

Continuous Level Monitor Systems

Ronan Engineering Co.
8050 Production Drive
Florence, KY 41042 USA

PHONE: (859) 342-8500
FAX: (859) 342-6426

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1	DESCRIPTION
2	THEORY
3	INSTALL/START
4	OPERATION
5	CALIBRATION
6	DETECTOR
7	ELECTRONICS
8	OPTIONS
9	REGULATIONS
10	DRAWINGS



Chapter 1 provides a general overview of Ronan's Retrofit Units.

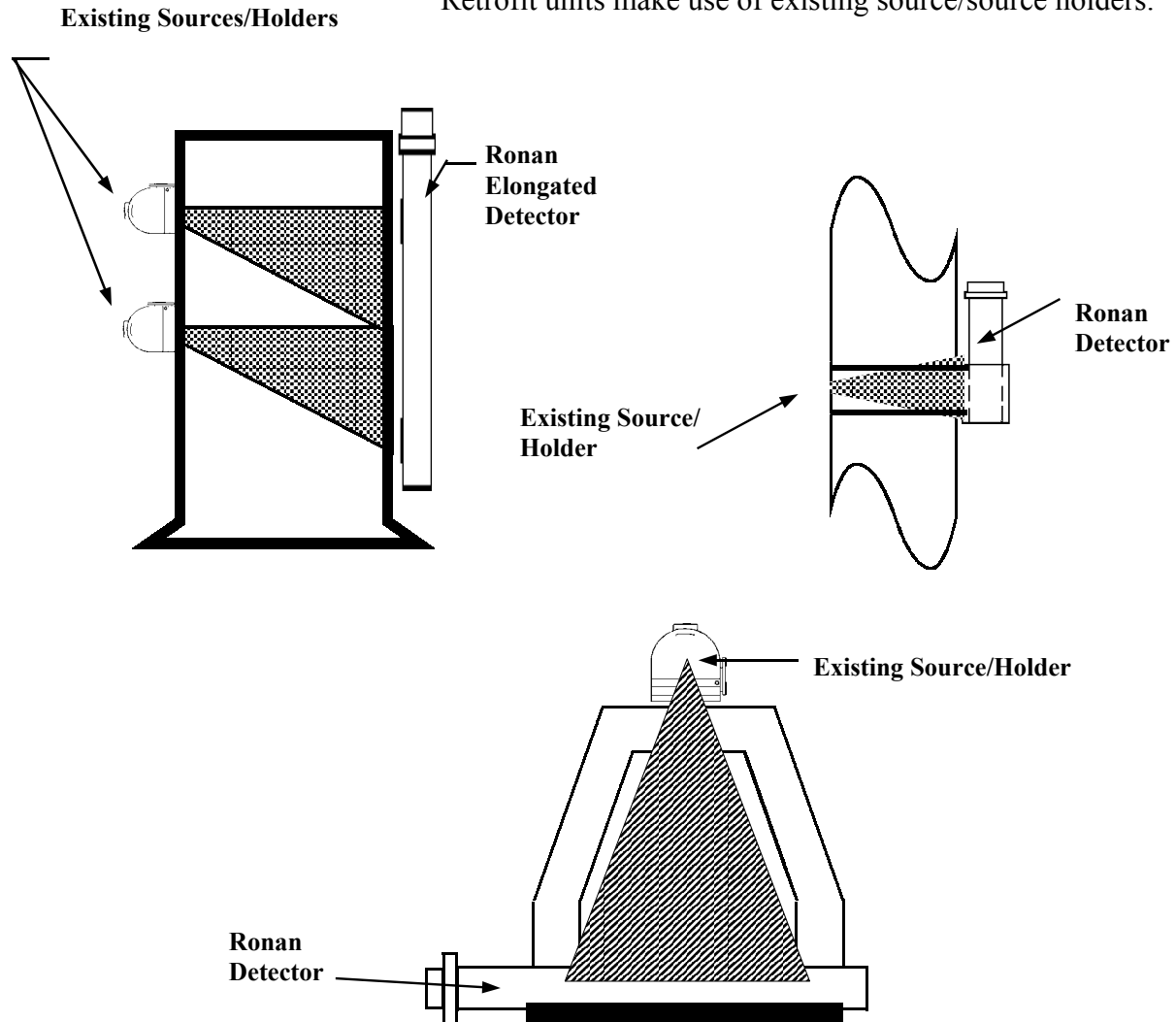
In most cases, Retrofit Units supply Ronan Detectors and Electronics to existing source/holders.

- 1.0 System Description
- 1.1 System Configuration/Components
 - Detector
 - Microprocessor
 - Cable

System Configuration

The user's application determines the system configuration requirements. Ronan's detector and electronics can be retro-fitted to update Level, Density, and Weight monitoring systems.

Retrofit units make use of existing source/source holders.



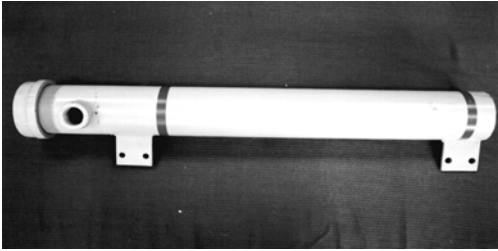
System Components

Many system configurations are available for a number of different retrofit applications. However, in most cases there are at least three major components included with each Retrofit Unit:

- Detector
- X96N Microprocessor
- Interconnect Cable

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.

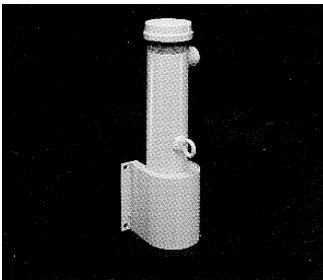


The active length of the detector corresponds to the full measurement range of interest, and is designated by bands of tape at the top and bottom of the detector housing.



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.

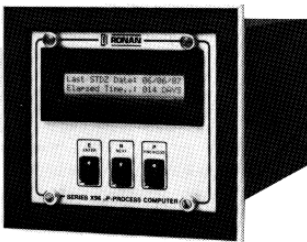


Chapter 6 contains more information about the detector that is supplied with your retrofit unit.

X96N Microprocessor

Ronan's X96N Microprocessor electronically manipulates the detector output signal and displays the results in a useful format.

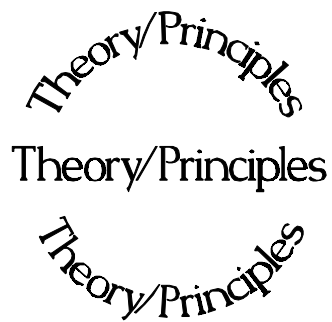
With just three push buttons, a liquid crystal display screen, and pre-programmed menus, the process level, density, or weight is continuously monitored with minimal operator effort.



Chapter 7 contains details about the hardware used in the X96N, and Chapter 4 explains the software used for this application.

Interconnect Cable

The interconnect cable provides a signal from the detector to the X96N Microprocessor. The cable is supplied with a pre-wired MS connector.



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 calibration procedure.

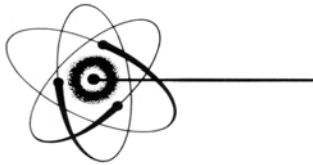
- 2.0 Theory / Principles
- 2.1 Theory of Radiation Gaging
- 2.2 Principles of Operation
 - Signal Processing
 - Calibration
 - Curve Correction

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.

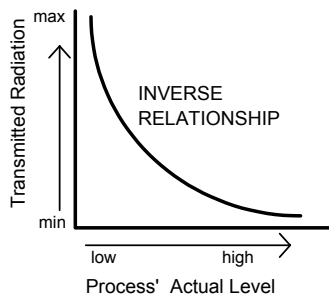
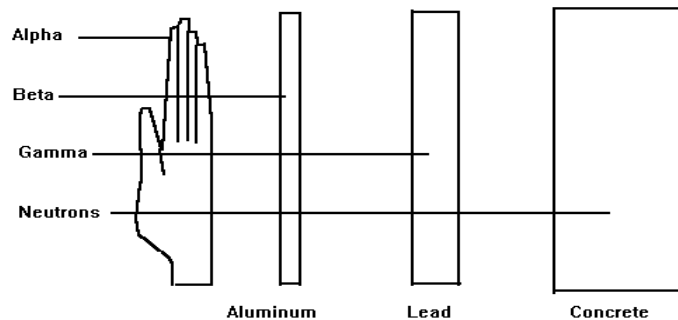
Some amount of radiation is *absorbed* by the material through which it passes, and some of the radiation is *transmitted* to the surface of the detector.



Gamma's advantages:

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

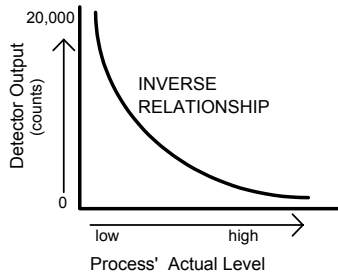
Absorption / Transmission



Process measurement is possible because the amount of radiation *absorbed and transmitted* is predictable.

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

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

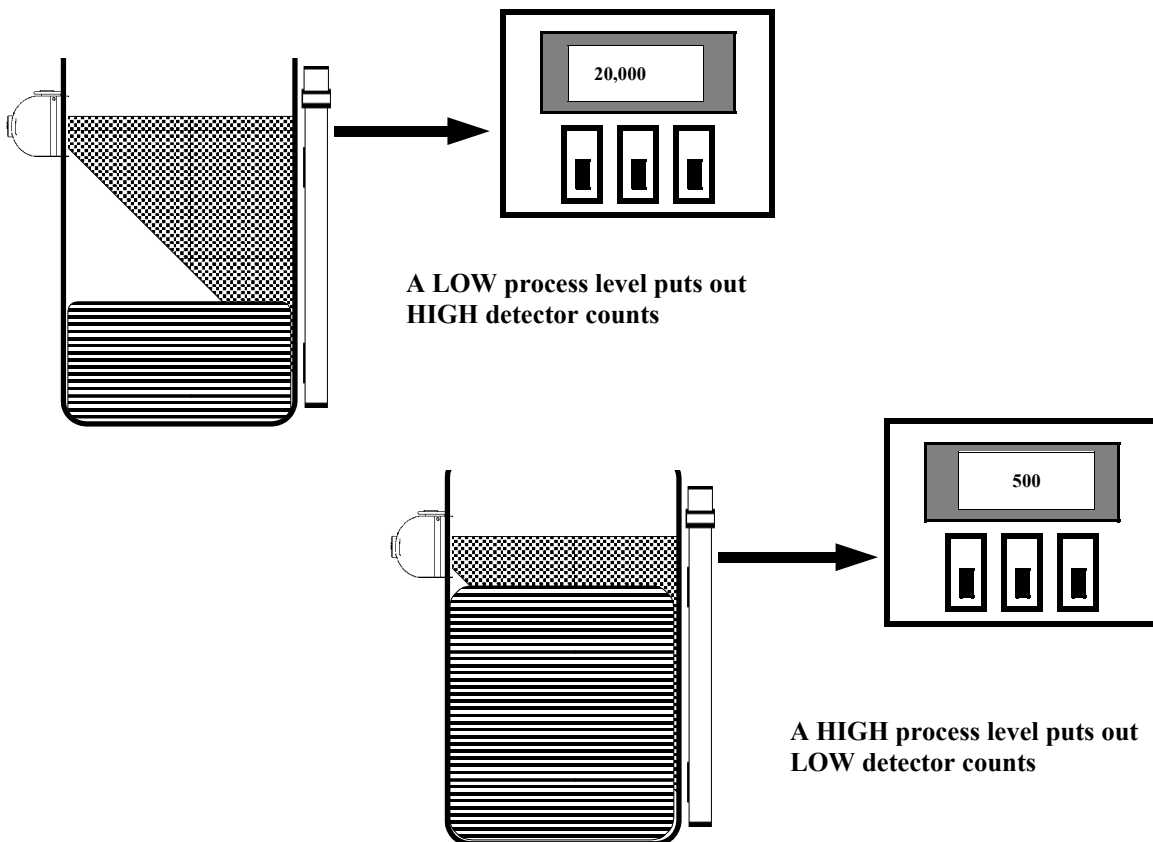


Since the radiation that's not being *absorbed* is being *transmitted*, the level of process can be inferred by measuring the amount of radiation reaching the detector at any point in time.

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

When the process level is absent (or low) the detector is exposed to a maximum amount of radiation which produces a HIGH output of counts.

When the process level is full (or high) the process material "shields" the detector which prevents radiation from reaching the detector, producing a LOW output of counts.



Principles of Operation

The detector's raw output signal is processed through several stages of software in the X96N.

Some of the more significant stages of signal processing are:

- Units Conversion
- Measurement Range
- Digital Filtering
- Dynamic Tracking
- Source Decay Compensation
- Calibration
- Curve Correction

Units Conversion

The X96N Microprocessor converts the detector signal to user's measurement units of inches, feet, millimeters, centimeters, or meters.

Measurement Range

The X96N displays the output measurement range in the selected user units. For Continuous Level Monitor Systems the "range" is equivalent to the active length of the elongated detector, which corresponds to the full measurement range of interest.

Digital Filtering

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" results in decreased signal noise.

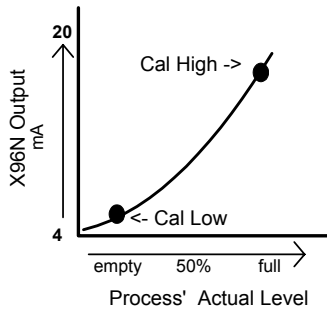
Dynamic Tracking

Dynamic tracking permits the gage 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.

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.

Calibration

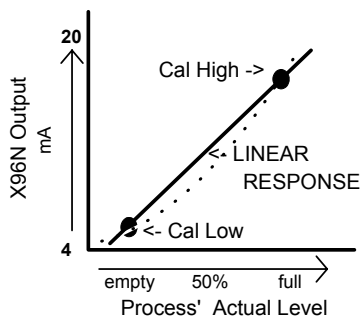


Calibration relates detector output (in counts) to numeric values that accurately represent the actual process level. The calibration procedure establishes reference points of known conditions against which the system can make ongoing comparisons. It requires at least two known points of reference - a low value and a high value. For best calibration results, the two reference points should cover as much of the full measurement range as possible.

As this example response curve shows, the calibration procedure also reverses the relationship between detector counts and actual process level. Now, a direct relationship exists, so that as the process level moves from empty to full, the X96N's display screen indicates an increase in user units from minimum to maximum - (example: 0 feet to 80 feet.).

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

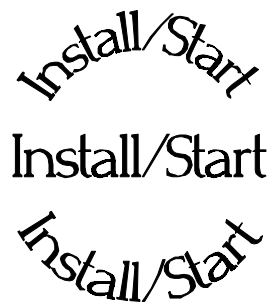
Curve Correction



Level measurement non-linearity can be caused by an irregular distribution of the radiation field over the full length of the detector. Vessel size and geometry, vessel wall construction, cross paths from multiple source fields, and other system configurations are among the potential causes of an irregular field distribution.

Because a linear output is desired, the adjustment is accomplished through another stage of software signal processing, curve correction.

The nature and form of the curve correction required for each application depends on a number of variables such as system configurations, detector geometry, process conditions, etc. Shown here is a typical response curve with curve correction applied.



- 3.0 Installation
- 3.1. Unpacking/Inspection/Storage
- 3.2 Precautions
- 3.3 Mounting
 - Mechanical
 - Electrical
- 3.4 Microprocessor Verification
 - Identification/Documentation
 - Power-up
 - Pushbuttons

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 push-button guide and menu overview will familiarize you with how the X96N functions.

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

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. (606) 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

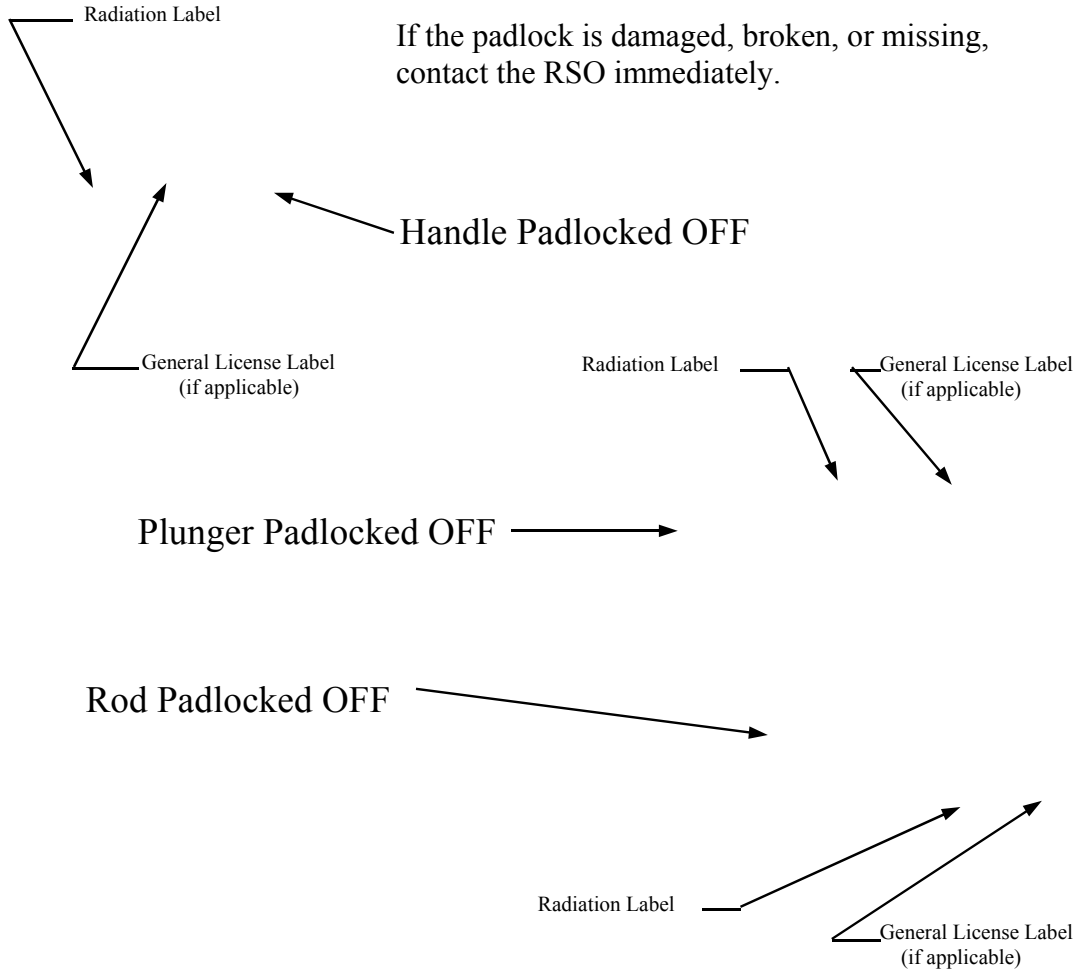
If it is necessary to store this equipment before mounting, the RSO will assign a safe and secure location with no personnel access.

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

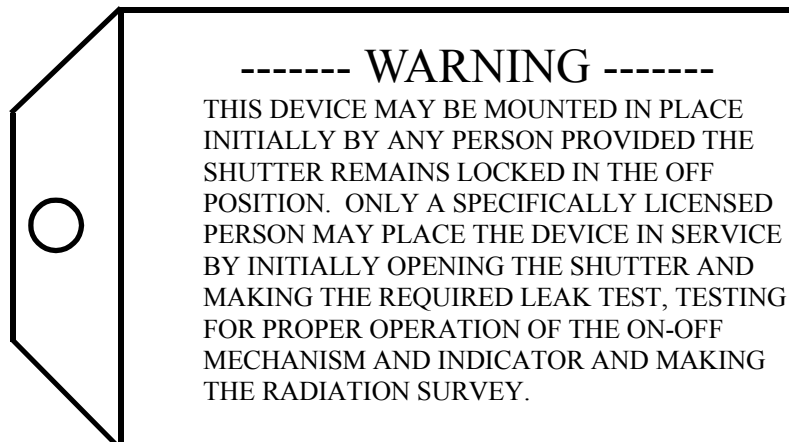
Inspection

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.

