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January 25, 1994 Rev. 0 (1/94)

# NORTEC 19e$^{II}$ SPO 3196 EDDYSCOPE

Operation Manual

STAVELEY INSTRUMENTS
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# 1.0 Introduction

## 1.1 General Description

The Nortec-19e$^{II}$ SPO 3196 is a portable AC or DC powered eddy current non-destructive testing (NDT) instrument. It features a digital storage display on a high resolution 5 inch diagonal screen and contains the same sensitive eddy current signal processing circuitry as the original Nortec-19. New display and data storage features provide more convenient and reliable operation, as well as better reporting capabilities for the inspector.

The Nortec-19e$^{II}$ SPO 3196 is designed to meet virtually all NDT eddy current application requirements including first and second layer crack detection, conductivity testing, coating and plating thickness and tubing inspection. It can display the current test and a reference memory on screen simultaneously for accept/reject comparison. Utilizing the optional dual frequency capability, the Nortec-19e$^{II}$ SPO 3196 can combine the signals from the two frequencies to reduce many unwanted variables in an inspection. State of the art circuitry and dual microprocessors provide a laboratory quality instrument in a portable package.

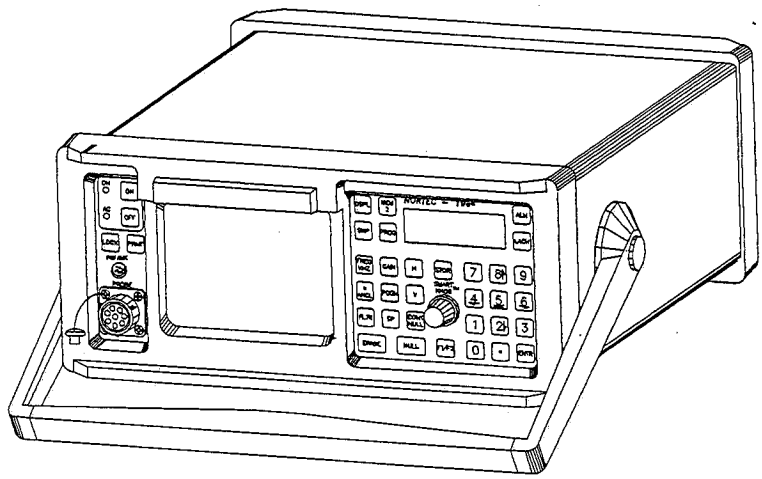


**Figure 1-1** *Nortec-19e$^{II}$ SPO 3196 Eddyscope*

Twenty memory locations are available to store eddy current data using either a "snapshot" (freezing of the current display) or by "memorizing" the movement of the eddy current impedance spot for any period from 2.5 to 60 seconds. This data may then be recalled to the screen, printed out, used as an on screen reference display, or downloaded to a computer for further processing or archiving.

The Nortec-19e$^{II}$ SPO 3196's wide frequency range of 100 Hz to 6 MHz allows for applications ranging from detection of large cracks in 1 inch aluminum to minute flaws in super alloy aircraft materials.

Utilizing digital controls, the Nortec-19e$^{II}$ SPO 3196 is programmed via the keypad and the SmartKnob™ on the front panel. The entire instrument may be controlled from an external computer as well. The construction of the Nortec-19e$^{II}$ SPO 3196 makes it operational under a wide range of environmental conditions.

The Nortec-19e$^{II}$ SPO 3196 is a multi-purpose instrument, using absolute, differential, comparison, or reflection coils. Unique and useful alarm features include 1, 2, or 3 alarm boxes, a polar (circular) alarm, a "pie" alarm, and an arbitrary polygon alarm to process complex signals. Other features include selectable continuous electronic nulling and high/low pass filtering for high speed automated testing. Up to 100 programs can be stored and then recalled at a later date. RS-170 (NTSC compatible) video output of the eddy current display enables external viewing on a monitor or television set. The same signal may be used as a powerful documentation tool when used with a videocassette recorder (VCR).

The RS-232 compatible serial port allows an external computer to control the instrument and read (download) any information stored in it. A compact, battery powered printer is available that allows printout of any currently displayed screen or stored information.

