, 19 Cond w/shield (panel status)	
501 to 1000 feet distance:	16 Ga, 4 Cond w/shield (motor pwr) 18 Ga, 6 Cond w/shield (detector) 18 Ga, 12 Cond w/shielded pairs (resolver feedback) 18 Ga, 19 Cond w/shield (panel status)	
Mechanical		
Housing	Motor Cabinet: NEMA-4 / IP65 (24x24x10")	Control Cabinet: NEMA-4 / IP65 (18x24x10")
Weight	100 - 150 lbs.	less than 50 lbs.
Loading	Source - 42 lbs. max Detector - 42 lbs. max	

Motor Drive Specifications

	Motor Panel	Control Panel
Performance		
Measuring Range	50 feet max	
Measuring Speed	.02 to 3 ft/min.	
Traversing Speed	.02 to 32 ft/min.	
Resolution	Selectable: 1/4", 1/2", 1"	
Repeatability	.060" @ 3 ft/min. .012 @ 1 ft/min.	
Sourceholder		
Model	SA-15 (SA-4 optional)	
Construction	Steel Weldment, Lead-Filled	
Weight	Approx 75 lbs.	
Safety	Lockable in the OFF position	
Stray Field	< 5mR/hr @ 12"	
Radiation Detector		
Model	DET-14662 Style	
Active Length	1.5"	
Type	Scintillator	
Material	304 SS	
Weight	8 lbs.	
Supply Voltage	+24 VDC from Computer	
Power Required	1 Watt	
Connection	CGB/Terminal Block	
Area Rating	General Purpose	
X99 Computer		
Model	X99 Motorized Density	
Supply Voltage	85 to 250 VAC +/- 10%	
Power Required	15 Watts	
Ambient Temperature	-40°C to 75°C	
Humidity	0 to 95% non-condensing	
Controls	Handheld Programmer	
Outputs	Level: 0-20mA/0-10V Density: 0-20mA/1-10V	

Motor Drive Specifications

	Motor Panel	Control Panel
Local Control Panel		
Functions	Local/Remote Switch Speed Pot Up Down Switch LED indicators	
Alarm Outputs		
User-Defined Alarms (3)		3 Form 'C' Relays
Detector Fault		1 Form 'C' Relay
Motor/Drive Error		1 Form 'C' Relay
Motor Panel Error		1 Form 'C' Relay
Computer I/O Comm. Error		1 Form 'C' Relay
Computer Power Fail		1 Form 'C' Relay
Source/Detector @ Home Position		1 Form 'C' Relay
User Inputs		
		Dry contact for emergency extraction
Remote Panel (Optional)		
Functions		Modes: Continuous Scan Density Seek Manual Up Manual Down Rag Interface Track
Distance		100 feet from Control Panel Max.
Interface		4 user-supplied dry contacts for modes, 4-20 mA/0-10V input for Density Set-Point
Head Temperature (Optional)		
		Selectable units (°C/°F) (For local display only or user-defined alarm)

Appendix B

Following is the list of I/O Modules supported by the Motorized Density Gage.

Module Address	Module Description	Functional Description
1	ION Chamber Input Scintillator Input	Detector Input
2	Analog Output	Gage Output #1 (Level)
3	Analog Output	Gage Output #2 (Density)
4 - 6	Encoder Input	Encoder Input (Low 16 Bits)
		Encoder Input (High 16 Bits)
		Encoder Output - Control
7	Analog Output	Motor Speed Control
8	Digital Output	Direction Control (2 outputs used)
9	Digital Input	Limit Switch Status
10	Digital Output	General Digital Alarms
11	Digital Input	Remote User Panel (Low Bits)
12	Head Temp Input	Detector Head Temperature
13	Digital Input	Motor Panel Status
14	Digital Output	Drive/Control Panel Alarms
15	Analog Input	Remote Density Seek Input Value
16	Digital Input	Remote User Panel (High Bits)
17	Analog Output	Low Phase RIT Mode
18	Analog Output	High Phase RIT Mode

Appendix C: System Access Codes

The system access codes were intentionally inserted into an appendix in order to protect those wishing to use the custom passwords. It is advised to set up the custom passwords, issue them to individual users, and then remove this page from the manual. The standard access codes are not listed anywhere else in the manual. This way, the owner will have 'master' access using the standard access codes listed below, but the individual users will only know their 'custom' password. Assuming access to the 'Password Access' Menu Variables has not been granted, the system's changeable Menu Variables are protected from unauthorized access.

When the system is displaying the Status screen, press one of the top 4 keys on the Panel Mount Programmer, and enter one of the following codes for access:

Menu Variable Access Code: 1, 2, 1, 3, 2, 3

I/O Status Access Code: 1, 3, 1, 2, 3, 2

Status Line Editor: 1, 2, 2, 2, 2, 3

Custom Password 1: _ _ _ _ _

Custom Password 2: _ _ _ _ _

Custom Password 3: _ _ _ _ _

NOTE: If usage of any user-defined (or custom) passwords in the system has been granted, record the passwords beside the Custom Passwords above for safekeeping.

Appendix D: Order of Characters shown in the Status Line Editor

When Modifying an alpha-numeric variable, 97 characters may be inputted. The following gives an order to the characters, so that the user can more easily input the desired characters.

```
[space] ! " # $ % & ' ( ) * + , . / 0 1 2 3 4 5 6 7 8 9 : ; < = > ? @
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [ \ ] ^ _
` a b c d e f g h i j k l m n o p q r s t u v w x y z { | } ~ □
```

Appendix E: Binary Address Calling of Modules and Gages.

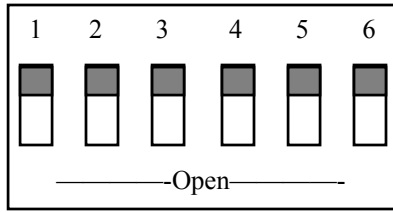


Figure 11a: Switch on CPU Board

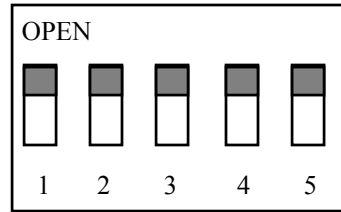


Figure 11b: Switch on Modules

When multiple gages are hooked up (daisy-chained), then the PMP needs to be able to identify each X99 Gage. This is done through binary addresses. Notice on the CPU module that there is a six switch orange box on the side, like in Figure 11a. The first five switches represent a binary address from 0-31. Each gage that is daisy-chained together must have a unique address. The sixth switch on the CPU is not used.

Each Module in an X99 has a unique address. This address is how the CPU talks to the Module, and how the PMP or PC talks to the Module in I/O Status. The gage software decides how many and which types of I/O moduels are acceptable for that gage. The list of addresses are shown in Appendix B for each Module.

Below is a chart explaining the call numbers that are represented by the binary switches. Note: 0=Closed and 1=Open on the chart.

Address	Switches (1-5)	Address	Switches (1-5)
0	00000	16	00001
1	10000	17	10001
2	01000	18	01001
3	11000	19	11001
4	00100	20	00101
5	10100	21	10101
6	01100	22	01101
7	11100	23	11101
8	00010	24	00011
9	10010	25	10011
10	01010	26	01011
11	11010	27	11011
12	00110	28	00111
13	10110	29	10111
14	01110	30	01111
15	11110	31	11111

Drawings/Checkout
Drawings/Checkout
Drawings/Checkout

Chapter 10 contains the information that applies to your specific equipment.

Included here are the Factory Configuration Sheets, Checkout Sheets, and detailed drawings:

Configuration
Interconnect
Outline/Installation