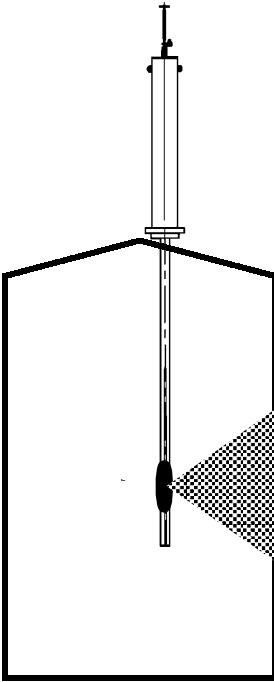


Lock Tag



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:



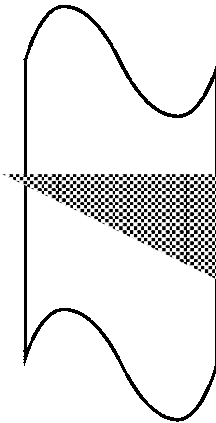
The source holder must remain padlocked in the OFF position until installation is complete.

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

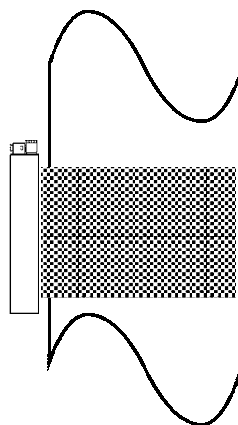
A specifically licensed individual MUST inspect the installation prior to placing the source holder in the ON position.

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**



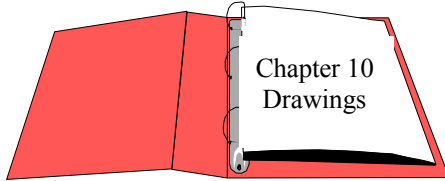
**A
C
T
I
V
E**

**B
E
A
M**

Mechanical Mounting

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

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



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

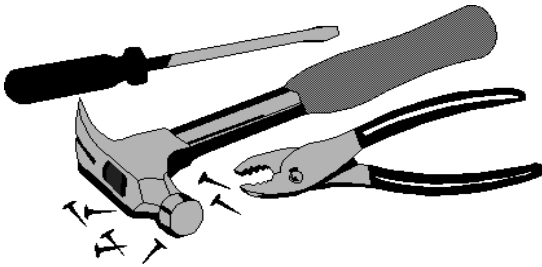
Avoid internal vessel obstructions such as baffles, agitators, manways, heater/cooler tubes, etc. which could interfere with the transmission through the vessel of the radiation's "active beam."

Drawings:
Configuration
Installation

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:

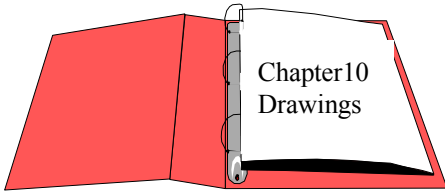
- the temperature of the process pipe at that spot exceeds 131°F (55°C), or
- the voltage transmission through the pipe could interfere with the signal transmission from the source to the detector.



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:

Drawings:
Interconnect

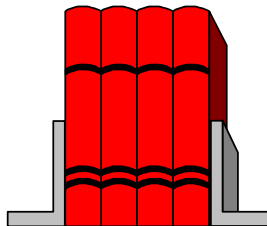
Use continuous conduit runs and protect housing junction boxes from dripping of condensed moisture off of conduit.

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 (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.

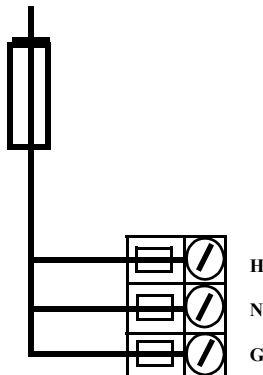


LOCAL CODE
NATIONAL CODE

WITH POWER OFF - - -

Connect cable pre-wired MS connector to detector.

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

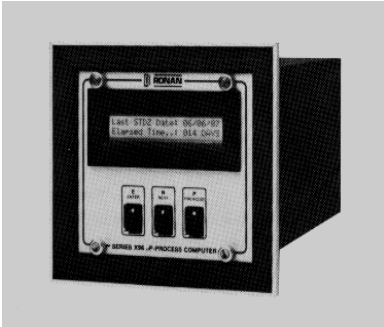


POWER INPUT

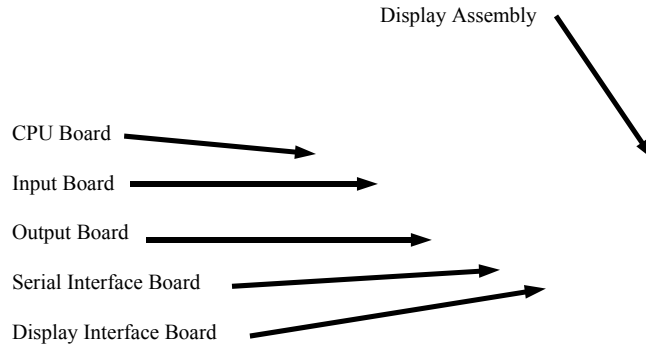
Check connections at microprocessor chassis terminals. Verify that all wires are fully inserted in terminal sockets and the screws firmly tightened.

Microprocessor Verification

Loosen the four thumb screws to open the front cover and check the board and cable connections. Identify the CPU and other major boards from the drawing below. **Optional configurations are possible.**



Press the push/pull latch to eject the CPU Board.

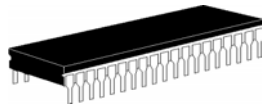
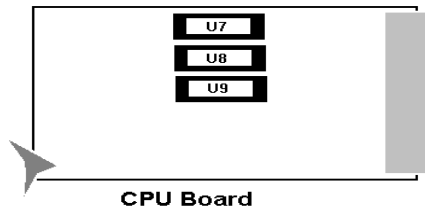


NOTE:
These boards are interchangeable in the frame's slots, but the ribbon cables **MUST** be connected to the correct boards.

- Some Hardware Options:**
- No Serial Board
 - 2 Serial Boards
 - No Input Board
 - 2 Input Boards
 - No Output Board

Identification/Documentation

The Ronan X96N 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 EPROMS located on the CPU Board and the unique hardware configuration used to support these EPROMS.* See Chapter 7 for details about your specific hardware configuration.



Your own set of EPROMS (U7, U8, U9) will be labeled with a specific Software Version Number. This software identification number should be documented for future reference.

CPU BOARD EPROMS:

- U7 _____
- U8 _____
- U9 _____

Replace the CPU Board back into the X96N's frame. Verify all boards are fully seated and cable connections fully inserted.

Power-up

Before applying power, ensure all boards are fully seated in frame's slots and ribbon cables fully inserted. Close front door of the X96N and tighten the thumbscrews.

When power is applied the X96N runs a self-diagnostic program.

RONAN (MONITOR SYSTEM)
VERSION XXXXXX

First the software version number is displayed.

RONAN (MONITOR SYSTEM)
SELF TEST OK

The LED's flash and the X96N scrolls through an operation guide.

OPERATION GUIDE
N - DISPLAY NEXT FIELD

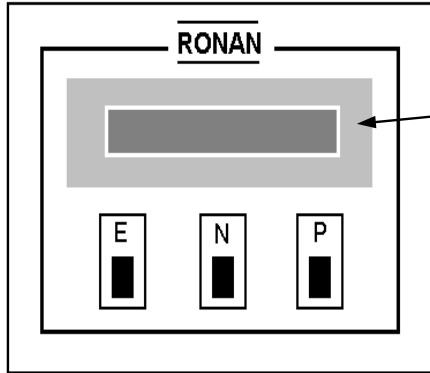
(P - PREVIOUS FIELD)
(E - ACCESS FIELD)

Press <N>

OPERATION GUIDE
TO START PRESS N

NOTE: If the operator does not Press <N> as instructed within one minute, X96N automatically goes to the first status display.

(Status Display #1)



LIQUID CRYSTAL DISPLAY SCREEN
STATUS DISPLAYS
PROGRAMMABLE FUNCTIONS (MENUS)

Pushbutton Guide

This list summarizes the functional uses for each of the three pushbutton.

- to:**
- Press <E>**
- Access the programmable functions from the status displays (ACCESS CODE REQUIRED).
 - Access the programmable function named on a menu.
 - Exit from the last programmable function back to the status displays.
 - Enter a choice (or number) from a menu (FLASHING LED).
- Press <N> to:**
- Advance to the NEXT status display.
 - Advance to the NEXT programmable function .
 - Answer "NO" to a question.
 - Increase a given number (FLASHING LED).
- Press <P> to:**
- Return to the PREVIOUS status display.
 - Return to the PREVIOUS programmable function.
 - Answer "YES" to a question.
 - Decrease a given number (FLASHING LED).

Displays/Menus

The programmed software, supplied to each system will determine the series of menus that are presented on the X96N display screen. Chapter 4 gives details about the software.



Chapter 4 gives details about the software used to program the microprocessor.

It includes an overview of the menus as well as detailed information about each of the status displays and the programmable functions.

- 4.0 Software Operation (LEV-STD)
- 4.1 Getting Started
- 4.2 Status Displays
- 4.3 Programmable Functions
 - Level A - Customer
 - Level B - Factory

Getting Started

This chapter explains how to use the X96N Microprocessor's software.

Menu Overview

The programmed software supplied to each system will determine the series of menus that are presented on the X96N display screen. The menu overview on the next page shows all possible displays. Your own system may not require all of these displays and menus. Your series of screens may vary depending upon the hardware and software configurations required by your application. Details follow for the software displays which are included in your own system.

Status Displays

Status Displays are the system "reporters." Incoming measurements from the detector, settings used by the system, and output variables are among the information you can observe on the status displays.

Programmable Functions

Programmable functions are more than "reporters." The programmable functions series of menus are used to enter and change information that's required to configure your system.

TURN ON

RONAN LEVEL GAGE
VERSION XXXXXX

RONAN LEVEL GAGE
SELF TEST OK

OPERATION GUIDE
N - DISPLAY NEXT FIELD

OPERATION GUIDE
TO START PRESS N

STATUS DISPLAYS

LEVEL...MM = XXXX
_____% OF SPAN <N>

TIME CONSTANT
RANGE <N>

TIME
DATE <N>

REF LO REF HI
DET COUNT <N>

OUTPUT
MAX. OUTPUT <N>

DIAGNOSTIC TEST <N>

LAST CAL DATE
ELAPSED TIME <N>

PROGRAMMABLE
FUNCTIONS (A)

Press <E>
Press<N N P N N P>

TIME <N>

DATE <N>

TIME CONST <N>

DISPLAY UNITS <N>

RANGE <N>

CALIB CONST <N>

CALIBRATE <N>

CURVE CORRECT <N>

RECAL PROMPT <N>

DYN TRACK <N>

PRINT TIME <N>

AUTO CALIB <N>

PROGRAMMABLE
FUNCTIONS (B)

Press <E>
Press<N N P N P P>

DETECTOR TYPE <N>

RAD DISCRIM <N>

Press E to Exit
<E> <N>

LEVEL.. MM = XXXX
_____% OF SPAN

SOURCE TYPE <N>

CALIB MODE <N>

PRINTER <N>

Press E to Exit
<E> <N>

LEVEL.. MM = XXXX
_____% OF SPAN

Programmable Functions

The programmable functions are more than information "reporters." The programmable function menus allow you to change the settings, limits, and parameters that govern your measurement system. There are two levels of programmable functions: customer and factory.

Customer-Programmable

Ronan factory personnel tested the equipment using settings, limits, and parameters that closely resembled your circumstances. However, your specific equipment and process conditions will produce their own unique results.

The programmable functions permit you to re-configure the measurement output to accommodate your own specific process conditions and customized measurement needs.

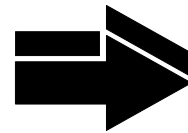
A code is required to access the programmable function menus.

To *access* the customer-programmable functions, do this:

Press **<E>** LEDs flash



Press **<N N P N N P>**

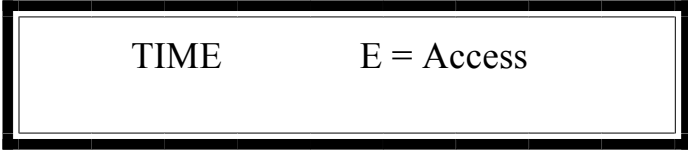
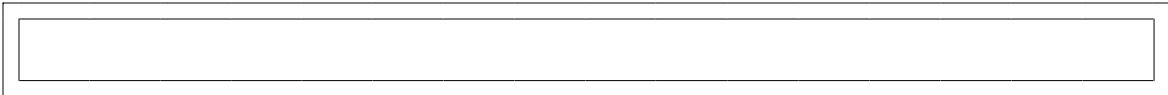


NOTE:

To *exit* the customer-programmable functions, do this:

Press **<N>** or **<P>** until the display reads "Press E to Exit"

Press **<E>** to return to Status Display #1



TIME:
The X96N keeps the current time in 24-hour format. Use this module to change the time.

A small lithium battery maintains the time in the event of a power loss.

Hours:Minutes:Seconds

Press <N>



DATE:
The X96N increments the date each day at midnight. Use this module to change the date.

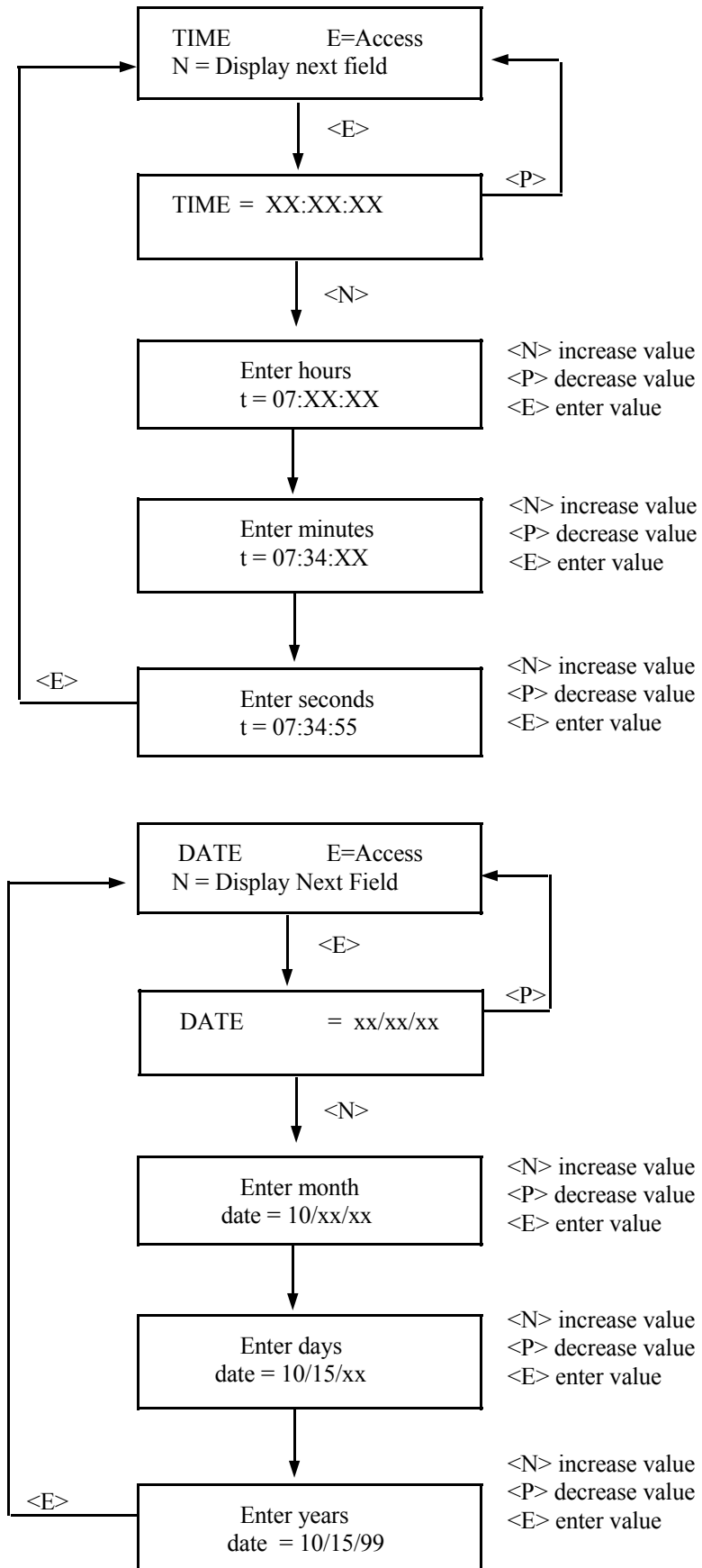
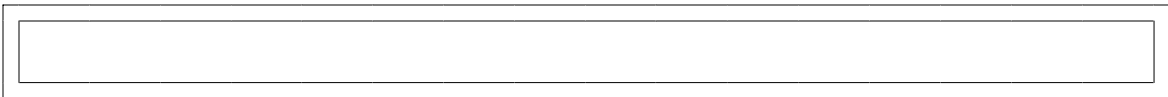
The date is stored as the "Last Cal Date" in the Status Display each time the system is calibrated.

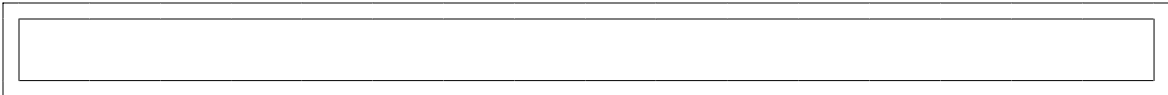
Battery back-up maintains the date during power loss.

Month/Day/Year

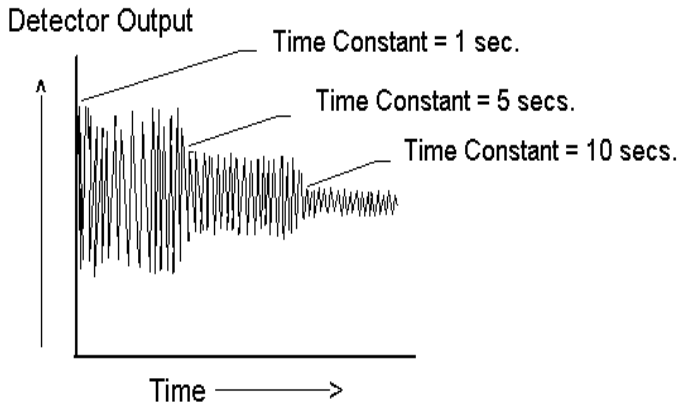
Press <N>

MM/DD/YY





TIME CONST E = Access



TIME CONSTANT:
Counts received from the detector are fed into a digital filter module. This digital filter uses statistical averaging to smooth, or dampen, any random, radiation, and process related noise.

The statistical averaging is adjusted through a time constant setting in this module. Increasing the time constant will increase the filter time and decrease the noise.

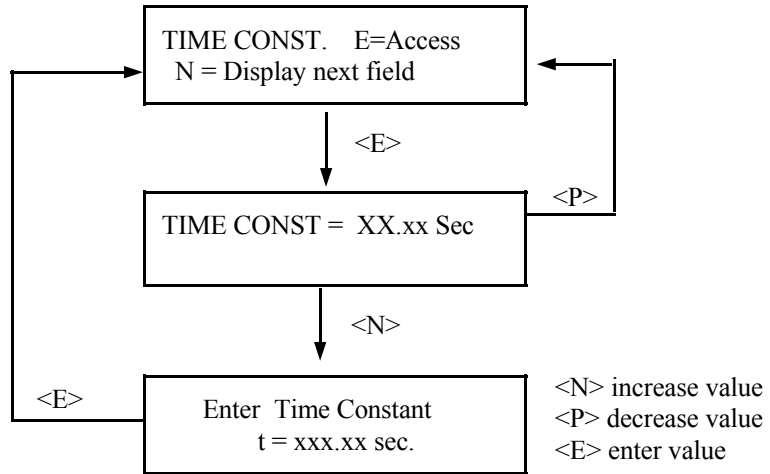
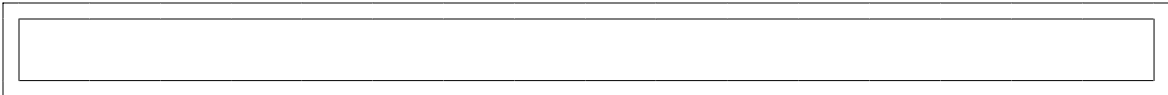
The digital filter is bypassed during calibration (See CALIB. module) .