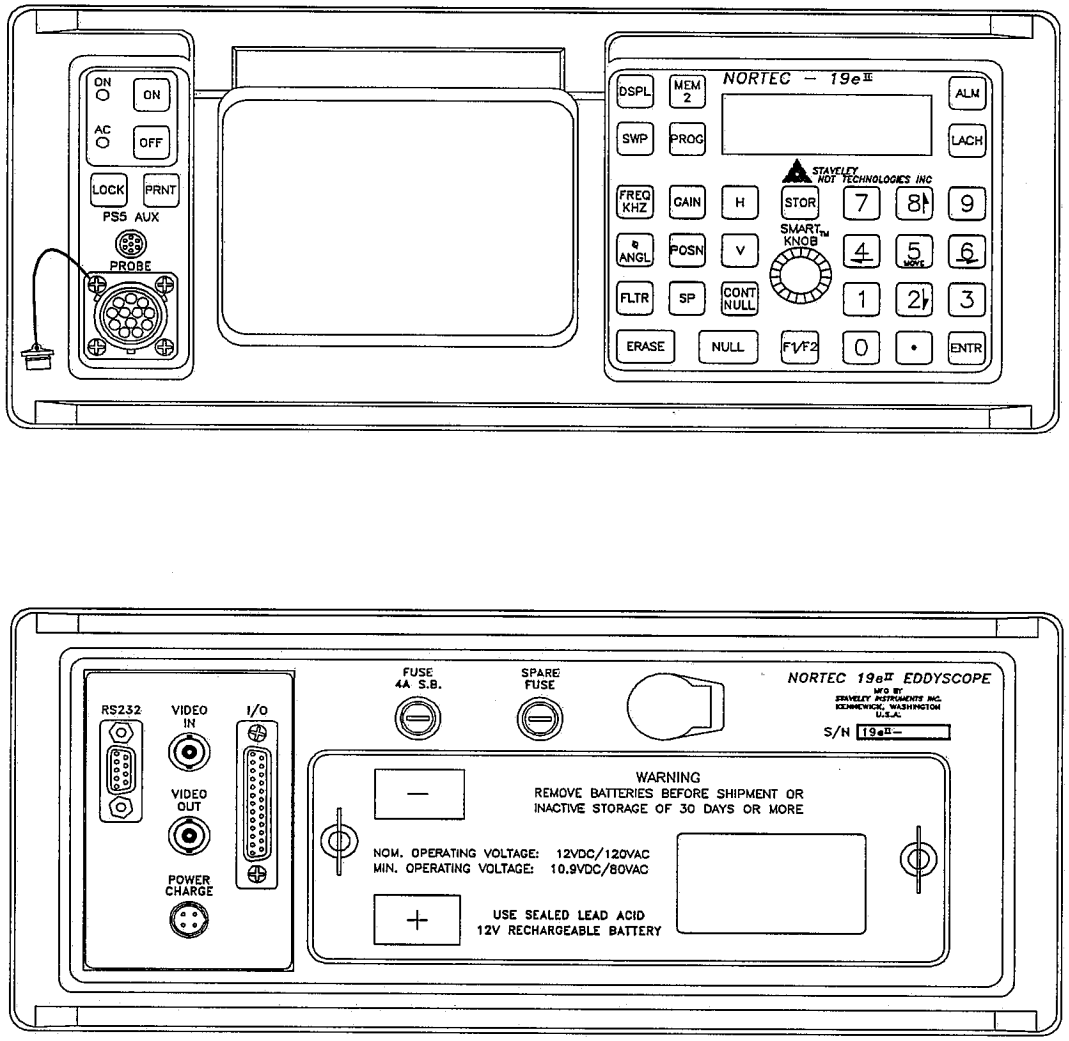



**Figure 1-2** *Nortec-19e$^{II}$ Front and Rear Panels*

A compact handheld eddy current scanner (model PS-5, SPO 3196) powered by the instrument is available for hole inspection. In this scanner mode, the instrument features an algorithm that holds the displayed scan steady regardless of changes in scanner operation speed, and an accurate reliable flaw alarm.

The front panel of the Nortec-19e$^{II}$ SPO 3196 uses a membrane keyswitch panel that resists contamination and a SmartKnob™ that streamlines parameter adjustments. The probe connector is configured to allow use for nearly every type of eddy current probe as well as the PS-5 scanner.

Access to the internal battery is available through the rear panel battery box, which uses quarter turn screws for reliability and ease of access.

## 1.2 Comparison of the Nortec-19e$^{II}$ SPO 3196 with the Nortec-19e and the Nortec-19

The Nortec-19e$^{II}$ SPO 3196 is the latest refinement in the Nortec-19 family of eddy current instruments. Thoroughout its lifetime, the Nortec-19 has been a stable, high performance eddy current impedance plane testing platform. To this basic performance, the Nortec-19e and 19e$^{II}$ SPO 3196 add a wealth of features for processing, display, and storage of the eddy current signal. On the following pages is a table comparing the major features of the Nortec-19 family of instruments.

| Feature | Nortec-19 | Nortec-19e | Nortec-19e$^{II}$ SPO 3196 |
|---|---|---|---|
| Alarms | Single box alarm | Impedance plane: multiple box alarms, polar alarm, pie alarm, polygon alarm, sorting gate Sweep: threshold (high/low) alarm | Same as Nortec-19e |
| Alarm outputs | Single TTL compatible alarm output | 6 outputs for use with multiple alarms and part sorting | Same as Nortec-19e |
| Program storage | 50 stored programs | 100 stored programs alphanumeric naming | Same as Nortec-19e |
| Data storage | None | 20 stored data areas frozen or capture/replay alphanumeric naming | Same as Nortec-19e, plus waterfall storage and playback in multiple modes |
| Memory 2 (reference memory) | Single reference memory; volatile (erases when power is turned off) | Any of the 20 stored data areas may be used for reference memory; nonvolatile | Same as Nortec-19e, plus single lines from waterfall storage may be used for Memory 2 |
| Computer/printer interface | None | RS-232C, 9600 baud interfaces to computer, terminal, and printer | RS-232C, 1200 to 38400 baud (9600 default) interfaces to computer, terminal, and printer |
| Printout | Video printer option only | Video and serial printer options, serial printer recommended | Same as Nortec-19e |
| Display | 256 x 256, no text | 320 x 240, text sidebar | Same as Nortec-19e |
| Recorder output/input | Recorder output and input allows use of FM recorders (tape in) | Recorder output only. Use capture/replay or video recorder for signal playback | Same as Nortec-19e, plus optional video playback allows video recorder playback on instrument screen |
| Clock | None | Time of day clock for data logging purposes | Same as Nortec-19e |
| High-pass filter selection | 0 Hz, 2 Hz, 4 Hz, 10 Hz, 20 Hz, 40Hz, 100 Hz, 200Hz | Same as Nortec 19 | Continuous from 0 to 500 Hz in 1 Hz steps |

## 1.2 Comparison of the Nortec-19e$^{II}$ with the Nortec-19 and Nortec-19e

| Feature | Nortec-19 | Nortec-19e | Nortec-19e$^{II}$ SPO 3196 |
|---|---|---|---|
| Low-pass filter selection | 10 Hz, 30 Hz, 100 Hz and 500 Hz | Same as Nortec 19 | Continuous from 10 to 500 Hz in 1 Hz steps plus wideband setting |
| External sweep | Displayed as a series of dots. No compensation for speed variations (binding) | Continuous line display that compensates for scanner speed variations | Same as Nortec-19e |
| Auto sweep | Erases at the end of each trace | Continuous erase that removes information only where the data will be displayed next | Same as Nortec-19e |
| Waterfall display | None | None | Adjustable from 5 to 64 sweeps |
| Number of points per sweep | 256, fixed by screen size | Fixed at 120 | Adjustable: 60, 120, 240, 480 |
| Waterfall display modes | None | None | Displays waterfall highlight in either sweep or impedance plane mode |
| Power-up self test | None | None | Checks all functional blocks of electronics |
| RA Scanner Software | Fixed at 1200 RPM | Fixed at 1200 RPM | Adjustable from 1000 to 1500 RPM |
| PS5 Scanner | No compatibility | Not functional on the unit | Adjustable from 40-200 RPM |

## 1.3 Specifications

*Frequency Range*

F1 = 100Hz to 6MHz. F2 (dual frequency Nortec 19e$^{II}$ SPO 3196) must be an exact division of F1 (1/2, 1/4, 1/8, 1/16), but never less than 100Hz

*Sensitivity*

Adjustable to 100 volts per ohm, MID probe drive

*Display*

5 inch digital storage, resolution 320 (H) X 240 (V). Data area is a 240 X 240 matrix, RS-170 (NTSC compatible) video monochrome monitor. A highlighted spot on the screen shows the current impedance position. Software controlled 10 x 10 graticule that may be disabled. Includes a camera bezel. Either F1, F2, F1-F2 or F1+F2 may be displayed. A sidebar on the right side of the screen shows the most important current instrument settings. Alphanumeric text is also displayed on the screen.

*Variable Persistence*

Variable persistence from 0.5 to 20 seconds is available, or the operator may select a complete, periodic screen erase at intervals of up to 1 minute.

*LCD Readout*

LCD display, 2 lines of 16 characters each, used when adjusting test parameters and for displaying status.

*Sweep*

0.005 to 4.0 seconds per division or externally triggered sweep. In external sweep, display automatically adjusts to speed of scanner. Manual or auto erase is selectable.

*Alarms*

Alarms available in 5 modes on impedance plane display. All alarms may be individually set to trigger when the spot enters the alarm area (positive) or is outside the alarm area (negative).

Alarm modes, impedance plane display:

1 to 3 independent box gates

1 polar (circular) alarm that may be positioned anywhere on screen.

1 "pie" shape alarm that may be set to any starting and ending radial position.

1 polygon alarm, using 8 sides that may be set to most arbitrary values.

1 sorting gate that divides the screen up into 9 quadrants, with the center quadrant designated the "good" position.

Alarm mode, sweep display:

1 high-low threshold alarm, positive or negative polarity

*Low Pass Filter*

10 Hz to 500 Hz with 1 Hz increments, plus wideband setting

*High Pass Filter*

0 Hz to 500 Hz with 1 Hz increments

*Flaw Response*

0 to 500 Hz nominal

| | |
|---|---|
| *Rotation* | Variable from 0 to 360° in 1° steps |
| *Adjustable Gain* | 0 to 90.0 dB, Readout in 0.1 dB steps, Horizontal and Vertical gain may be adjusted separately or together. |
| *Probe Types* | Differential, absolute, reflection, I.D., O.D., sliding |
| *Probe Drive* | Adjustable in 3 steps (low, medium, high) corresponding to 2, 6, and 12 volts peak to peak nominal voltages with a ±0.5 volt tolerance. |
| *Null* | Three-stage digital null, electronic, front panel selected continuous null with 10 second time constant. |
| *Program Storage* | Up to 100 instrument setups may be saved and recalled. All programs record the date and time they were stored, and allow an alphanumeric name for each storage location of up to 26 characters. Instrument will maintain program storage at least 2 weeks with the battery removed. |
| *Data Storage* | Up to 20 data storage locations may be saved and recalled. These locations may store any combination of frozen screens or movement of the impedance spot. The date and time of storage is recorded and available for the operator to view, and each location may be named with up to 26 characters. Spot movement may be recorded from periods of 2.5 to 60 seconds, with longer times giving lower resolution of movement. Any stored data may be downloaded to an external computer, printed out, or used as a "Mem 2" reference display. |
| *Recorder Outputs* | Vertical and horizontal outputs, ±5 volts into 1K ohm load, 1 volt (±0.10 V) per division. |
| *External Null/Erase* | Null and erase are externally controllable, through rear panel "D" connector. |
| *Video Output* | RS-170 monochrome (NTSC compatible) |
| *Alarm Outputs* | 5 TTL compatible active high alarm outputs. 1 TTL compatible on/off screen signal, high for on screen (impedance plane only). Each output is capable of supplying 10mA. |
| *Serial Interface* | RS-232 compatible serial interface, adjustable from 1200 to 38400 baud, with 9600 baud as the default setting. Communicates with external computer or serial printer. All instrument parameters except for power on and off may be controlled through the serial interface. In addition, all data and program storage locations are accessible through this interface. |
| *Printout* | Hard copy printout available with optional serial printer. Text on printout may be customized by the user from either the front panel or an external computer. |
| *Power Supply* | 12 volts DC, gelled lead-acid battery with a full 8 hour battery life. External plug in charger runs on 120 or 240 VAC 50/60Hz, and can power instrument as well as charge batteries. |