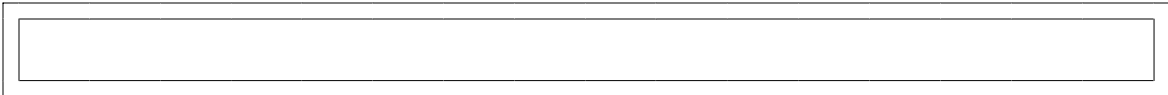
The digital filter is also bypassed if dynamic tracking is enabled and process interruptions occur that exceed the established threshold. (See DYN. TRACK. module).

NOTE:

Values from 0.40 to 250.00 seconds can be used as the time constant entry.

Press <N>





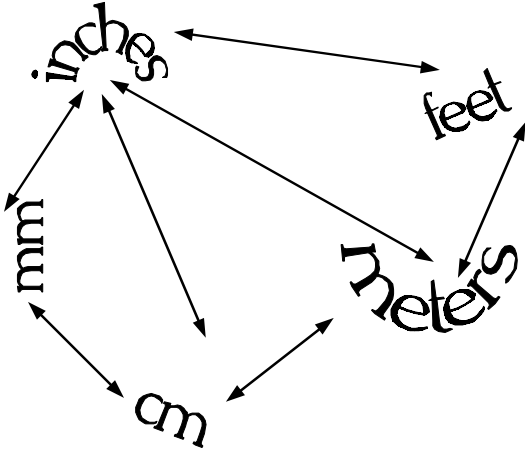
DISPLAY UNITS E = Access

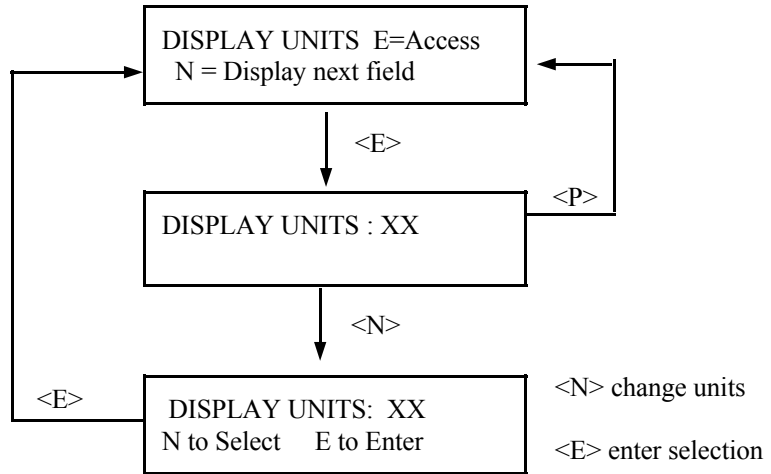
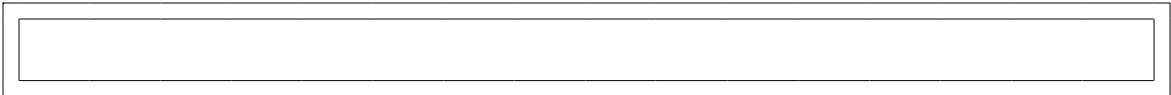
DISPLAY UNITS:
This menu determines the user's units being displayed for the process measurement.

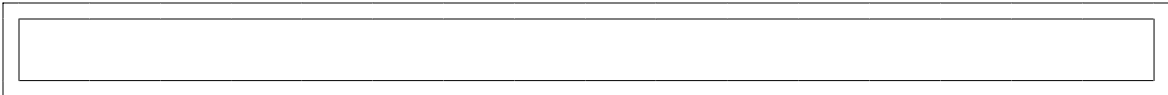
Level applications choose from inches, feet, millimeters, centimeters, and, meters.

If new units are selected, the system makes the necessary conversions.

Press <N>







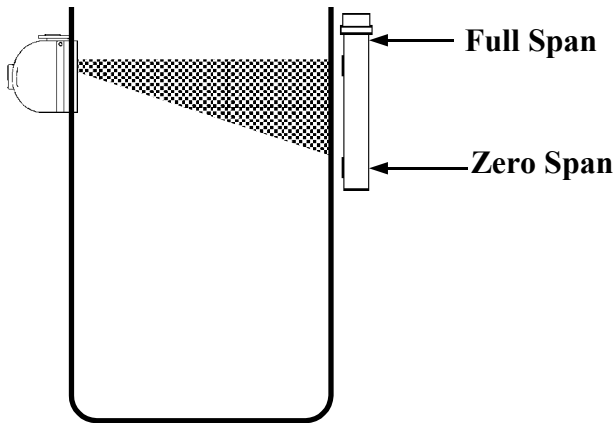
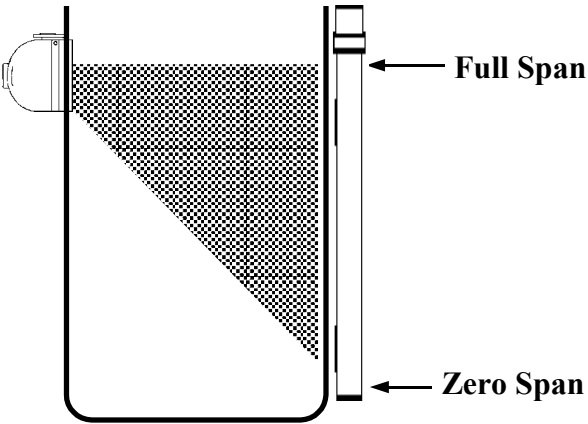
RANGE E = Access

RANGE:
The measurement range is entered in user units. It covers the process level that is of interest.

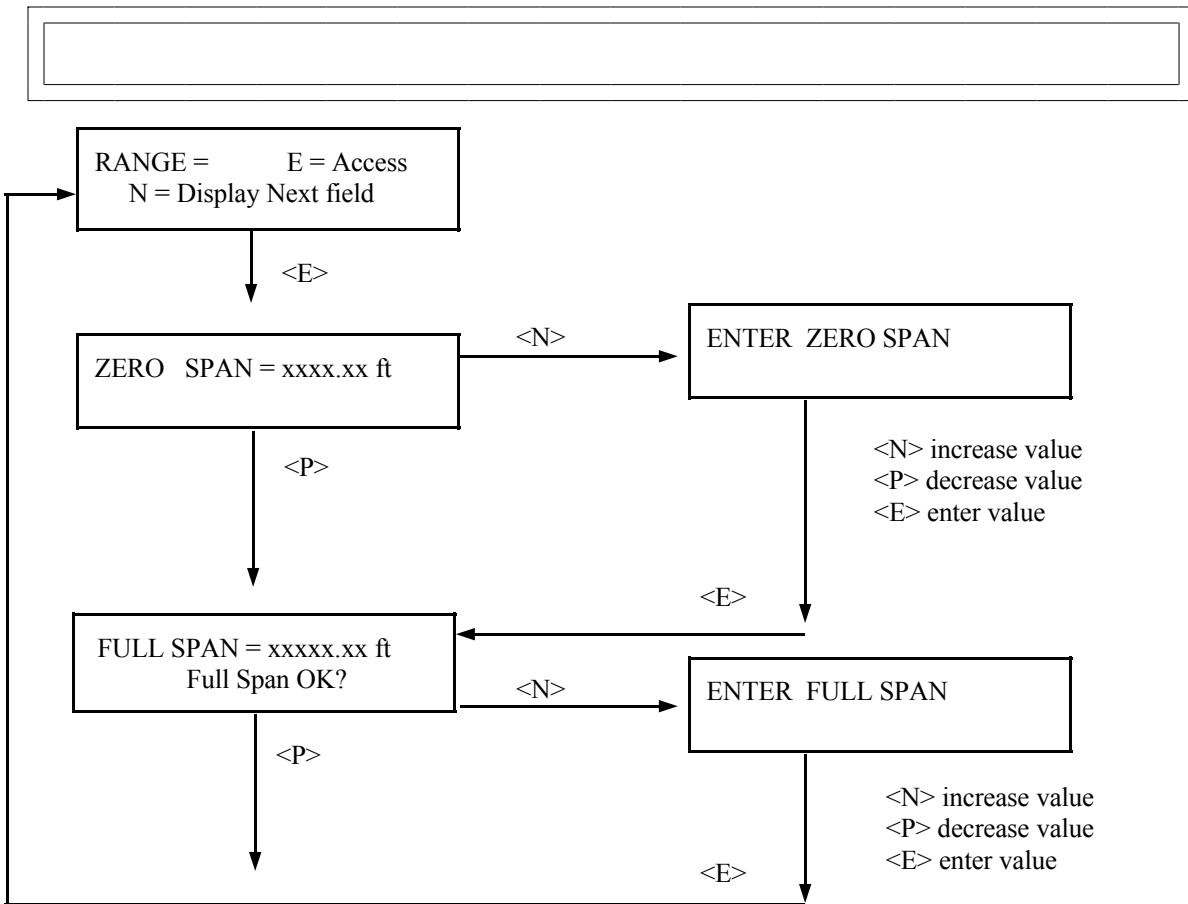
This menu asks for the "zero span" which is the low end of the range, and the "full span" which is the high end of the range.

For best calibration results, the low calibration point should be as near as possible to the start of the range (zero span), and the high calibration point should be as near as possible to the high end of the range (full span).

For Continuous Level Measurement Systems, the range cannot be longer than the active length of the elongated detector.



Press <N>



CALIB. CONST.

E = Access

Calibration Time - the length of time (in seconds) spent by the system doing the calibration. This is the actual amount of time the gage will spend averaging counts from the detector.



The signal noise band determines the value that should be entered here. Typically it is set at seven (7) times the digital filter time constant that was entered in the Time Constant Module. Values from 0 - 2500 can be used for this entry.

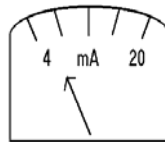
Fault Count Low - the minimum number of counts expected from the detector during low calibration. This count should be set at a value no greater than half the background counts but not less than one. Factory default setting is 10.

Fault Count High - the maximum number of counts expected from the detector during high calibration. Set to a value no smaller than twice the background counts plus the highest normal operating counts. Factory default setting here is 20,000.

NOTE: If you do not have the ability to determine the actual background and the normal operating counts, use the factory default setting of 10 for Fault Count Low and 20, 000 for Fault Count High.

NOTE: The fault counts (LOW and HIGH) are used as threshold values for the RAD DISCRIM feature - if enabled. Values from 1 - 32767 can be used for these entries.

Span Zero - the transmitter output's low signal (in mA). This value should match the selection made during setup of the transmitter output board. Typically - 4mA.



Span Max - the transmitter output's high signal (in mA). This value should match the selection made during setup of the transmitter output board. Typically - 20mA.

Values from 0 - 50 can be used for these entries.

NOTE: All of these settings are stored for use during the calibration procedure.

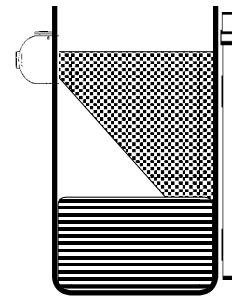
CALIBRATION CONSTANTS:

This menu lets you make settings that are applied during the calibration procedure.

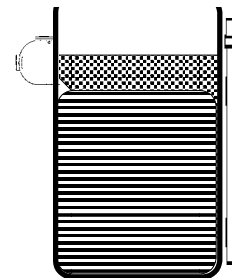
CALIB. TIME

FAULT COUNT -
LOW/HIGH

SPAN - ZERO/MAX

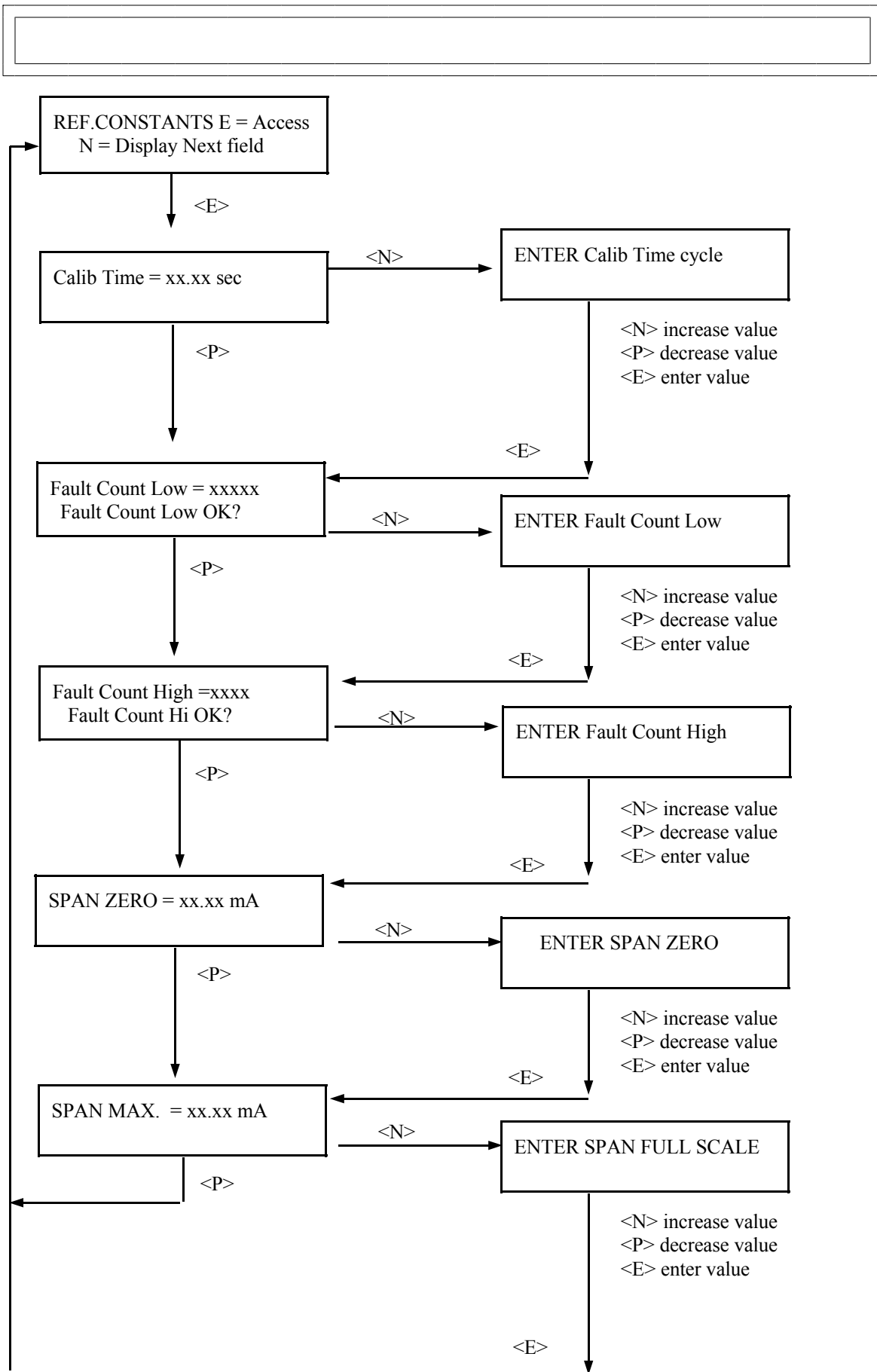


LOW
LEVEL=
HIGH
COUNTS



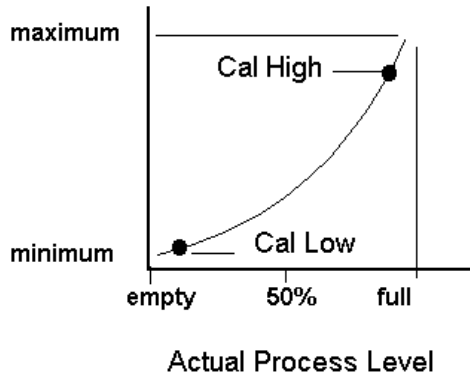
HIGH
LEVEL=
LOW
COUNTS

Press <N>



CALIBRATE E = Access

X96N Output - Calibrated



Chapter 5 gives detail about the calibration procedure.

NOTE: Three things will cause the system to abort a calibration cycle:

- 1) The average counts received during Cal High is above the FAULT COUNT HIGH entered in CALIB.CONST. module.
- 2) The average counts received during Cal Low is below the FAULT COUNT LOW entered in the CALIB.CONST. module.
- 3) A key on the front panel of the X96N is pressed to manually abort the calibration.

CALIBRATE:

This menu initiates the calibration function.

The calibration procedure relates the counts from the detector to an actual level of process.

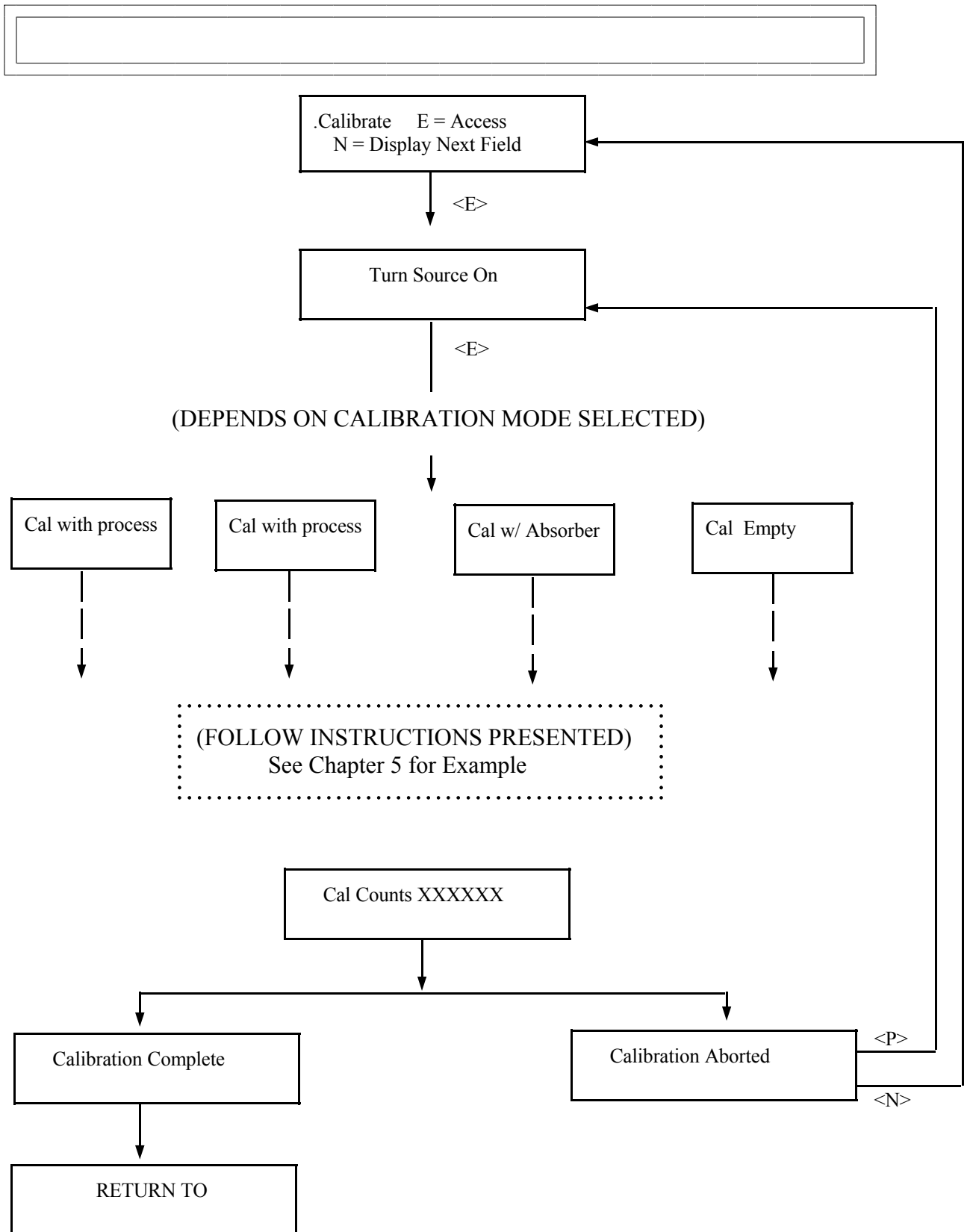
In all circumstances, the level gage requires at least two actual points of reference - a low value and a high value.