| | |
|---|---|
| *Hazardous Area Operation* | Safe operation in explosive atmospheres when in DC mode (battery), up through Class I, Division 2, Group D, as defined by the National Fire Protection Association Code 70 (NFPA 70), Section 500 and tested using MIL-STD-810E, Method 511.3, Procedure I. |
| *Operating Temperature* | 0° F (-17° C) to 130° F (54° C) |
| *Storage Temperature* | 0° F (-17° C) to 150° F (66° C) |
| *Humidity* | Safe operation in exposure to Class 3 Temperature/Humidity environment (-10° C to 55° C at 95% +/- 5% Relative Humidity) |
| *Altitude (Max Operating)* | 7,280 feet above sea level |
| *Altitude (Max Non-operating)* | 40,000 feet above sea level |
| *Size* | 15 inches deep, 5-1/2 inches high, 12 inches wide |
| *Weight* | 19 pounds |
| *Chassis* | Modular aluminum construction, protected by high impact polyurethane bumpers |
| *Waterfall Display* | Mapping display variable from 5-64 sweeps |
| *Display or Store* | 60, 120, 240, 480 selectable points/sweep,<br>Depth and phase angle adjustable on recall,<br>Single sweep on impedance plane display,<br>Sweep display or multisweep waterfall |

**PS-5 Specifications**

| | |
|---|---|
| *Probe Types* | Absolute, differential, and reflection (single and multiple coil) |
| *Signal Coupling* | Axial rotary slip rings |
| *Noise* | 12:1 minimum peak to peak signal to maximum peak to peak noise |
| *Modes* | Translate/rotate only |
| *Travel* | Adjustable 0 to 1-1/2 inches |
| *Extension Limit* | Variable from 0 to 1-3/8 inches, visible adjustment window, and automatic stop |
| *Retraction Limit* | Zero adjust -1/8 to +3/8 inches, and automatic stop |
| *Null* | Three-stage digital null |
| *Erase* | Screen erase |
| *Translation* | +/-0.025 inches per revolution (0.0625 inches per second @ 150 RPM) |
| *Direction Control* | Forward/Stop/Reverse |

| | |
|---|---|
| *Speed* | 40-200 RPM set from instrument front panel, accurate to +/-5%, repeatable to +/-5% |
| *Power Requirements* | Powered by the Nortec 19e$^{II}$ instrument using a special circuit board.<br>Motor: 2-26 volts DC, 15 watts maximum<br>Electronics: 12 Volts |
| *Hazardous Area Operation* | operation in explosive atmospheres when in DC mode (battery), tested using MIL-STD-810E, Method 511.3, Procedure I. |
| *Operating Temperature* | 0° F (0° C) to 130° F (54° C) |
| *Storage Temperature* | 0° F (-17° C) to 150° F (66° C) |
| *Humidity* | 0% to 95% relative humidity |
| *Altitude (Max. Operating)* | 7,280 feet above sea level |
| *Altitude (Max. Non-operating)* | 40,000 feet above sea level |
| *Size* | 5 inches deep, 2-1/2 inches high, 1-7/8 inches wide |
| *Weight* | 2 lbs |
| *Chassis* | Stainless steel construction |

## 1.4 Power Requirements

As a fully portable inspection instrument, the Nortec-19e$^{II}$ SPO 3196 relies on a battery as a primary source of power. The 12 volt "Gell Cell" (lead-acid) battery is located at the rear of the unit. The battery is conveniently accessed by releasing two quarter turn screws and removing the battery box on the rear panel of the instrument.

A model LA12CE Battery Charger/Eliminator unit is provided with the Nortec-19e$^{II}$ SPO 3196 that recharges the battery and allows the instrument to be operated from AC line power. The charger unit auto senses 120 or 240 (nominal) volts AC line power, at 50 or 60 Hz.

The condition of the lead-acid type battery used in the Nortec-19e$^{II}$ SPO 3196 is monitored by the charger. Charge cycles are automatically initiated by the charger. A fully discharged battery will require up to 14 hours for a complete charging cycle.

Prior to connecting the charging unit to line voltage, verify that the correct LED is on. A yellow charge light on the LA12CE will glow for the duration of a charge cycle. The charge lamp on the top surface of the charger will illuminate for a battery placed on the charger case, while the indicator on the side of the charger case will illuminate while charging a battery installed in the instrument. The lamp will extinguish only when the battery is fully charged, however a partially charged battery may provide over 6 hours of operation.

The LA12CE Charger/Eliminator is supplied with one charging cable and an AC power cord.

**WARNING**

**Use only the charging cables provided with the instrument.**

**Note**

The LA12CE charger/eliminator will also work with the instrument using the charging cable supplied with the LA12CE charger/eliminator.

## 1.5 Operating Environment

The Nortec-19e$^{II}$ SPO 3196 is designed as a portable instrument, and as such, requires no special site preparation before operation. When operated, the instrument should be firmly supported on its tilt handle to prevent damage due to a fall. The unit should be protected as much as possible from water or chemical splashes, rapid temperature changes, and should be operated away from large electrical equipment that may interfere with the operation of internal circuitry.

## 1.6 List of Items Furnished

The Nortec 19e$^{II}$ SPO 3196 package includes the following items.

* 2 12V batteries, 7.2AH
* 1 Power cord line, 7 ft.
* 1 Cable, charger to instrument
* 1 Carrying case, nylon
* 1 Poly bag, 12 x 15 w/logo
* 1 Operation Manual
* 1 Battery charger, LA12CE
* 1 PS-5 Scanner
* 1 Probe, Eagle adapter
* 1 Probe, BNC adapter

## Options

A wide variety of options are available for the Nortec-19e$^{II}$ SPO 3196. A short listing of some of these options follows. For specific needs not listed below, contact your Staveley Instruments sales representative.

**Remote Null and Erase** (part number 9506320). A pushbutton operated device that allows the operator to null and erase the instrument from a distance of up to 8 feet.

**Protective Carrying Cover** (part number 1006264). This convenient carrying bag may be used to transport the instrument and accessories.

**19/RA Scanner** (part number 9008791). The 19/RA is a lightweight, high speed, non-indexing, low profile scanner that may be used for bolt hole and first layer fastener inspection.

**Kodak Diconix Printer** (part number 0813351). Used for printing out stored data and programs, and for screen printouts. Lightweight and battery powered. Requires part number 9116580 interface cable. A 220 volt adapter (2113631) is required for overseas use.

**Nortec Detachable Probe Kit (Burndy)** (part number 9213010). This probe kit contains a variety of eddy current probes using convenient detachable connectors. It also includes a 6 sample conductivity standard and a test block. The entire kit is contained in a lightweight carrying case.

## 1.7 Statement of Inspection and Warranty

This statement covers new instruments, electro mechanical devices, probes, transducers, and supplies manufactured and sold by Staveley NDT Technologies (hereinafter referred to as SNDT) to an end user in consideration of the purchase price paid.

**Inspection and Unpacking**
All cartons should be opened and inspected upon receipt. The cartons and contents should be inspected for any signs of damage that may have occurred during shipment. If damage is noted, contact the carrier and retain the damaged shipping materials until an inspection can be performed by a representative of the carrier. With the exception of the LA12CE Battery Charger/Eliminator Unit and external accessories such as probes and scanners all Nortec-19e$^{II}$ SPO 3196 options are installed before the unit is shipped. Check the contents of the carton or cartons against the packing list to ensure that all accessories ordered have been received.

If the instrument is shipped frequently from site to site, the packing carton and cushioning can be retained. If not, discard the materials after the unit is determined to be operational.

**Limited Warranty**
SNDT warrants its instruments to be free from defects in materials and workmanship for a period of 12 months from the date of shipment, under conditions of normal use and service.

SNDT warrants its electro mechanical devices to be free from defects in materials and workmanship for a period of 90 days from the date of shipment under conditions of normal use and service.

SNDT warrants unused eddy current probes and ultrasonic transducers to be free from defects in materials and workmanship for a period of 90 days from the date of shipment.

Batteries and other wear-out items are excluded from this warranty.

Specifically excluded from this warranty is equipment that becomes defective due to: a) normal wear, b) damage resulting from accident, misuse, abuse, or negligence, and c) attempts to modify, repair or perform internal adjustments by parties other than authorized SNDT service personnel.

SNDT reserves the right to charge on a time and material basis for repairs that are necessitated by a, b, and c above. Seals may be applied in critical locations on the equipment to protect the integrity of factory calibration and QA acceptance. The "tamper-proof" design of these seals renders them fragile, so care should be taken not to break or remove these, as this will void the warranty.

If any of the above items should prove defective within the warranty period, SNDT will, at its option, repair or replace them without charge, FOB the nearest SNDT Service Center. Our policy is to accept only repaid shipments to our authorized service centers. Repair at customer facilities will be quoted as requested.

SNDT makes no other warranty of any kind whatsoever and there are no implied warranties of merchantability or fitness for a particular purpose. SNDT shall not be liable for any failure of the equipment or equipment operators to discover defects in components being tested with such equipment or for any consequential damages arising from the purchase or use of the equipment. In no event shall damages for breach of warranty exceed the purchase price paid to SNDT hereunder.

SNDT reserves the right to modify or change the specifications of its products without notice and without incurring any responsibility for modifying previously manufactured products.

## 1.8 Manufacturer Recommendation for Service

Staveley recommends the instrument should be checked and factory performance certified after the first year of service, and thereafter on a schedule governed by MIL-STD-45662A.

## 1.9 Returning Instruments For Service

If your instrument is in need of service, either under warranty or after your warranty period has expired, please contact the Staveley Service Center nearest you prior to returning the instrument to have a RMA number assigned. This will ensure that the instrument is repaired and returned to you as quickly as possible. If a return of this instrument is necessary, use of the original container is recommended for best shipping protection.

**Staveley NDT Technologies, Inc.**
Authorized Service Centers

For **PRIORITY SERVICE**, the following telephone number will put you in touch with the Service Center best capable of meeting your requirements.