Intermediate values can be verified and corrected by using the Curve Correction function. (See CURVE CORRECT module).

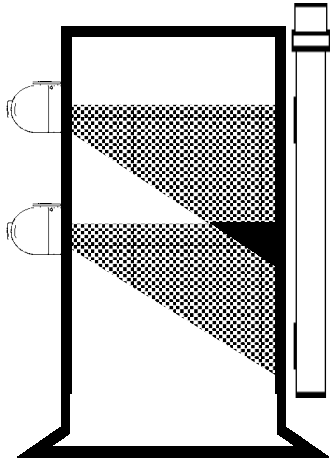
The series of screens presented during the calibration procedure will vary depending on which mode of calibration is selected. (See CALIB MODE module for more information).

During calibration the digital filter is by-passed so the system can use the actual counts received during the full calibration time period. After calibration, the counts are set to the averaged counts, and the digital filter is enabled again. (See TIME CONSTANT module).

Press <N>

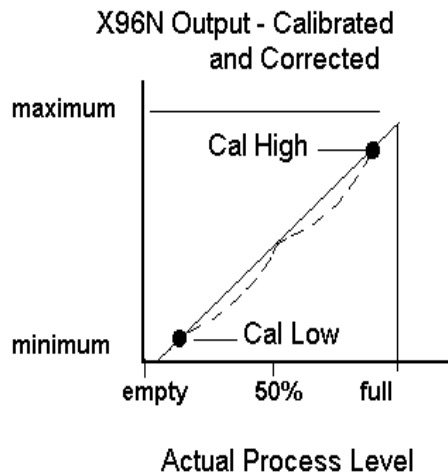


CURVE CORRECT E = Access



EXAMPLE:

Two point sources could create an irregular distribution of the radiation field.



Chapter 5 gives details about the Curve Correction procedure.

CURVE CORRECT:
The Curve Correct feature can be used in some system configurations to produce a more linear measurement.

In a level measurement, non-linearity is caused by an irregular distribution of the radiation field over the entire length of the detector.

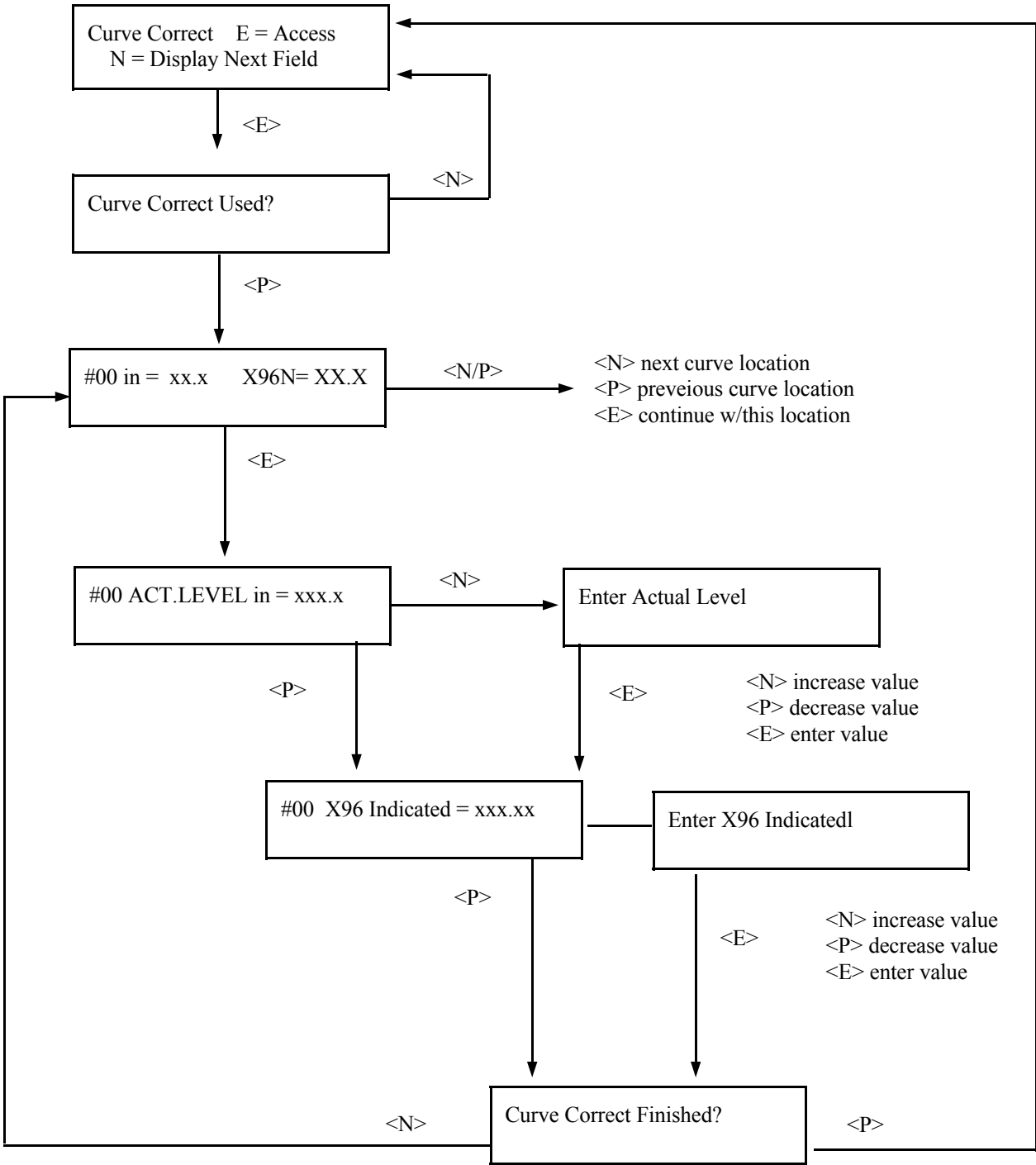
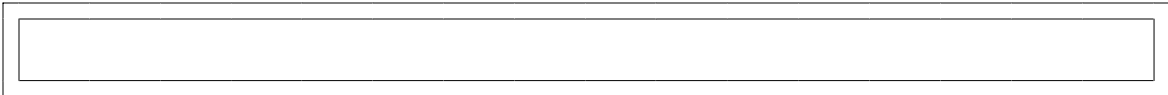
Among the circumstances that can cause this non-linearity are:

- Vessel size
- Vessel geometry
- Multiple point sources
- Vessel wall construction

This menu permits entry of up to ten increments that can be used to linearize the output. The first increment (#00) and the last increment (#09) must match the values you entered as "zero" and "span" in the RANGE module.

NOTE: To use Curve Correct when Auto-Calibrate is enabled set the Ref Low Level equal to the Auto-Calibrate Low Level.

Press <N>



RECAL PROMPT E = Access

RECAL PROMPT:
This menu permits you to set the length of time until a prompt is issued that reminds you to recalibrate the gage.

The factory default setting here is 90 days.

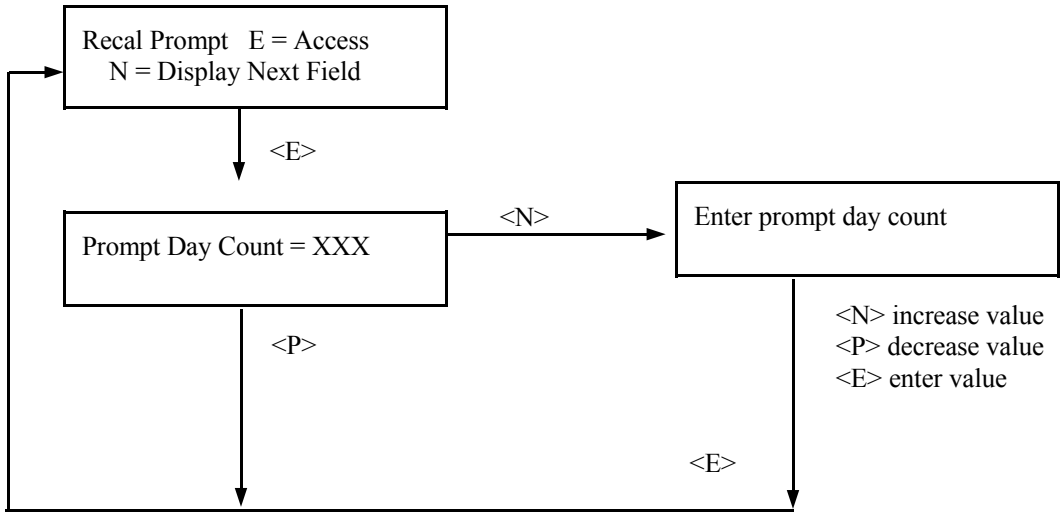
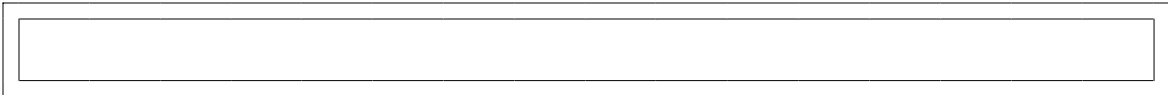
If your own normal process conditions, such as build-up on the interior vessel walls, require more frequent calibration, then you will want to decrease the default setting by decreasing the "Prompt Day Count."

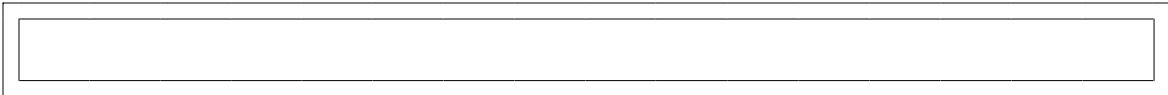
← Pin 14 - open collector
Max = 50mA at 24V

When the set number of days since the last calibration has elapsed, Input Terminal (TB-A), pin 14 will be enabled and the system will remind you to perform the re-calibration.

Once the calibration is completed, the number of days since Last Cal is reset to zero and the system begins counting over again.

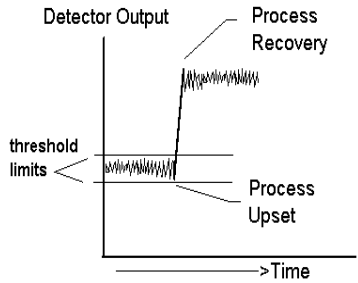
Press <N>





DYN TRACK E = Access

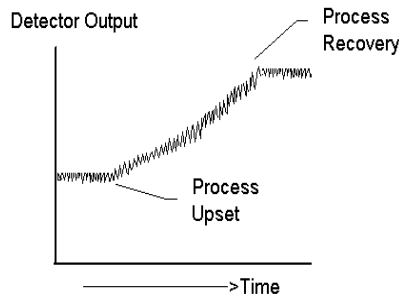
DYNAMIC TRACKING:
This feature permits sudden process step changes to bypass the digital filter so they can be observed in their "unfiltered" state.



Time Constant = 10 secs.
Dynamic Tracking Enabled

This menu requests if dynamic tracking is desired. If enabled, a response threshold value is entered in "detector counts" and is adjustable so that the normal process fluctuations can be considered.

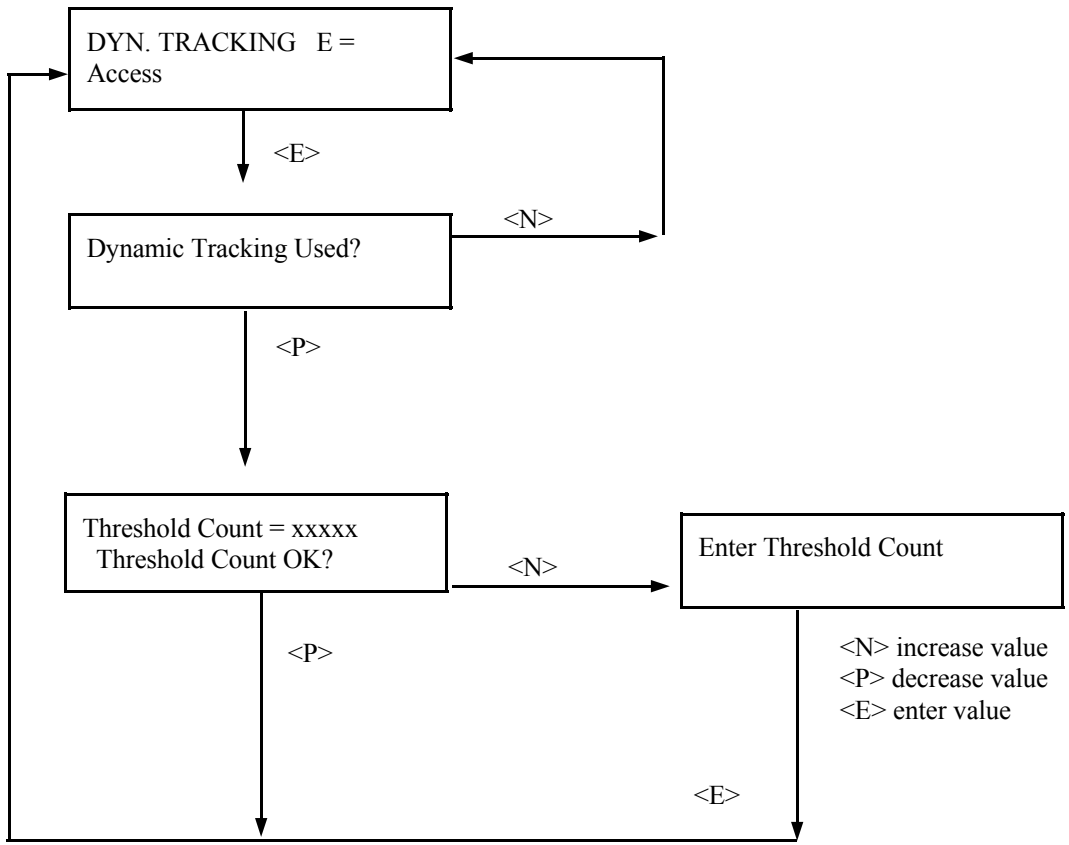
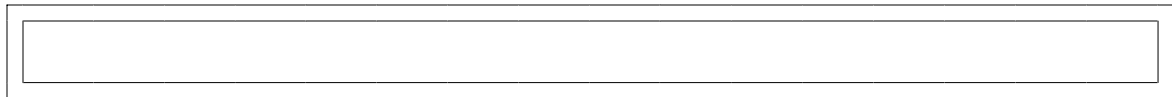
If a sudden process change occurs that exceeds the set threshold, the filter is bypassed and the actual response is displayed.

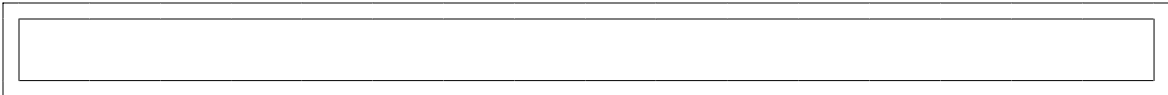


Time Constant = 10 secs.
Dynamic Tracking Disabled

Upon process recovery, the time constant filter is resumed.

Press <N>





PRINT TIME E = Access

Example Print Out when Print Time is set to 10:

```

15:00:00  014.84%  -----x
15:00:10  016.40%  -----x
15:00:20  022.65%  -----x
15:00:30  010.54%  -----x
15:00:40  000.78% x
15:00:50  UNDERRANGE x
15:01:00  UNDERRANGE x
...etc.

```

NOTE:

The bar graph gives a visual representation of level conditions to help analyze trends or identify problem areas.

PRINT TIME:

This feature applies only to systems that use the optional serial link interface printer and board.

This menu lets you specify the time interval (in seconds) between printed reports. An entry of zero (0) turns off the print function.

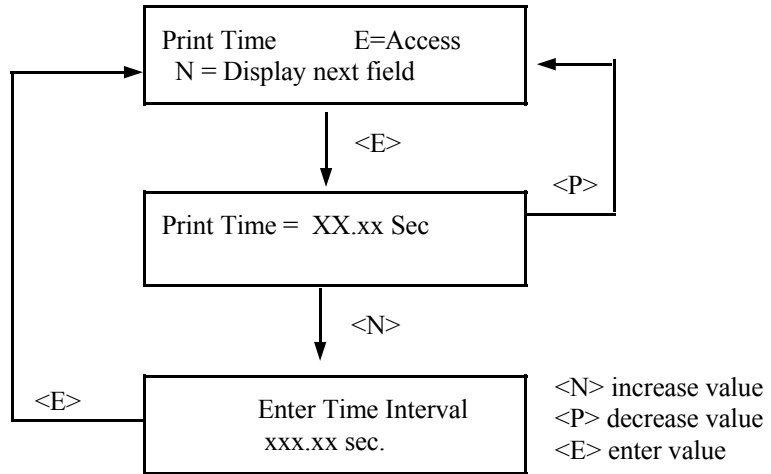
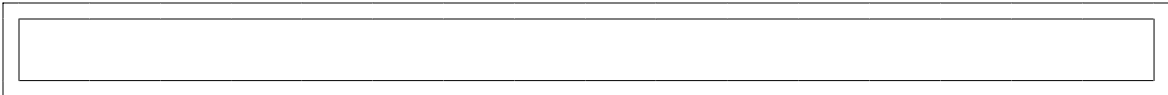
The report prints three fields in this format:

- 1) TIME
- 2) % OF FULL RANGE
- 3) -----x
(BAR GRAPH)

Every 59 lines a "footer" is printed with this information:

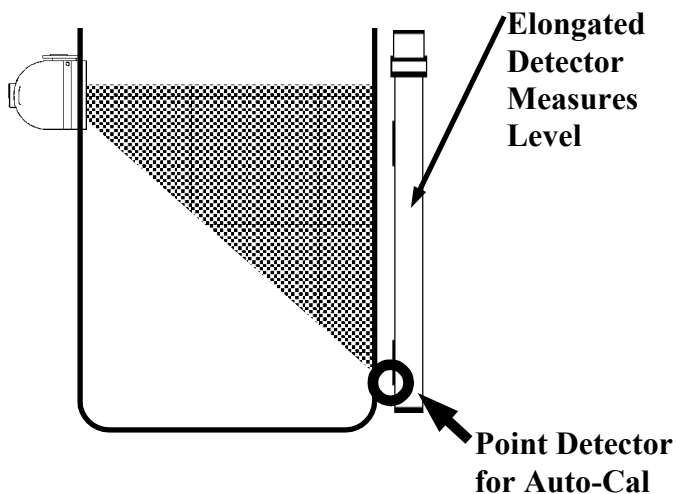
- Date:
- Time:
- Constants:
- Time Constant (secs):
- Channel 1 Span:

Press <N>



NOTE: This menu does not operate unless a printer is attached to the system's optional serial link.

AUTO CALIB E = Access



NOTES:

- 1) If the curve correct feature is enabled, always set the auto-cal level at zero (0).
- 2) If the optional pushbutton version of Auto-Cal is used, the auto-cal level is set to the process level where the operator will be pushing the button each time.

AUTO CALIBRATE:
This optional feature requires additional hardware.

With a point detector installed, the system will automatically perform a calibration each time the process reaches the preassigned level.

Auto-cal maintains the gage calibration with virtually no operator interaction.

The Auto-Cal module asks for two values:

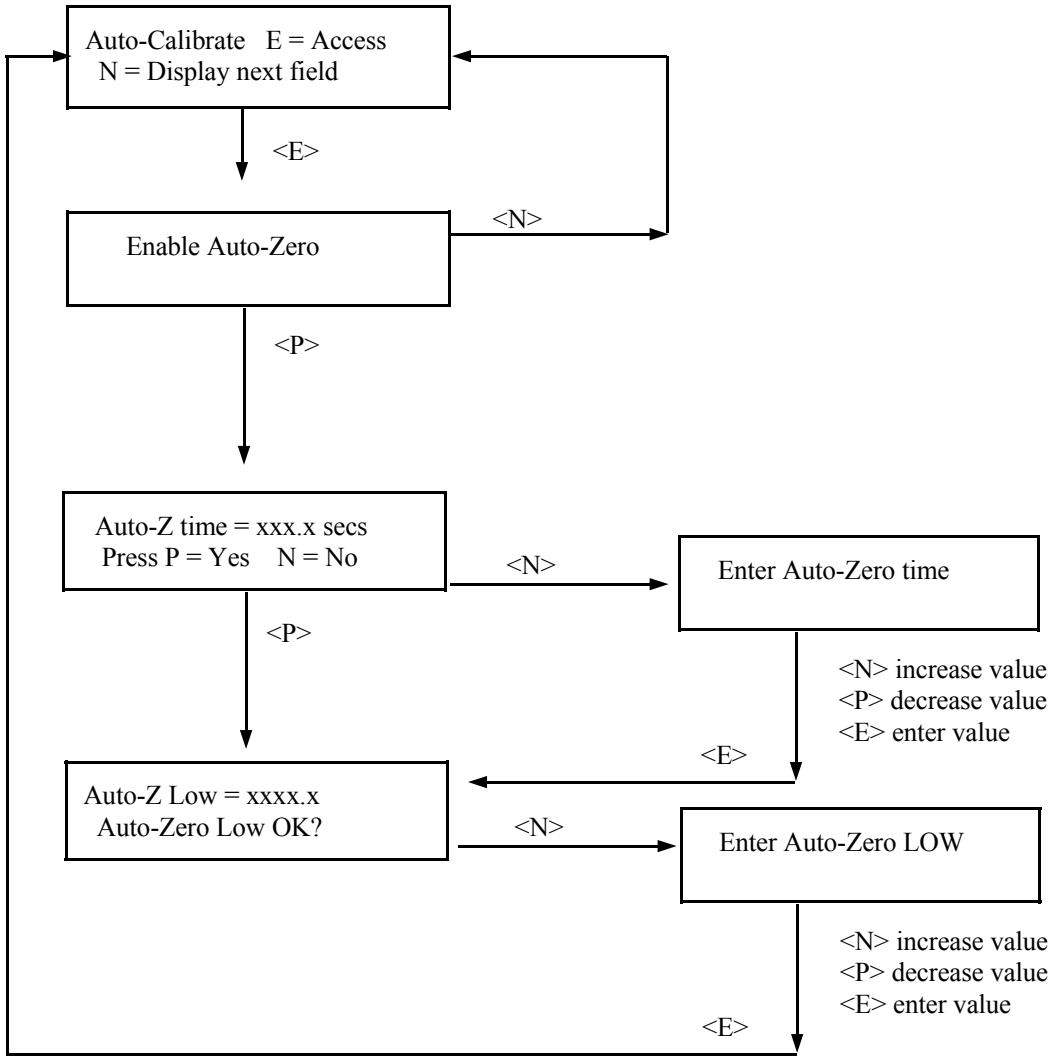
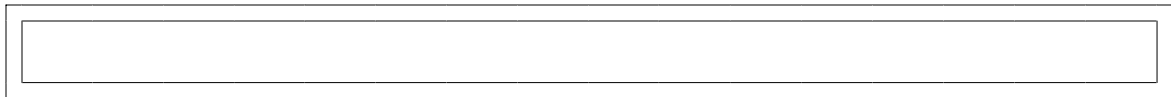
AUTO-ZERO TIME - the time, in seconds, the external contact should be closed.

AUTO-ZERO LOW - the actual level at which the Auto-Cal point detector is mounted.

See Chapter 8 for details about this optional feature.

Press <N>

← Pin 5 optional Auto-Cal input.



DETECTOR TYPE E = Access

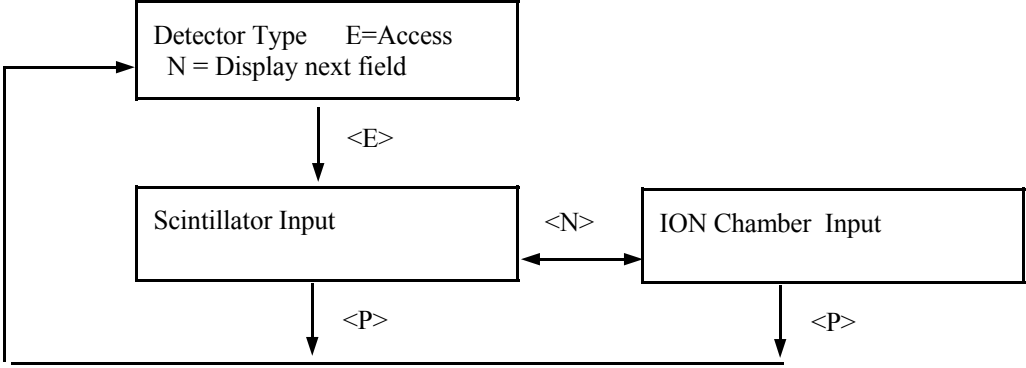
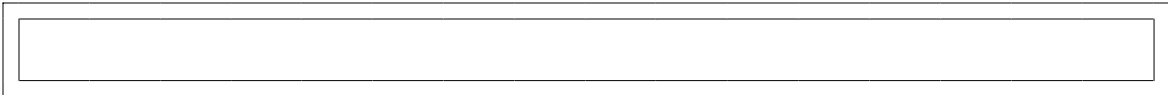
Choose one of these detectors:

- ION Chamber - Analog Output
- Scintillation - Digital Output

DETECTOR TYPE:
The choice of a detector is a factory setting that should not have to be changed.

See Chapter 6 for technical information on the detector that is included with your system.

Press <N>



RAD. DISCRIM E = Access

Radiation Discriminator Description

Ronan's Radiation Discriminator function is designed to permit normal level output operation during temporary periods of large, external radiation fields. It employs a separate detector outside the field of the source used for the level gauge itself.

The Radiation discriminator function will detect up to three separate conditions: radiation discriminator detector saturation, a low sigma external field, and a high sigma external field. Radiation fields above the maximum for the Radiation Discriminator detector will cause the detector to go into saturation and drop its output to zero. This condition effectively disables the input to the Radiation Discriminator function and causes the system to freeze the level output until the high field is removed and the detector recovers.

When an external field is applied to the Radiation Discriminator detector (and consequently the level detector), the outputs of both will increase. When the output of the Radiation Discriminator detector increases above the calculated threshold and remains there for a number of consecutive scans, the Radiation Discriminator function will trigger. When first triggered, the function will temporarily freeze the level output, and the current elevated level and Radiation Discriminator detector outputs will be averaged for a period of four times the current time constant. The average values are used to calculate the effects of the high field on each detector. The change in level detector output is calculated and stored as an Offset value. The change in Radiation Discriminator detector output is calculated and stored to be used in the Ratio algorithm. The Ratio will determine the adjustment to the level detector's output if the Radiation Discriminator detector's output should change. At first, the result of the Ratio is one. If we then subtract the Offset from the level detector's output and multiply this by the Ratio, the level detector's output remains the same as before the high field was applied.

If the external field changes (which changes the output from both detectors) and the actual level remains constant, the ratio will adjust the change in level detector output to remain constant. If the level actually changes in the tank, causing a change in level detector output but no change to the Radiation Discriminator detector's output, then the level output will change as the ratio remains the same.

When the Radiation Discriminator detector's output drops below the low sigma threshold, the alarm condition will cease, and Offset will be set to zero. This will produce a level output based solely on the level detector's output, as normal.

RAD. DISCRIM E = Access

Surge Filter: This is the time constant for the system to average the Radiation Discriminator detector and obtain the average counts before the trigger. This should be a relatively long time constant in the order of one to two minutes.

Low Sigma; This is the low sigma threshold that will trip the Radiation Discriminator function. It must be set above the noise band for your system, normally about 2.5.

Low Sigma Fault Count: This is the consecutive activation counter for the low sigma. The low sigma threshold must be exceeded for this number of scans to trip the Radiation Discriminator function. Normal value here is two.

High Sigma: This is intended to be a quicker acting trigger. Set its value around 5 or 6. This is high, but if you set the High Sigma Fault Count to zero, it will trigger immediately.

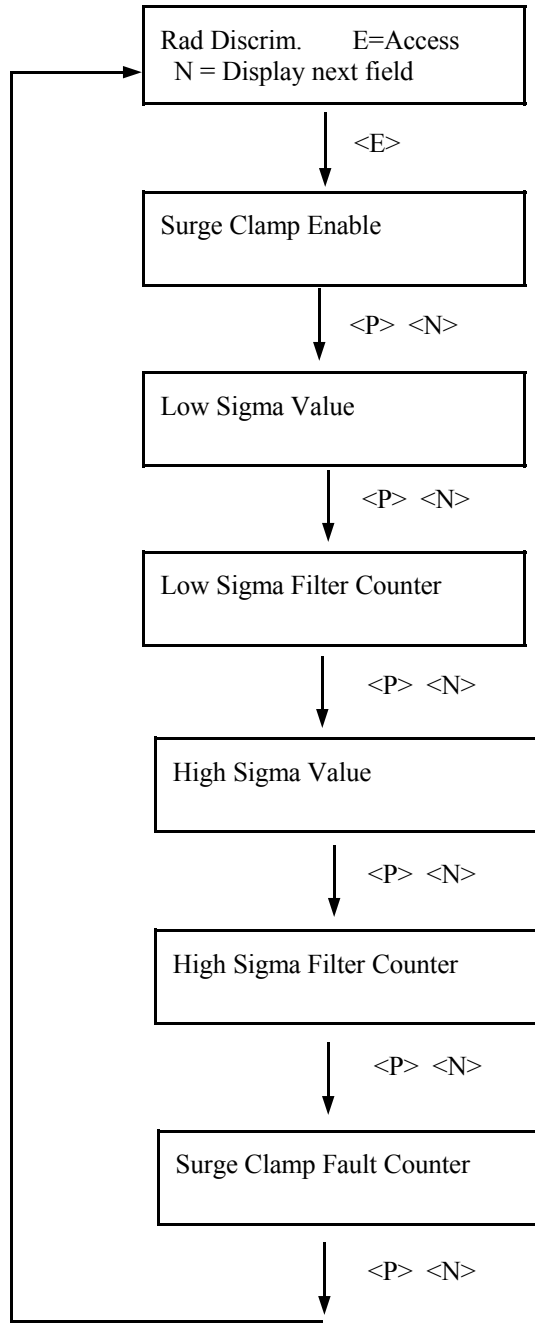
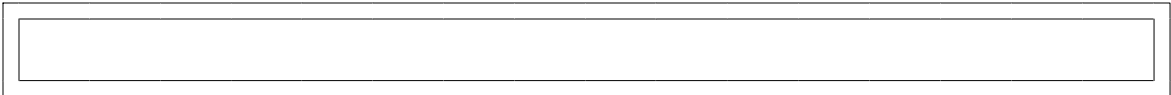
High Sigma Fault Count: Normal value here is zero. This allows the Radiation discriminator function to trip immediately if the High Sigma threshold is ever exceeded.

Surge Clamp Fault Count: This is the saturation level count from the detector. Its value should be down around 5, assuming your background counts never get that low. If they do, then use a value of 1.

If the threshold values are exceeded, the X96N's display and LEDs will flash indicating the gage has detected interference from an outside energy source.

“Surge Clamp Detected” message is given during Calibration if Rad Dis detects a Fault Count violation.

Input Terminal (TB-A), pin 12 provides an open collector for this feature.



Factory-Programmed

Some of the programmable functions were set at the factory based on information provided at the time your Monitor System was ordered.

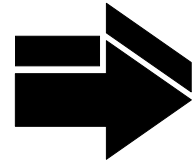
Oftentimes, these settings will be appropriate and will NOT require revision. However, if one or more of the parameters need to be re-configured, a code is required to access the menus.

To *access* the factory-programmed functions, do this:

Press <E> LEDs flash



Press <N N P N P P>

**NOTE:**

To *exit* the factory-programmed functions, do this:

Press <N> **or** <P> until the display reads
"Press E to Exit"

Press <E> to return to Status Display #1.

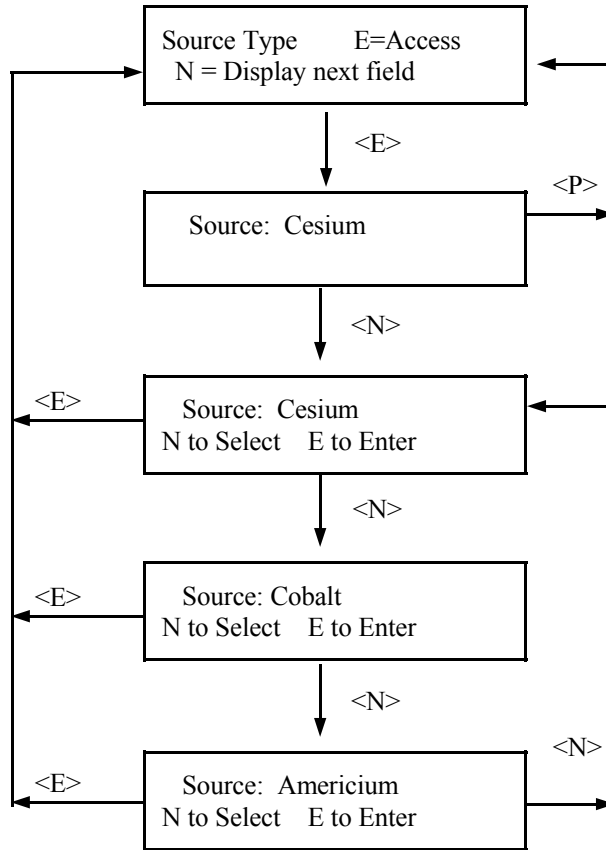
SOURCE TYPE E = Access

Choose one of these source types:

CESIUM
COBALT
AMERICIUM

SOURCE TYPE:
Selects radioisotope being used. This permits the appropriate source decay factor to be applied through software signal processing.

Press <N>



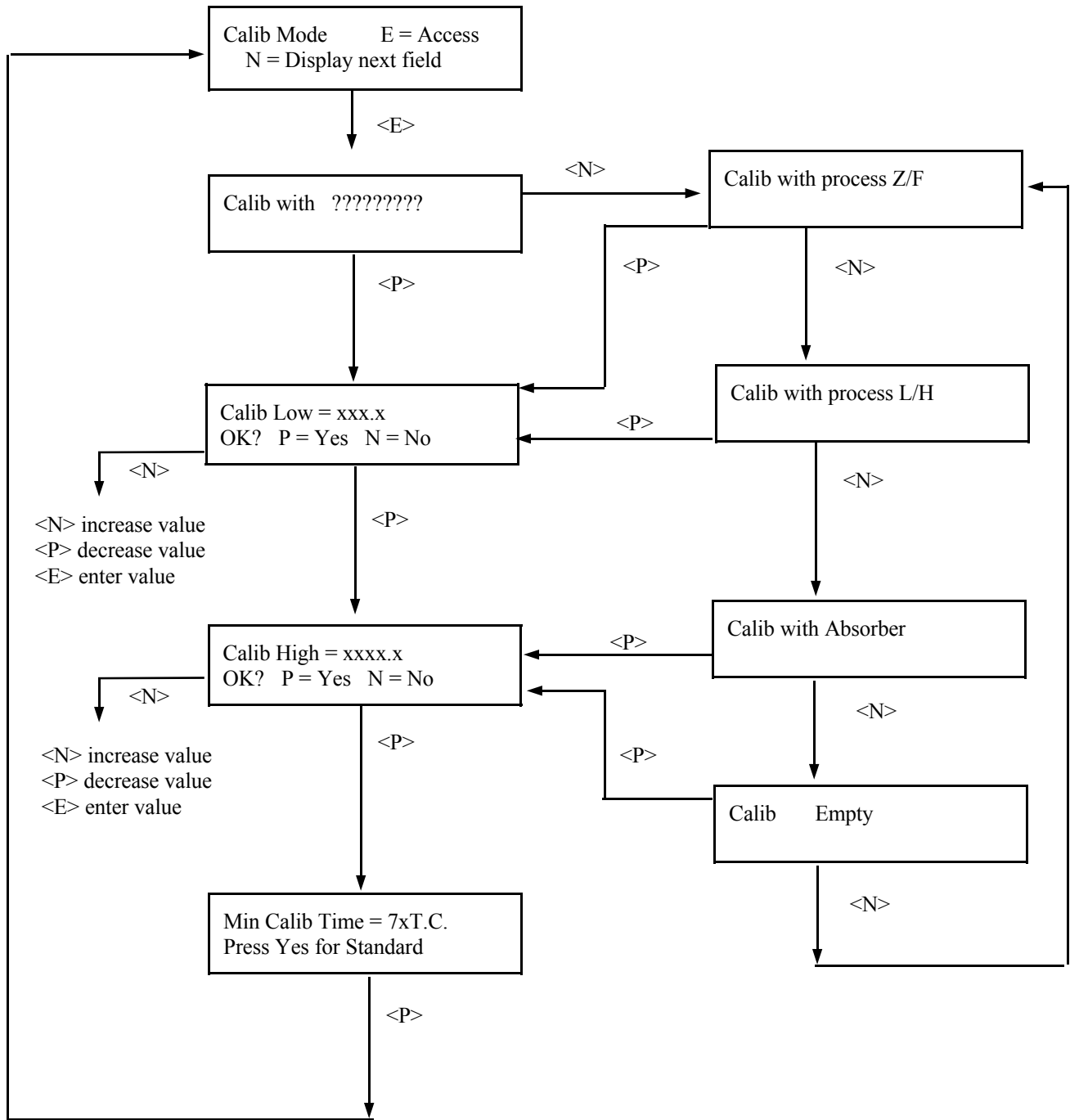
CALIB MODE E = Access

CALIBRATION MODE:
Selects one of four modes
to be used each time the
system is calibrated.

Choose one of four calibration modes that
represent the conditions that will be encountered
EVERY TIME a calibration is done.

Press <N>

- 1) EMPTY - If vessel can be emptied each time.
- 2) WITH PROCESS (Z/F) - If vessel can be
emptied and filled to 100% each time.
- 3) WITH PROCESS (L/H) - If vessel cannot be
completely emptied and filled each time.
- 4) ABSORBER - If calibration cannot be done
while process is running. Absorber plates will
simulate required calibration conditions.



PRINTER E = Access

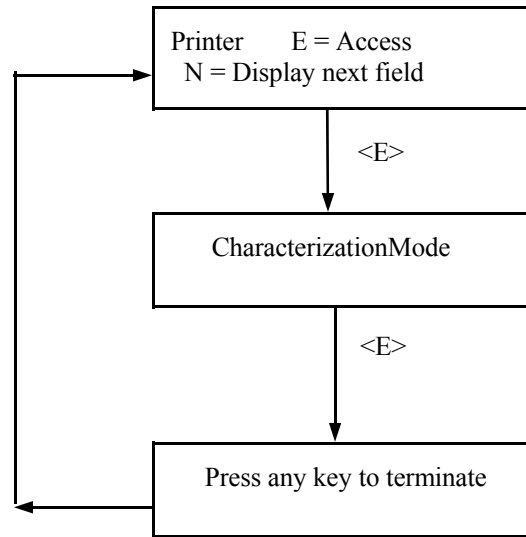
PRINT:
Requires the optional serial
link interface printer and
board.