**FOR PRIORITY SERVICE**
**PLEASE CALL**
**(513) 671-2428**

**CINCINNATI TECHNICAL CENTER**
1329 E. Kemper Road
Bldg. 400, Suite 4222
Cincinnati, OH 45246
(513) 671-6951
(513) 671-6950 Fax

**PHILADELPHIA TECHNICAL CENTER**
188 Lincoln Hwy
Suite 201
Fairless Hills, PA 19030
(215) 945-1904
(215) 945-2168 Fax

**SAN ANTONIO TECHNICAL CENTER**
4243 Piedras Drive East
Suite 150
San Antonio, TX 78228
(512) 737-1677
(512) 737-1678 Fax

**PITTSBURGH TECHNICAL CENTER**
1400 S. Braddock Avenue
Pittsburgh, PA 15218
(412) 371-3335
(412) 371-2240 Fax

**KENNEWICK TECHNICAL CENTER**
421 N. Quay
Kennewick, WA 99336
(509) 735-7550
(509) 783-8526 Fax

**DETROIT TECHNICAL CENTER**
4000 Crooks Road
Suite 205
Royal Oak, MI 48073
(313) 288-6850
(313) 288-6851 Fax

**BETHEL TECHNICAL CENTER**
25 Francis Clarke Circle
Bethel, CT 06801
(203) 792-4969
(203) 792-6881 Fax

**LOS ANGELES TECHNICAL CENTER**
9860 Owensmouth
Suite 3
Chatsworth, CA 91311
(818) 718-8820
(818) 718-4097 Fax

## 1.10 Warning Message

The microprocessor constantly monitors the frequency stability of the Nortec 19e$^{II}$ SPO 3196 instrument. In the event the frequency exceeds its tolerances, the instrument will interrupt operation and display the following message on the CRT:

```
******************
*  SYSTEM ERROR  *
*      PLL       *
******************
```

The LCD will display the text * *SYSTEM ERROR* *, *ENTR to continue*. Testing may be continued at this point by pressing the [ENTR] key. However, the instrument should be returned for repair as soon as possible.

Once the warning message is bypassed, no further checking on the status of the frequency will be performed until a new frequency is selected. Then, if the frequency is again out of tolerance, the error message will re-appear.

## 1.11 Performance Check Sheet

The following is a list of the sequential steps for a quick check-out performance for Nortec 19e$^{II}$ SPO 3196.

Turn on the instrument:

1. No power, battery operated

   - Replace the fuse
   - Recharge the battery
   - Replace the battery

2. No power, AC operated

   •• AC light off

      - Reset the breaker
      - Replace the charger

   •• AC light on

      - Refer to the Troubleshooting guide on the power supply board

3. No video display or LCD

   - Refer to Troubleshooting information

4. Instrument shuts down shortly after power is switched on

   - Refer to Troubleshooting information

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# 2.0 Initial Inspection and Checkout

## 2.1 Preparation For Use

After the Nortec-19e$^{II}$ SPO 3196 has been unpacked and inspected, a test should be made of the unit's basic operation. This initial test will both determine that the unit is operating properly and allow an operator to become familiar with the basic functionality of the instrument.

The Nortec-19e$^{II}$ SPO 3196 is shipped from the factory with a battery installed. Upon delivery of the instrument, the battery should have an adequate charge to power the unit up. If the instrument will not come on when the [ON] button is pressed, refer to Section 1.4, *Power Requirements*, for AC operation of this unit.

The instrument checkout is divided into 2 sections. *Basic Operation* checks to see if the instrument has basic functionality without attaching a probe. *Impedance Plane* verifies that the instrument works properly on a conductivity standard using a probe and standard from the optional *Nortec Detachable E.C. Probe Kit* (part number 9213010).

Only the basic steps necessary for instrument checkout are outlined here. For further details on various functions of the instrument, refer to Section 3, *Control Descriptions* and Section 4, *Instrument Operation*. Section 5, *Application Examples*, gives many illustrations of actual tests that may be done with the Nortec-19e$^{II}$ SPO 3196.

### Basic Operation

Apply power to the unit by pressing the [ON] button. The LCD screen should display a Sign-On Sequence similar to the one shown in *Figure 2-1* (dual frequency instruments will display *DUAL FREQUENCY* on the LCD). The CRT should momentarily display a Sign-On Screen similar to *Figure 2-2*. Note that the revision of the software for the instrument controller microprocessor may be read on the LCD, and the software revision for the CRT microprocessor may be read on the CRT during this time. The software revisions in your instrument may differ, as periodic revisions are made to improve performance.

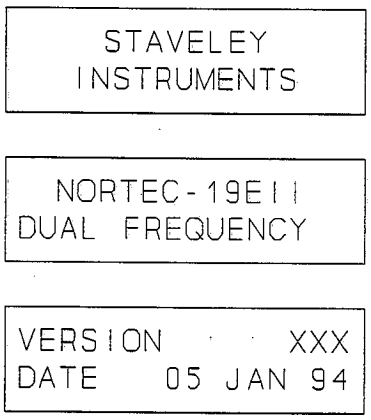



**Figure 2-1** *Sign on sequence for LCD*

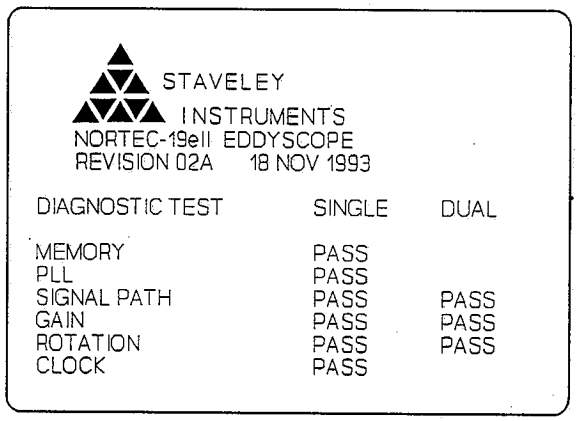



**Figure 2-2** *CRT Sign-On Message Screen*

After the eddy current signal screen appears on the CRT, perform a complete instrument reset using the procedure below (SP98). **CAUTION-If this is not the initial receipt of the instrument from the factory, check to be sure that stored data, programs, and customized report are not needed, since they will be erased in this step. If unsure, an SP99 reset may be substituted here, which will enter default settings but not erase the instrument memories.**