This module will produce a report in this format:

DATE TIME DET COUNT PRO. TEMP DET. TEMP

Press <N>

Press <E> to exit



LEVELin = xxxxx.x

LEVEL.....:
Current process level in user units.

_____% OF SPAN:
Percent of the total output range represented by the current measurement.

EXAMPLE:

IF Level Range = 0.0 to 100.0 in
AND Present level = 25 in
THEN Status Display #1 reads:

If the current level falls below the value set as the low end of the measurement range, the bottom line message reads:

LEVELin = 25.0

"UNDERRANGE of span"

IF level goes to 103 in
THEN Status Display #1 reads:

If the current level rises above the value set as the high end of the measurement range, the bottom line message reads:

LEVELmm =103.0

"OVERRANGE of span"

Press <N>

Time Constant = xxx.xx sec

TIME CONSTANT:
Filter Time Constant (in seconds) that is being applied to the level measurement.

RANGE:
Output Range (in user units) that is set as the high and low points of the level measurement span.

Press <N>

Time: XX:XX:XX

TIME:
Current time of day in
24-hour format

DATE:
Current date in
MM-DD-YY format.

Press <N>

RefLo xxxxxx RefHi xxxxxx

NOTE:

RefLo and RefHi are values stored in memory during the calibration procedure.

IF Rad Discriminate is enabled AND RefLo falls below the LOW FAULT COUNTS set in CALIBRATION CONSTANTS MODULE, the X96N's display and LEDs will flash.

IF Rad Discriminate is enabled AND Ref HI goes above the HIGH FAULT COUNTS set in CALIBRATION CONSTANT MODULE, the X96N's display and LEDs will flash.

REF LO:
The detector's output in counts currently being used as LOW reference.

REF HI:
The detector's output in counts currently being used as HIGH reference.

DETECTOR COUNT:
The detector's unfiltered output (in counts).

Press <N>

Output xx.xx mA

OUTPUT:
X96N output board's
present reading (normally
between 4-20mA)

MAX.OUTPUT:
X96N output board's full
scale maximum reading
(normally 20.00mA)

Press <N>

Diagnostic Test

Diagnostic tests of auxiliary equipment (if applicable)

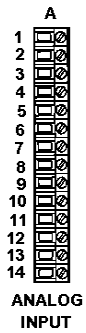
First value:
Detector Temperature
(in degrees K * 10).

Second Value:
Detector's filtered, decay compensated output (in counts).

Press <N>

NOTE:

Output active when detector temperature exceeds 323°K (50°C.)



← Pin 13 -open collector
Max = 50MA at 24V.

Last Cal Date: XX:XX:XX

LAST CAL DATE:
Date the system was last calibrated.

ELAPSED TIME:
Number of days elapsed since last calibration.

Press <N>



Chapter 5 gives step-by-step instructions for calibrating the Continuous Level Monitor System.

The curve correction procedure is also detailed.

An accurate calibration and curve correction will produce the optimal measurement results from Ronan's Continuous Level Monitor System.

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

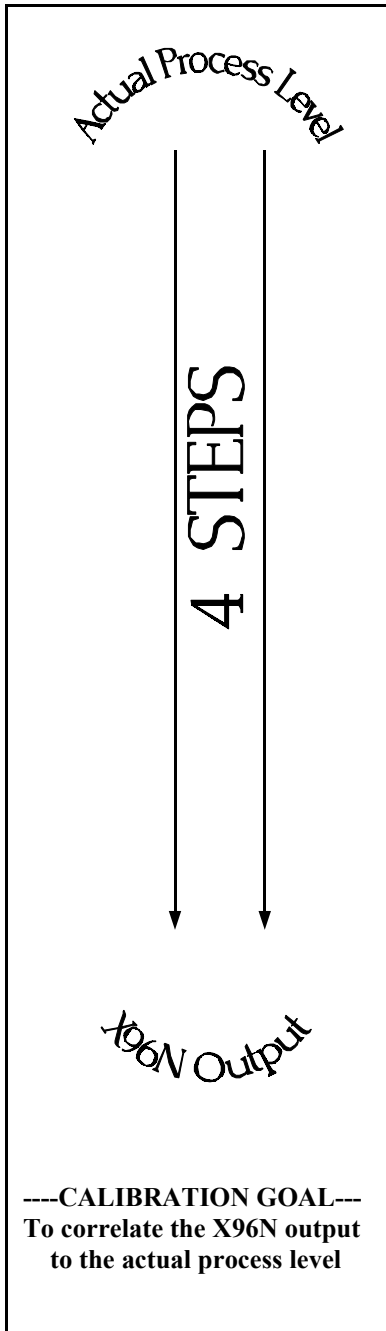
- 5.0 Calibration
- 5.1 Reconfiguring the System
- 5.2 Factory-Default Settings
- 5.3 Initial Calibration Procedure
- 5.4 Curve Correct Procedure
- 5.5 Documentation
- 5.6 Example

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

Reconfiguring the System

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

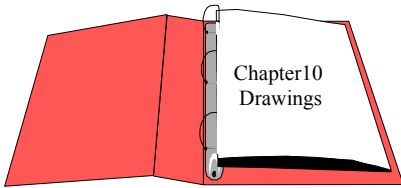
After installation at your site, you will want to customize the system to fit your own application and process variables. The goal is to correlate the X96N output with your own process level, thus producing an accurate level measurement. The list below summarizes the activities that are detailed in the remainder of this chapter:



- 1 Check the factory-default settings to be sure they are appropriate for your circumstances. If NOT, make necessary changes and document those changes for future reference.
- 2 Perform an initial calibration. This procedure relates the actual process level to the system's output.
- 3 Use the curve correction procedure to further refine the output, producing a more accurate measurement, if required.
- 4 Document some critical readings for future diagnostics and troubleshooting. Also, record any changes you made to the factory-default settings. Keep this information for future reference.

1 Factory Default Settings

Locate the "Factory Configuration and Inspection Sheets" which are filed with drawings in Chapter 10 of this manual. That information will indicate how the system operated under factory conditions.



Reference: :
Factory Configuration Sheet

DOCUMENT ALL CHANGES

The factory-default settings were selected based on information provided at the time your Continuous Level Monitor System was ordered. In most cases these settings should be appropriate for your circumstances. If you change any of the factory-default settings, be sure to document the changes for future reference.

You can check these settings through the X96N display modules by entering the programmable-functions access code: Press <E>
Press <N N P N N P>
Press <N> to reach the function...

CAL MODE
TIME CONSTANT
RANGE - (zero/full span)
CAL CONSTANTS -
Calibration Time
Fault Counts (high/low)
Output Span (zero/max.)

Calibration MODE

One of your first tasks will be to calibrate the system. The steps involved in the calibration will vary slightly depending upon the *mode* of calibration selected as the constant.

NOTE: Instructions which follow are for a "Calibration with Process - Zero/Full" mode. *Your own mode* may be different, in which case your own screens may vary slightly from the example shown on the following pages. In that case, follow the prompts on your screen and enter the information requested for your own circumstances.

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

Cal on EMPTY
Cal with PROCESS - Zero/Full
Cal with PROCESS - Low/High
Cal with ABSORBER

Most applications use the "Calibration with Process" Mode. Changing the CALIBRATION MODE requires access to the Factory-Programmable Functions.

2 Initial Calibration

The initial calibration procedure relates the X96N's output to your actual process conditions. It instructs the microprocessor to read and store the detector counts for a low and high level of process. Once the system is conditioned to recognize the low and high levels, it will provide a 4-20 mA output over the entire range of interest.

Calibration Procedure

The CALIBRATION module is located in the customer-programmable functions.

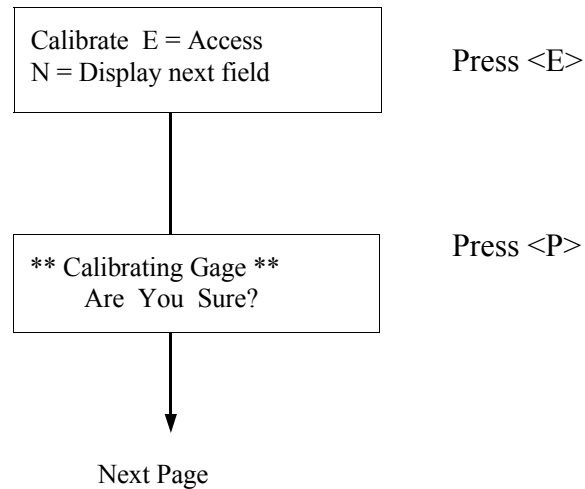
YOU MUST KNOW THE ACTUAL LOW AND HIGH LEVELS OF YOUR PROCESS VESSEL FOR THIS PROCEDURE and EQUIPMENT SHOULD BE RUNNING AT NORMAL ENVIRONMENTAL CONDITIONS - TEMPERATURE, PRESSURE, PROCESS FLOW, ETC.

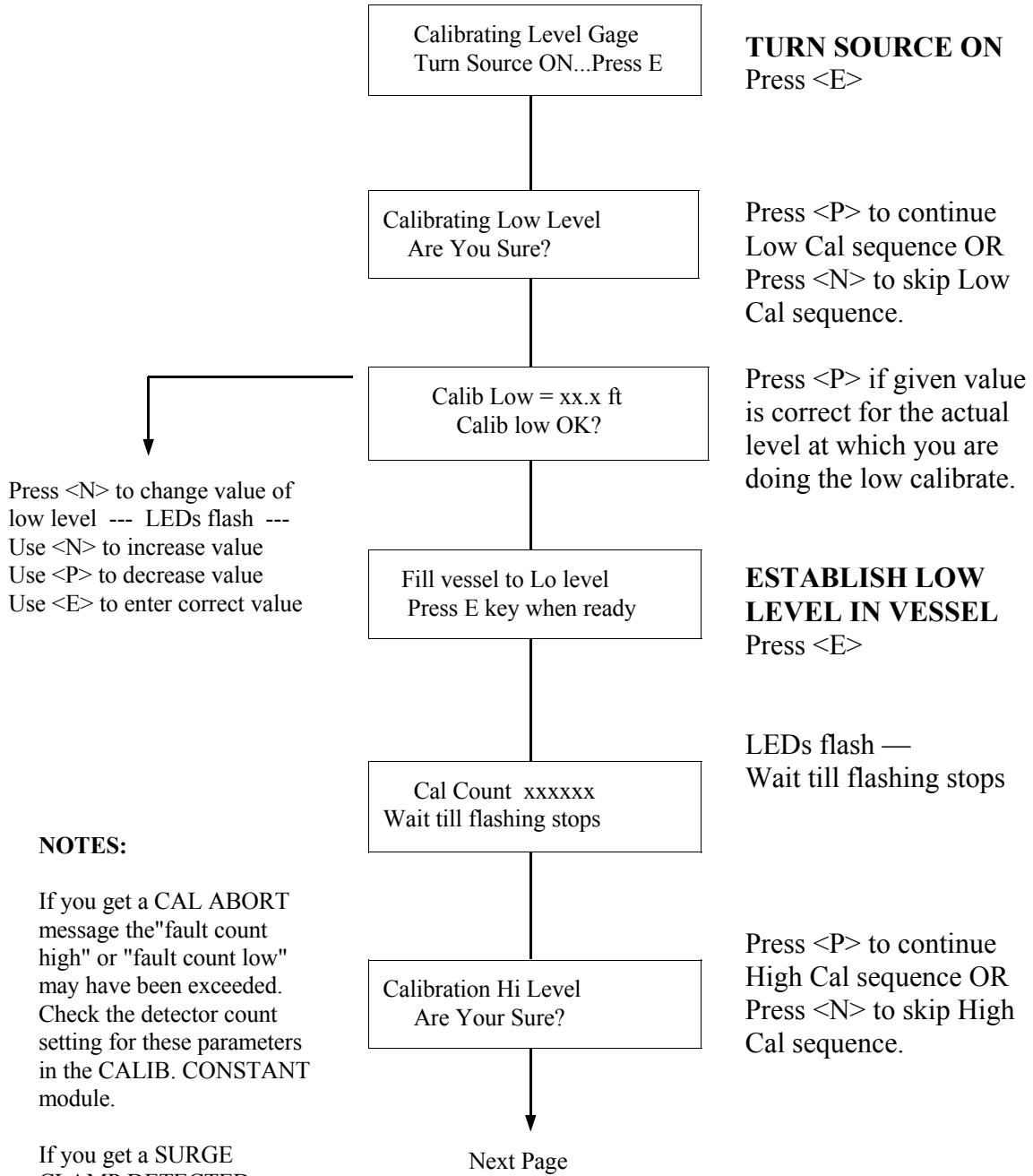
Begin by entering the access code:

Press <E> LEDs flash
 Press <N N P N N P>
 Press <N> to reach CALIBRATE

NOTE: The series of screens presented during the calibration procedure will vary depending on which mode of calibration is selected. (See CALIB MODE module for more information).

If your system is set for a Calibration Mode different from "Cal with Process-Z/F" you will be asked for information slightly different from what is shown on this series of screens. In that case, follow your own prompts - enter the requested information, and press the indicated key.



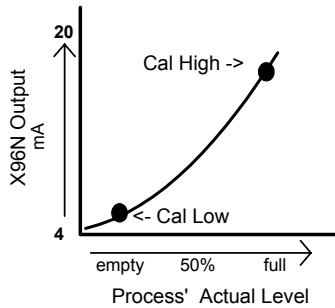
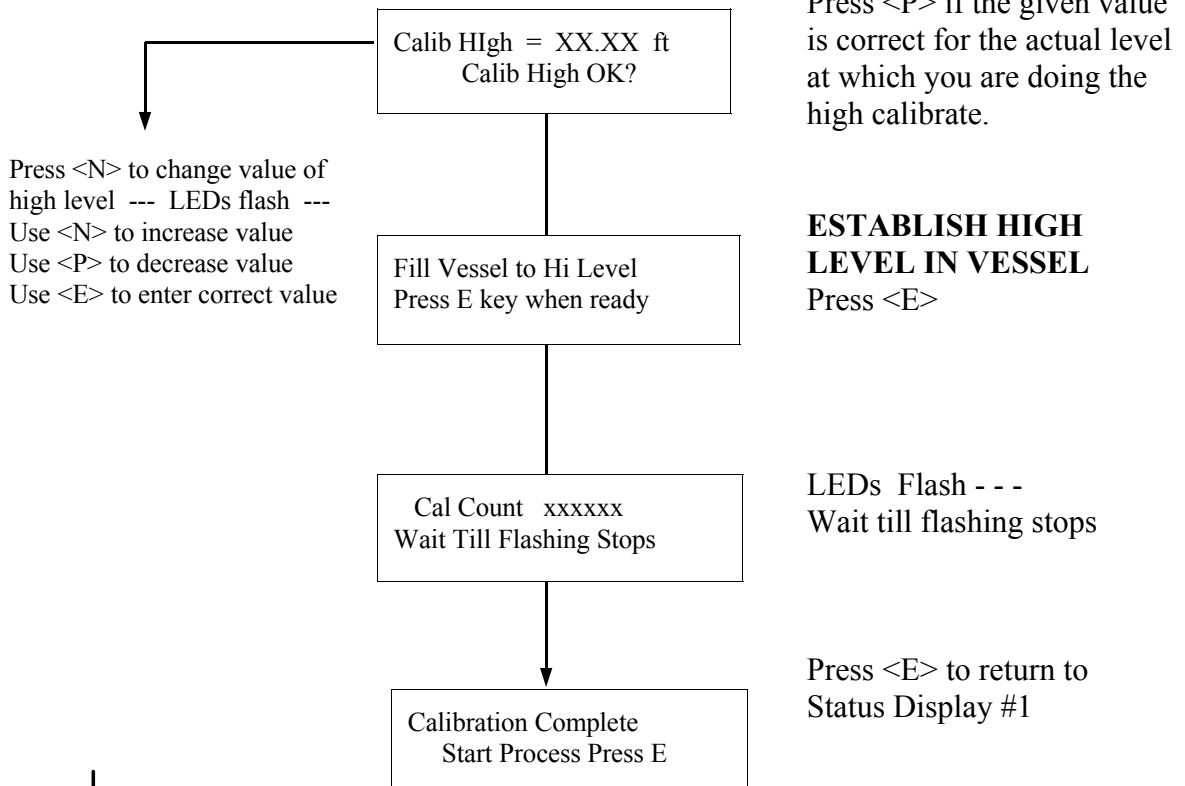


Press <N> to change value of low level --- LEDs flash ---
Use <N> to increase value
Use <P> to decrease value
Use <E> to enter correct value

NOTES:

If you get a CAL ABORT message the "fault count high" or "fault count low" may have been exceeded. Check the detector count setting for these parameters in the CALIB. CONSTANT module.

If you get a SURGE CLAMP DETECTED message the RAD. DISCRIMINATE may have detected outside radiological influence.

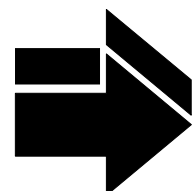


Go to the status display where the Reference Hi and Lo counts are stored and document these two values for future reference:

RefHi xxxxx RefLo xxxxxxxx
Det Counts xxxxxxxx

Ref Hi _____ ←
Ref Lo _____ ←

Move on to
Curve
Correction



3 Curve Correction

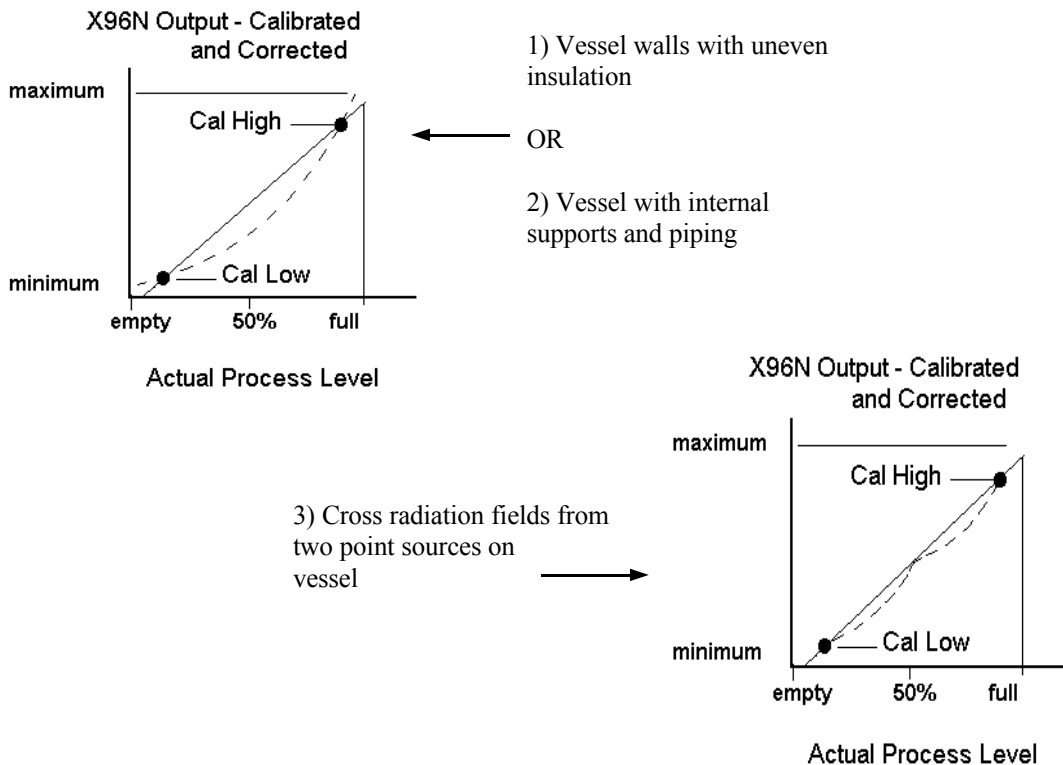
The calibration procedure detailed on the previous page instructed the system to recognize two known points - an actual low level and an actual high level.