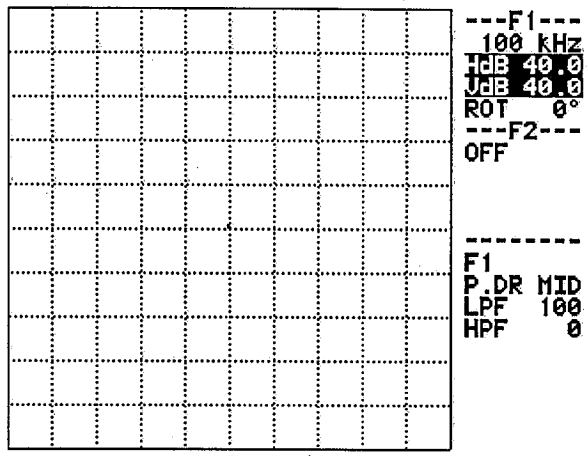



**Figure 2-3** *Eddy Current Screen After SP98 or SP99*

Press [SP], [9], [8], then [ENTR] to enter the SP98 routine. Perform the reset by pressing the [ENTR] key one more time. The sign-on messages will appear again momentarily, then the eddy current screen with default settings will appear as shown in *Figure 2-3*. At this point the GAIN function may be read on the LCD which indicates the current gain level. The gain parameters for F1 are also highlighted on the CRT sidebar.

Rotating the SmartKnob™ clockwise increases both horizontal and vertical gain, counterclockwise decreases gain with a range from 0.0 to 90.0 dB.

Press [FREQ KHZ], then press [.], [1], and [ENTR] on the numeric keypad. F1 should change to .10 kHz (100 Hz). Now, press [3], [0], [0], [0], and [ENTR] on the numeric keypad. F1 should change to 3000 KHz (3 MHz).

This concludes the checkout of basic instrument operation. If you have the probes and standards listed in the next segment, or ones that are similar, you may proceed to *Impedance Plane*. Otherwise, refer to Section 3, *Controls Description*, and Section 4, *Instrument Operation* for more details of the operation of the instrument. Section 5, *Application Examples*, provides several illustrations of actual tests that may be performed with the Nortec 19e$^{II}$ SPO 3196.

### Impedance Plane

In addition to the Nortec-19e$^{II}$ SPO 3196, this phase of the checkout uses the following items taken from the *Nortec Detachable E.C. Probe Kit* (part number 9213010):

| | |
|---|---|
| **Probe** | 100 KHz surface probe, Nortec S/100 KHz-500 KHz/.44 |
| **Standard** | Nortec Conductivity Samples (set of six) |

Attach the probe to the PROBE connector on the front panel and apply power to the instrument.

Perform an instrument parameter reset using SP99. This will not erase any stored data or programs, only the current test parameters. Press [SP], [9], [9], then [ENTR]. Press [ENTR] one more time to perform the reset.

Press [SP], [2], [ENTR]. Rotate the SmartKnob™ counterclockwise until the LCD reads *PROBE DRIVE LOW*.

Press [NULL] to move the dot to the middle of the screen.

Press [ERASE] to clear the screen.

Press [$\phi$ ANGL]. Then, while holding the probe on the ferrite sample from the standard, turn the

SmartKnob™ until the dot is directly above the center of the screen.

Press [GAIN]. Now, hold the probe on the 7075-0 aluminum sample, and turn the SmartKnob™ until the dot just touches the bottom of the screen.

Remove the probe from the sample, then press the [ERASE] key to clear the CRT again. Now, touch the probe to the middle of the samples, each in turn for all 6 samples. The CRT display should be similar to *Figure 2-4.* It is called a Conductivity Curve and shows how the instrument is affected by lift-off and conductivity of various materials.

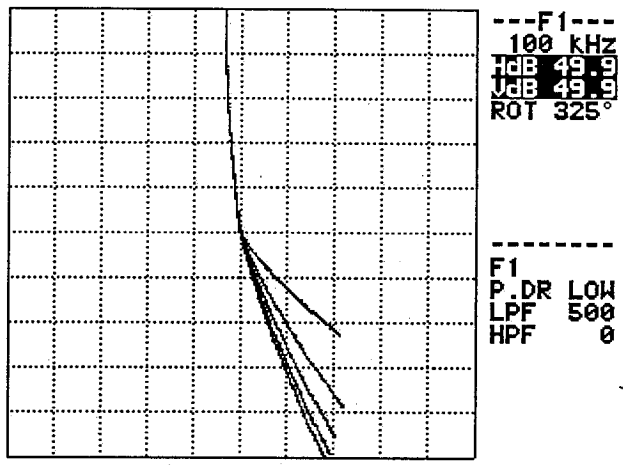



**Figure 2-4** *Conductivity Curve*

This concludes the impedance plane operational checkout. Refer to Section 3, *Control Descriptions*, and Section 4, *Instrument Operation* for more details regarding the operation of the Nortec-19e$^{II}$ SPO 3196. Section 5, *Application Examples*, provides examples of actual tests that may be performed with the instrument.