The intermediate levels were computed based on a linear (straight line) relationship between the two actual points. (See Chapter 2). This linear relationship assumes the radiation field is distributed evenly over the entire range of the vessel.

Unfortunately, however, the system's configuration does not always produce an evenly distributed radiation field. That is to say, things like the size and shape of the vessel, the dynamics of process movement, the geometry and placement of the system components can all interact to produce an uneven distribution of radiation which, in turn, produces a non-linear response.

Examples:
Non-linear responses due to uneven distribution of radiation field

By applying a curve correction through software, a linear relationship can be simulated.



Curve Correction Procedure

The curve correction procedure entails giving the system a number of additional intermediate points of actual process levels.

The X96N software permits entry of up to eight additional intermediate points. This procedure involves varying the process level to cover as much of the full range as possible.

You must first collect the data by observing the status displays for each increment to see the X96N's reading, and compare it to what you know to be the actual level at that increment.

TABLE for Data Collection

As you observe the X96N reading, record the results in the TABLE below. The first increment (#00) and the last increment (#09) MUST match the values you entered as "zero" and "full" span in the RANGE module.

levelft = xxx
____% of span

Diagnostic Test
xxxx / **XXXXXX**

YOU MUST KNOW THE ACTUAL PROCESS LEVEL OF EACH INCREMENT

	Actual Level (units)	X96N Output (units)	Detector Output (counts)
"zero" span ---->	#00	_____	_____
	#01	_____	_____
	#02	_____	_____
	#03	_____	_____
	#04	_____	_____
	#05	_____	_____
	#06	_____	_____
	#07	_____	_____
	#08	_____	_____
"full" span ---->	#09	_____	_____

NOTE: Not all curve locations have to be used, however, covering as much of the entire range as possible will produce the best results.

Applying Curve Correction

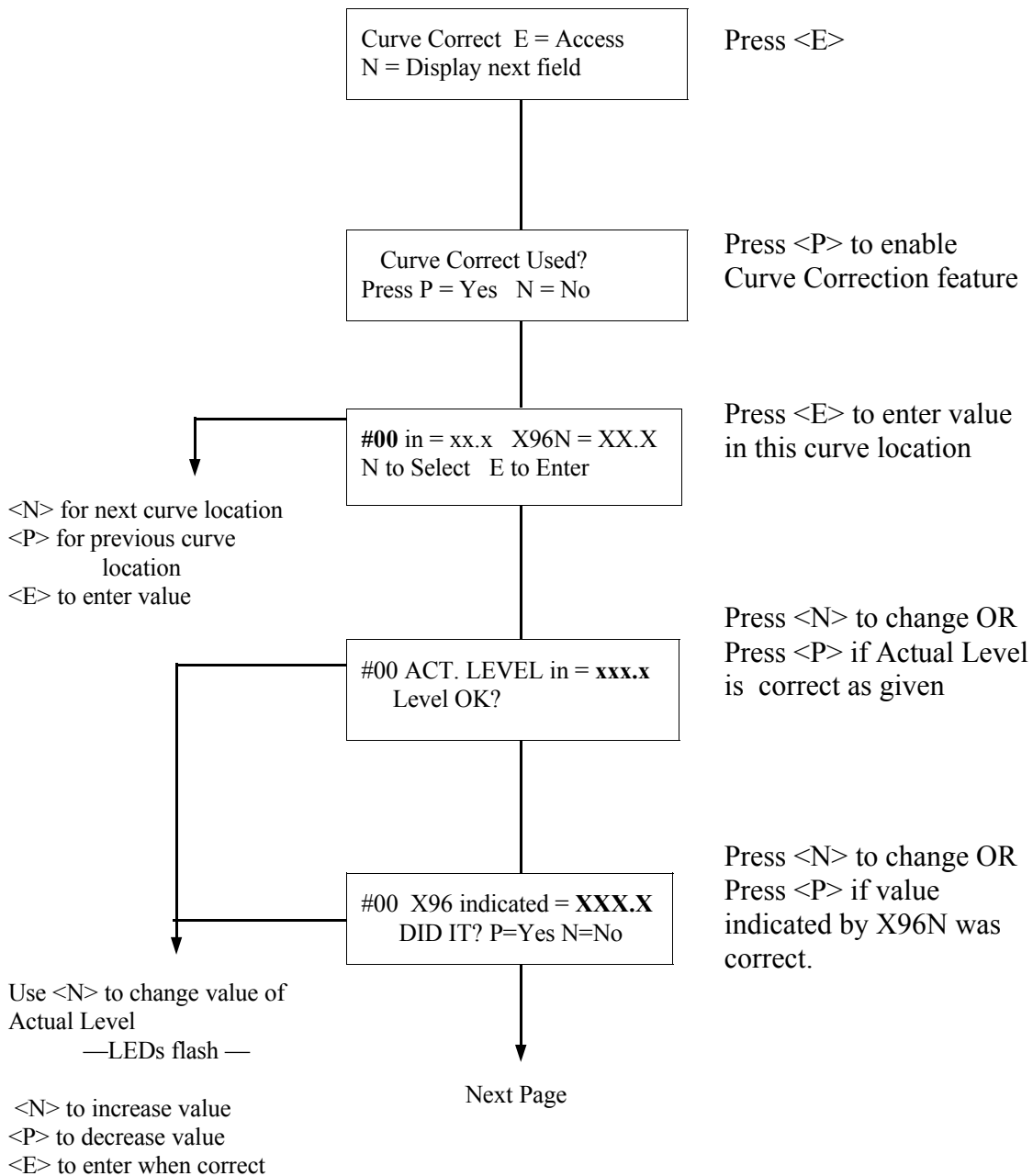
The CURVE CORRECT module is located in the customer-programmable functions.

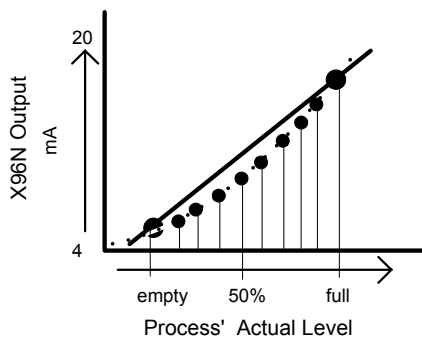
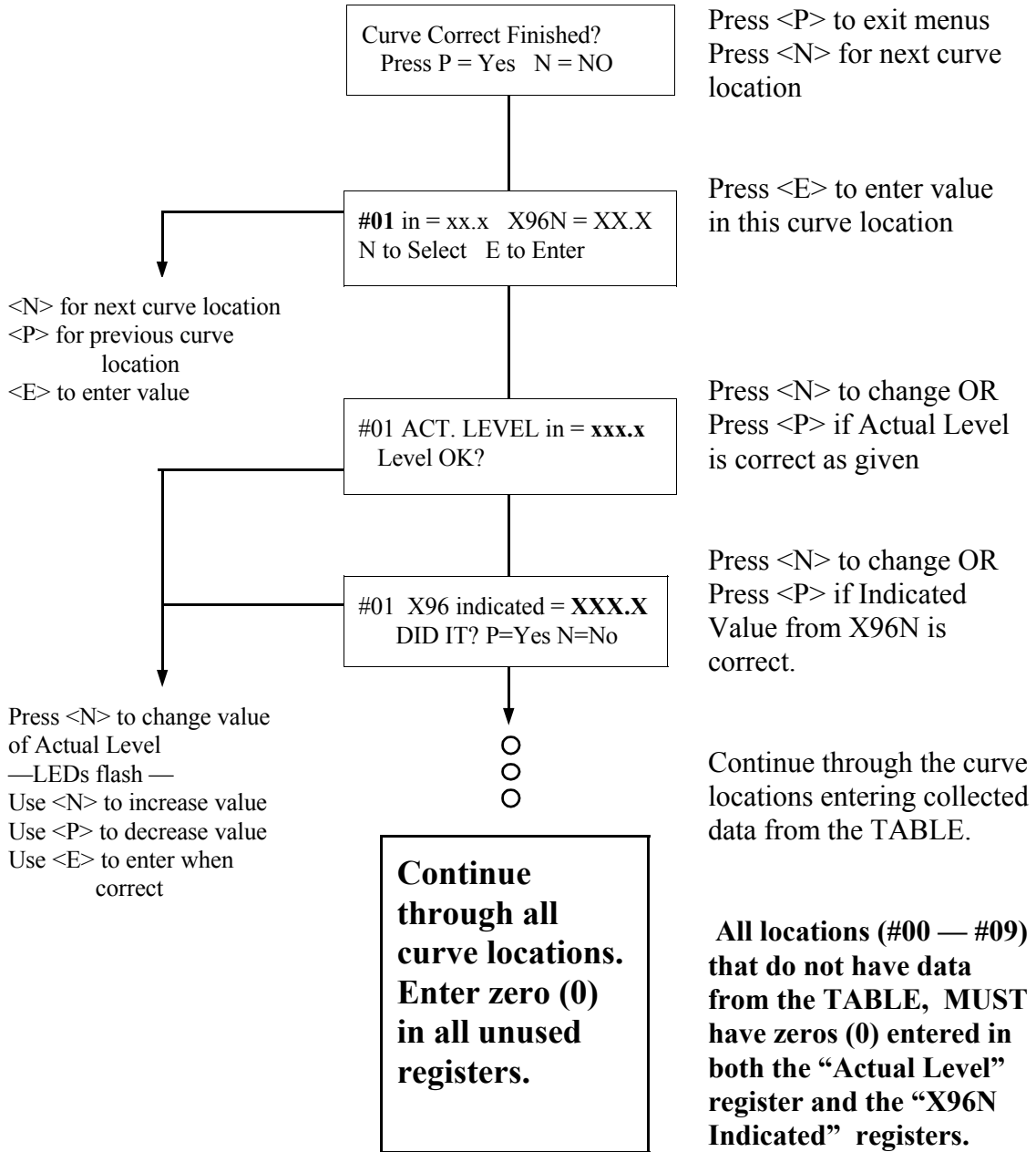
Begin by entering the access code:

Press <E> LEDs flash

Press <N N P N N P>

Press <N> to reach CURVE CORRECT





**Example:
Intermediate Points Plotted
and Curve Correct Applied**

4 Documentation

For future reference, document these items:

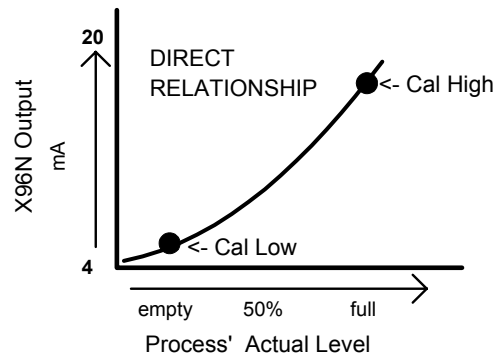
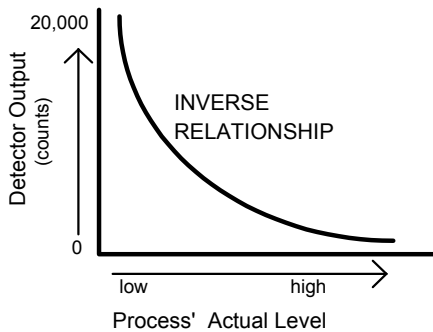
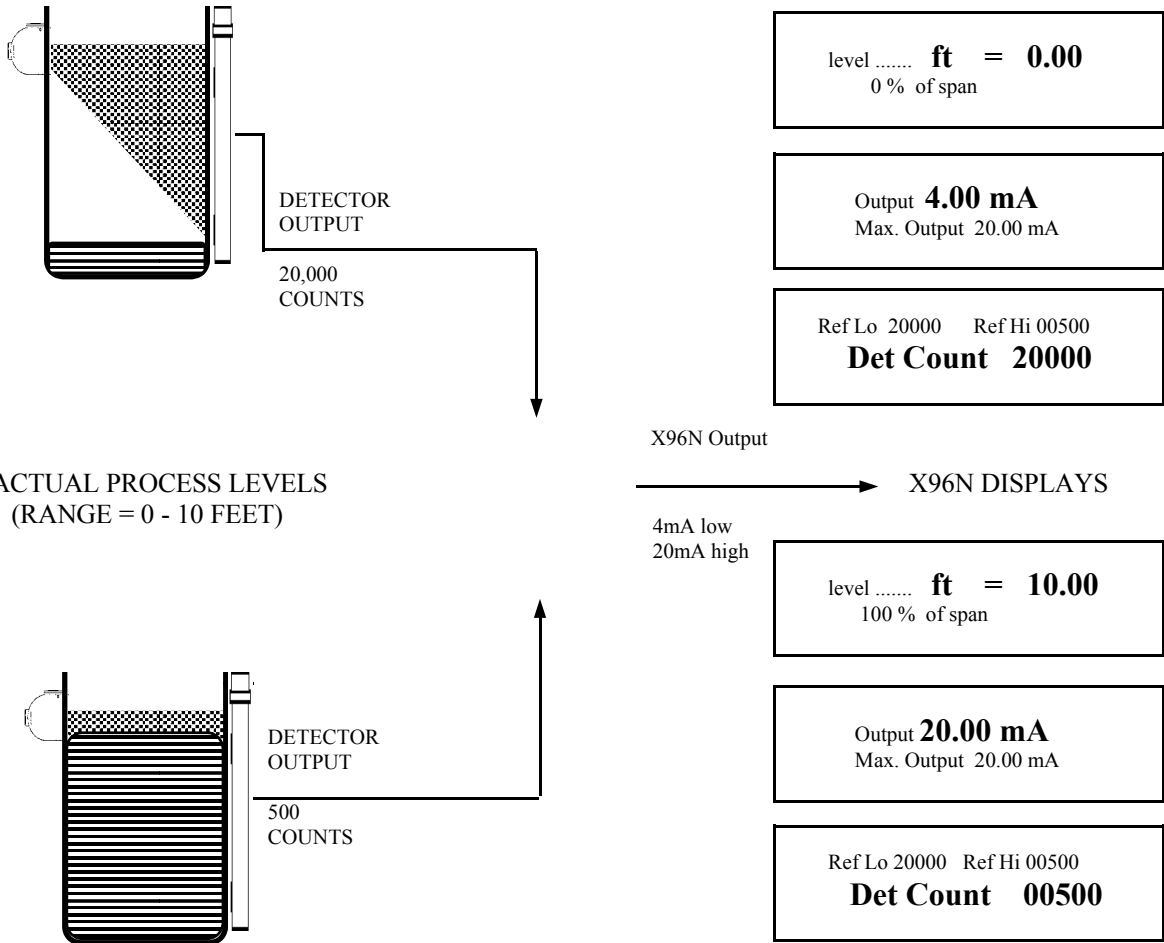
- (a) All conditions that are present during the calibration and curve correct procedures. That is, any information that will be needed to reproduce these exact circumstances the next time a calibration is performed. For example, note if agitators are running, vessel is at normal operating temperature, process is flowing from top of vessel through "active radiation beam," etc.
- (b) All changes made to factory-default settings such as time constant, calibration constants, gain, etc.
- (c) The "Ref Hi and Ref Lo" counts received during the Calibration procedure.
- (d) The Linearizer Curve entries made during the Curve Correction procedure.

TB-A pin 6+ to 2- _____ ←

TB-A pin 7+ to 2- _____ ←

Also, for Ion Chamber detectors (analog input) with the source turned "ON" and the process at, or near LOW LEVEL, use a voltmeter to measure and record these two voltage readings from the Input Terminal (TB-A). This information may also assist with future troubleshooting efforts.

Example:



Technical

Ion Chamber

Technical

B-6102-K
B-6409-K

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

Directions are included for replacing the detector's amplifier circuit board.

- 6.0 Technical
- 6.1 Detector Circuit Description
- 6.2 Detector Amplifier Service
- 6.3 Detector Replacement
- 6.4 Notes/Drawings

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^{-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 X96N Microprocessor, which converts the voltage signal to a level (or density) output of 4-20mA for a specified measuring range.

Circuit Description

Reference:

B-6409-K

B-9742-K

Refer to drawing B-6409-K. 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 X96N input board. (B-9742-K).

The detector's gain is adjusted whenever the signal output of the detector is too high and may saturate the input of the X96N, 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 glyptal 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.

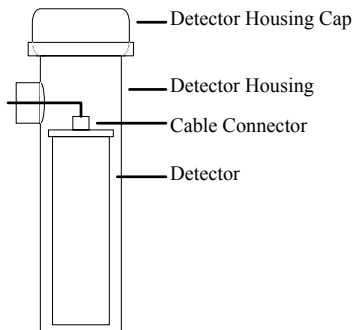
Servicing the Detector

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

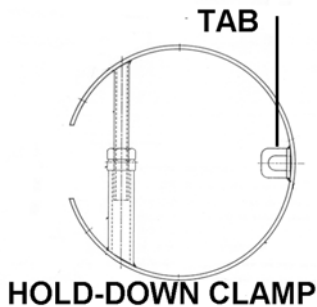
However, a qualified technician can troublehoot and service the detector's amplifier assembly. Instructions follow for that procedure as well. Some precautions are needed when handling the detector/amplifier assembly.

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 gasketed lid.

Detector Removal/ Replacement



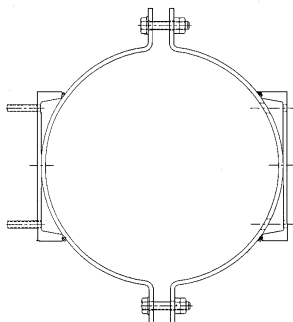
- 1) Check NOTES below for illustrations and cautions that apply to your specific equipment.
- 2) Unscrew cap on detector housing.
- 3) Unscrew connector on top of detector.
- 4) Remove detector from housing.
- 5) Carefully install replacement detector in housing.
- 6) Screw connector back onto detector.
- 7) Immediately replace detector housing cap.
- 8) 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 its chain handle, or other lifting devices, for prolonged periods of time.

When detector is properly seated on the bottom of the housing, the hold-down clamp "tab" will engage and the extension rod screw can be adjusted to tighten detector assembly into housing.



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.

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

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

Replacing the Detector Circuit Board/Connector Assembly

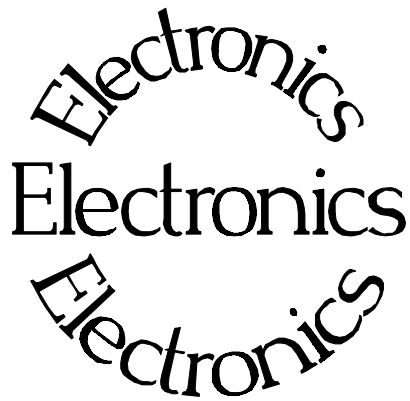
Reference:
B-6102-K

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 glyptal, 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.



B-9742-K

Chapter 7 contains information about the Electronics used in your Continuous Level 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

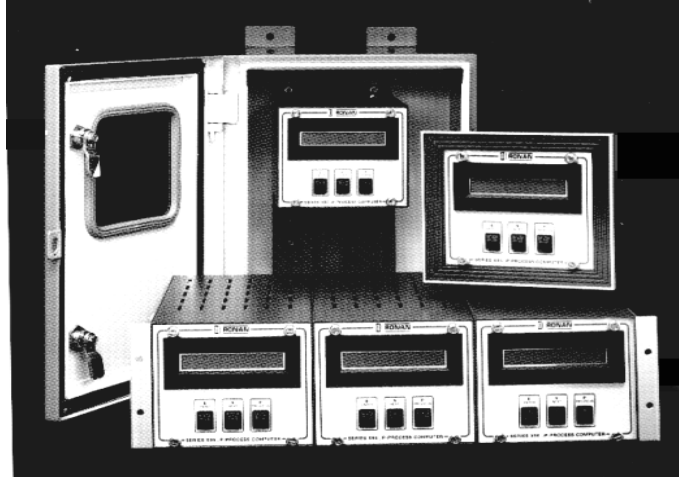
- 7.0 X96N Microprocessor
 - Board Setup
 - Alarm Trips
 - Reference Drawing
- 7.1 Troubleshooting Tips - Isolate Problem
 - Accessories/Configuration/
Process/Measurement Equipment
- 7.2 Using X96N Status Displays to Troubleshoot

X96N Microprocessor

Power Supply Assembly

Input: 24VDC
 110VAC +/-15% 50/60Hz
 220VAC +/-15% 50/60Hz

Output: +/-15VDC
 +5VDC



To remove fuse for inspection,
PUSH IN and **TWIST**
 COUNTERCLOCKWISE:



Test the power supply with a voltmeter by temporarily disconnecting all input wiring from TB-A. Do not allow the wires to touch other terminals or chassis. Suspect power supply problems if:

- +15V, -15V or +5V LEDs are NOT illuminated.
- +15V is NOT measured across pins 1 and 2 of TB-A.
- 15V is NOT measured across pins 2 and 3 of TB-A.

If necessary, access the power supply assembly by removing the four screws around the **OUTSIDE** edge of the panel.

Four screws around outside edge of panel will access Power Supply Assembly.



Temporarily disconnect TB-A input wiring.



Check LEDs



X96N Microprocessor Boards

Most troubleshooting of the X96N can be done to the board level. Loosen the four thumbscrews from the front cover of the display/keypad. Open the front cover and refer to Drawing B-9742-K for board identification.

Reference:
B-9742-K

Each board can be easily removed and replaced. Replacement part numbers are given on the Factory Checkout and Test Sheets in Chapter 10.

NOTICE:

The boards are interchangeable in the chassis slots, however each ribbon cable **MUST** be plugged into the correct board.

CPU Board

The central processor unit (CPU) consists of the Intel 8088 Microprocessor, clock generator, the RAM, ROM and E² ROM memory devices and the buffers providing the interface to the input and output busses.

Suspect CPU board problems if readings on the display screen are incorrect or erratic.

Before replacing the entire board, check to be sure the EPROMS are positioned correctly. Also, try replacing EPROMS on U7, U8, and U9.

Input Board

The input board provides analog-to-digital conversion to condition the detector output and signal(s) for processing by the CPU.

Suspect problems with input board if any of the following conditions arise:

-15/+5V LEDs on back panel are not illuminated.

Detector input (analog or pulse) is not being converted to counts on the display screen.

The open collector outputs from TB-A do not function properly. (Measured at TB-A pins 12,13,14).

Output Board

The output board converts digital values of active units to two transmitter outputs (4-20 mA or 10-50 mA.) Also, two alarm trips with single setpoints providing two SPST contact outputs each. A fail-safe relay, supervised by the system watchdog, transfers if the unit fails or if it loses power.

The output board may need to be replaced if a problem arises with either one of the output signals, or if the alarm trips are not initiating properly.

Display Interface Board

The display interface board connects the main bus to the display board. It contains decoder/buffers, power failure battery back-up, and the real-time clock.

This board may need replaced if the Time and Date on the X96N do not work correctly.

Display Assembly

The display assembly is comprised of the Display Board, LCD Board, and Switch board. This assembly contains the operator display screen and three pushbuttons.

Suspect problems here if the pushbutton inputs send errant signals to the microprocessor.

Serial Interface Board

The *optional* serial interface module provides output facilities to a hard-copy printer or a computer.

Suspect problems here if devices external to the X96N are setup with correct system parameters, but are still not receiving a communication signal.

X96N Transmitter Output Board Setup

The output range (normally 4-20 mA) is entered in the CALIB CONST. screen of the X96N and should match the selection on the output board.

Reference:
B-9742-K

Two methods for setting up the transmitter output are given on the following pages:
Setup Using a Calibrator and
Setup Using the Gage Signal

Transmitter Output Board Setup Using a Calibrator

Reference:
B-9742-K

1. Temporarily disconnect the yellow wire from input terminal (TB-A) at pin6. DO NOT allow it to touch other terminals or chassis.
2. Connect the calibrator to TB-A at pin6 (+V) and pin2 (-V).
3. Select Status Display #1.
4. Set the calibrator until Status Display #1 indicates UNDERRNG (around 3.00V)
5. Refer to drawing B-9742-K for ZERO control.
COUNTER-CLOCKWISE INCREASES ZERO SPAN
6. Adjust the transmitter zero control (Z1) for channel 1 and (Z2) for channel 2 to obtain an output current/voltage corresponding to ZERO of range (eg. 4 mA)
7. Set the calibrator until Status Display #1 indicates OVERRANGE (around 0.00V)
8. Refer to drawing B-9742-K for SPAN control.
CLOCKWISE INCREASES FULL SPAN
9. Adjust the transmitter span control (SP1) for channel 1 and (SP2) for channel 2 to obtain an output current/voltage corresponding to SPAN of range (eg 20 mA).
10. Disconnect the calibrator and replace yellow wire input terminal TB-A at pin6. RESUME NORMAL OPERATION!

pin 2 (-)

pin 6 (+)

Transmitter Output Board Setup Using the Gage Signal

Reference:
B-9742-K

- 1 (-) Ch 1
- 2 (+) Ch 1
- 3 (-) Ch 2
- 4 (+) Ch 2

1. Calibrate the gage.
2. Empty the process or establish a "Cal LO" condition.
3. Turn source ON.
4. Using an ammeter for current output or a voltmeter for voltage output, monitor the gage signal in series directly across the output terminal (TB-B) for channel(s):
Channel 1: pin 1(-), pin 2(+)
Channel 2: pin 3(-), pin 4(+)
5. Select Status Display #1 and record the reading(s) in units and %.
6. Access the RANGE module and record the ZERO SPAN value (s) for Channel(s). Temporarily reset this value to some number higher than what was recorded in Step #5.
7. Return to Status Display #1 and verify it now indicates "UNDERRNG"
8. Refer to drawing B-9742-K for ZERO control.
COUNTER-CLOCKWISE INCREASES ZERO SPAN.
9. Adjust the output zero control (Z1) for channel 1 and (Z2) for channel 2 to obtain an output current/voltage corresponding to the zero span of range (eg. 4mA).
10. Turn the source OFF.
11. Select Status Display #1 and record the reading(s) in units and %.

RECORD FOR REFERENCE:

Step # 5 (Ch1) _____ ←

(If Used-Ch2) _____ ←

Step # 11(Ch1) _____ ←

(If Used-Ch2) _____ ←

12. Again access the RANGE module and record the FULL SPAN value(s) for Channel(s). Temporarily reset this value to some number lower than the reading in Step # 11.
13. Return to Status Display #1 and verify it now indicates "OVERRNG"
14. Refer to drawing B-9742-K for SPAN control.
CLOCKWISE INCREASES FULL SPAN
15. Adjust the output span control (SP1) for channel 1 and (S2) for channel 2 to obtain an output current/voltage corresponding to the full span of range (eg. 20 mA).
16. Turn the source ON.
17. Access the RANGE module a third time and reset channel(s) ZERO and FULL SPAN to the original values as recorded in Steps #5 and Step #11. RESUME NORMAL OPERATION!

Alarm Trip Setup Using a Calibrator

Reference:
B-9742-K

Ch 1: 7 = C
8 = NC
9 = NO
Ch 2: 10 = C
11 = NC
12 = CO

pin 2 (-)

pin 6 (+)

1. The alarm trip set-points are normally field-calibrated after the system's process measurement calibration is completed. Periodic re-calibration of these modules is NOT normally required.
2. The alarm output controls two relays. Each relay has normally open and normally closed contacts. Output terminal (TB-B)
Channel 1: alarm pin7 (C), pin8 (NC) and pin9 (NO)
Channel 2: alarm pin10 (C), pin11 (NC) and pin12 (NO)
3. Temporarily remove the yellow wire from TB-A, pin 6. Do not allow it to touch other terminals or the chassis.
4. Connect the calibrator to TB-A pin 6(+) and pin 2 (-).
5. Select Status Display #1.
6. Set the calibrator until Status Display #1 indicates the desired setpoint value (3.00 to 0.00V = 0-100% of gage measurement output.)
7. Refer to drawing B-9742-K.
COUNTER-CLOCKWISE DECREASES SETPOINT
8. Adjust the SETPOINT control (TP1) for Channel 1 on the alarm trip until the alarm just occurs indicated by the red LED on keypad.
9. Set the hysteresis (HS1) to the desired value.
COUNTER-CLOCKWISE INCREASES HYSTERESIS.

The hysteresis starts at 5% of input span and adds about 1.5% of span each turn.
10. Repeat Steps 6-9 for Channel 2 using (TP2) and (HS2).
11. Disconnect calibrator and replace yellow wire input terminal TB-A at pin 6. RESUME NORMAL OPERATION!

ION Chamber Detector Signal Gain

Reference:
B-9742-K

If Low Reference counts are below 10,000 or above 20,000 counts, the signal gain may need adjusted. Follow this procedure:

RefLo xxxxxx RefHi xxxxxxx Det Counts xxxxxx

Diagnostic Test xxxx / 15000

1. Obtain empty vessel or low level condition.
2. Turn source ON.
3. Observe the "Diagnostic Test" status display.
4. Refer to drawing B-9742-K.
5. Adjust (R2) control on Input Board until the display reads between 10,000 and 20,000 counts

Isolate Problem

Most problems can be isolated to one of four overall causes. Eliminate each, one at a time, until the cause is determined.

Accessories

Begin by disconnecting potentiometers, recorders, and controllers from the system. Accessories, when operating properly, should have NO effect on the X96N display.

**Configuration/
Installation**

If the problem is not affected by the accessories, look for configuration changes that may have occurred since the Measurement System was installed.

When troubleshooting, it is important to consider the "Theory and Principles of Operation" information in Chapter 2. Process measurement is possible due to the principles of radiation transmission and absorption. The total mass of material between the radiation source and the detector (i.e. "measuring gap") will affect the final measurement. You must eliminate possible configuration/installation type of changes as the cause of your problem.

For example, consider these possibilities:

- Did the vessel insulation expand due to absorbed moisture during a wash down or absorbed process during a spill? This condition would increase the total mass of material in the "measuring gap" and would therefore indicate a higher level.
- Did something happen to compress the vessel insulation and therefore change the total mass of material.
- Could dust from process material or surrounding environment be collecting in "dead space" between the radiation source and detector? This would also indicate a higher level.
- Are changes taking place inside cooling or heating coils that carry liquid or vapor through the "active beam" of radiation?

Process Conditions

If configuration causes are eliminated, consider the process conditions themselves.

For example, entrained air or gas bubbles in the process material present pockets of minimum mass (i.e. low vessel conditions). If the amount of entrained gas remains constant, the system's calibration procedure will automatically allow for its effect. However, if the amount of entrained gas increases or decreases, the system will indicate lower or higher process levels.

Measurement Equipment

After eliminating the accessories, installation/configuration, and process conditions as possible causes of the problem, you will want to consider the measurement equipment. The X96N Microprocessor itself will be of great help in this troubleshooting procedure.

* If the problem is traced to the Detector, Chapter 6 contains technical information that may help to further isolate the problem.

* If the problem is traced to the Optional Accessories the information in Chapter 8 may assist you.

Using the X96N Status Displays to Troubleshoot

The X96N continuously monitors system operation. The following Status Displays may help to uncover the cause of system malfunctions.

ALL STATUS DISPLAYS:

Begin by ensuring the displays are operational. If all of the **display screens are blank** consider these possible causes:

- Power off - Check AC power line or fuses.
- Total system failure - Check for faulty power supply
Check for faulty CPU board.
- Faulty display board - Check for shorts at X96N:
TB-A pins 1-2 and 2-3
TB-B pins 1-2 or 3-4

If all display screens begin flashing:

- Radiological Discrimination may have detected outside source of radiation. Check Calibration Constant for Fault Count.

(blank display)

(flashing display)

STATUS DISPLAY #1:

Detector signal below calibration range
(UNDERRANGE):

level in = xxxxx.x
UNDERRANGE

- Process condition
- Empty vessel
- Calibration error
- Faulty input board

Detector signal above calibration range
(OVERRANGE):

level in = xxxxx.x
OVERRANGE

- Process condition
- Source OFF
- Calibration error
- Faulty input board

Detector signal erratic:

level in = ??????
???????

- Response time too fast - increase time constant.
- Dynamic tracking threshold too low - increase threshold.
- Radiation field varying independent of process - check to ensure source holder handle is secured in the ON position.

COUNTS STATUS DISPLAY:

Detector counts greater than Reference (low) counts:

Ref.Lo: 9350 RefHi xxxx
Det Count: 10500

- Level measurement below limits - check for calibration error.
- IF Ion Chamber Detector, check detector signal adjustments.

OUTPUT STATUS DISPLAY:

Output always 4.0 - Detector signal is below the calibration range:

Output ...: 04.00 mA
Max. Output 20.00 mA

- Process condition
- Calibration error
- Empty vessel/pipe

Output always 20.00 - Detector signal is above the calibration range:

Output 20.00 mA
Max. Output 20.00 mA

- Process Conditions
- Calibration error
- Source OFF

Erratic output:

Output ...: ?????
Max. Output 20.00 mA

- Response time too fast: increase time constant.
- Dynamic tracking threshold too low - increase threshold.
- Radiation field varying independent of process - check to ensure source holder handle is secured in the ON position.

**DIAGNOSTIC TEST DISPLAY:
(Second Value)**

No detector signal:

Diagnostic Test
-----/00000

- Faulty detector
- Faulty detector amplifier
- Faulty +/- 15V power
- Faulty cabling
- Source OFF

Detector signal above expected limit of counts:

Diagnostic Test
-----/32767

- Calibration error
- Faulty detector/detector amplifier

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Accessories/Options
Accessories/Options
Accessories/Options

B-4062-K

10.0 Accessories/Options
10.1 Auto-Cal

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 Continuous Level Monitor Systems that use these options.

Auto-Calibration Set-up

The auto-cal feature maintains the accuracy and repeatability of your measurement with little or no effort on the part of the operator.

When is Auto-Cal needed?

If interior walls of the vessel are prone to normal process build-up, the auto-cal feature is especially useful.

What does Auto-Cal do?

Auto-Cal provides a "shortcut" method of calibrating the Continuous Level Monitor by causing the X96N to go directly to the CALIBRATE LOW function. This eliminates the need for an operator to manually access the "calibrate" sequence of menus and keystrokes.

What 's required to use Auto-Cal?

In it's "semi-automatic" mode the Auto-Cal feature can be initiated manually with a pushbutton. In that case, the operator simply pushes a button in order to initiate the caibration procedure.

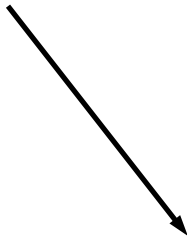
In it's truely automatic mode, Auto-Cal can be initiated by a signal from a point detector, strategically installed on the process vessel. In that case, the operator is completely by-passed.

What is a "Point Detector?"

Much like the "elongated" detector that is included in your Continuous Level Monitor, the "point" detector also senses the change in radiation field as the level of process changes.

In most cases Ronan's Remote Probe Detector/Remote Electronic Switch is used for this purpose. If this option is part of your Continuous Level Monitor System, the Outline and Interconnect Drawings are included in Chapter 10.

Optional
Pushbutton



Point Detector/
Electronic Switch



NOTE:

X96N Input Board Jumpering:
JU4 must be relocated from 2-3
to 1-2.

How is Auto-Cal Set-up?

Auto-Cal can be used ONLY AFTER the initial LOW and HIGH calibration is done. (See Chapter 5)

The AUTO CALIBRATION module is located in the customer-programmable functions.

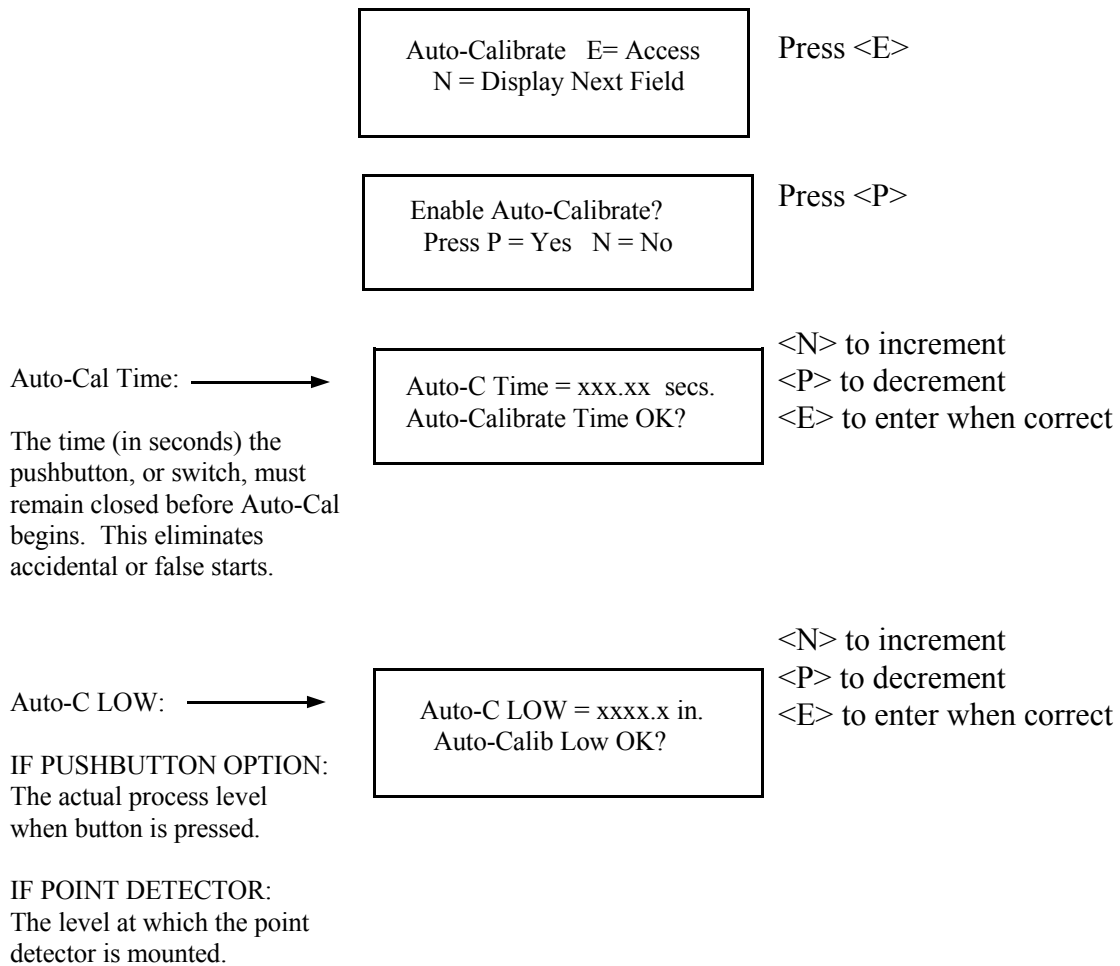
Begin by entering the access code:

Begin by entering the access code:

Press <E> LEDs flash

Press <N N P N N P>

Press <N> to reach AUTO CAL.



Once Auto-Cal is set-up, and the calibration is initiated (either by the pushbutton or the point detector/ electronic switch) the X96N display will inform you when an auto-cal is taking place.

Messages:

Auto-Calibrating
Low Level

TO ABORT: Press <N>

Auto Calibrate Aborted
Retry Auto Calibrate?

Press <N> to return to
Status Display #1
OR
Press <P> to continue
auto-calibrating

Open External Contact or
Disable Auto-Cal

This message indicates
the pushbutton is stuck, or
the external electronic
switch has failed.

Release the pushbutton
OR disable the external
switch to return to Status
Display #1.

Auto-Cal Fault Counts -
Retry Auto-Calibrate?

This message indicates an
Auto-Cal was attempted
with a full vessel or with
the source turned OFF.

Press <N> to return to
Status Display #1.

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