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# 3.0 Control Descriptions

## 3.1 Introduction

The Nortec-19e$^{II}$ SPO 3196 has many features designed to ease the job of eddy current testing and recording results. Although the large set of features may at first seem imposing, great care has been taken in the design of the controls of the instrument to simplify operation. Keys are grouped according to function, and all similar functions operate in a nearly identical fashion.

This section describes the names and general functions of each of the front panel controls, displays, and indicators. For details regarding the operation of the instrument, refer to Section 4, *Instrument Operation*.

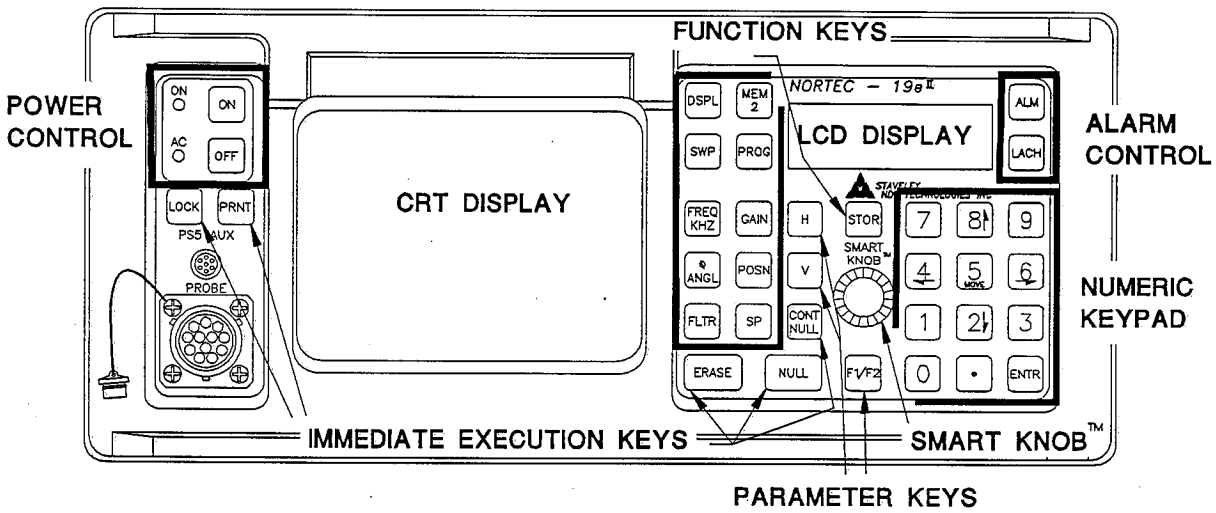



**Figure 3-1** *Front Panel Control Groups*

All displays, controls, and indicators are located on the front panel. As shown above, the front panel of the instrument is divided into 9 functional control groups:

- CRT Display
- LCD Display
- Power control
- Function keys
- SmartKnob™
- Numeric keypad
- Parameter keys
- Immediate execution keys
- Alarm control keys

Each group is described in more detail on the following pages.

## 3.2 CRT Display

The CRT Display (*Figure 2*) displays the eddy current signal. Also shown on the right side of the sidebar, are some important parameters of the test, such as frequency, gain, rotation, and filtering. When required, it displays full screen text as well. On dual frequency instruments the operating parameters for F2 (frequency 2) are displayed below those of F1.

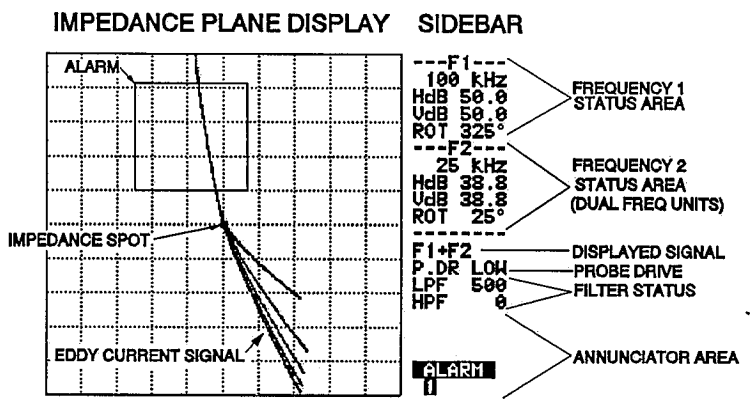



**Figure 3-2** *CRT Display*

In normal operation, the left side of the display shows the eddy current signal and is divided into 10 graticule divisions in both directions. It has been designed to be square, so that the eddy current signal will show the same amount of movement regardless of the setting of signal rotation. The graticule may be turned off to view the signal and alarms more clearly. Alarms cause an annunciator in the lower right of the screen to display.

Whenever a parameter that is shown on the sidebar is selected for adjustment, it will be highlighted in inverse video.

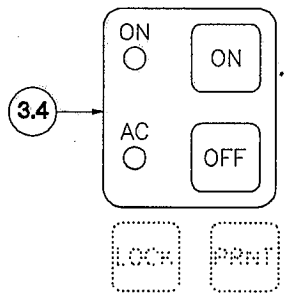
## 3.3 LCD Readout

The LCD Readout is a multi-purpose text display that shows an instrument function together with the value of that function. As soon as a function key is pressed, the LCD will display the function name and its current setting.

A backlight feature (*SP6*) allows the user to turn on the LCD backlight for better visibility in low light conditions. Note that when the backlight is turned on, it will reduce the length of time the instrument will run on battery power.

## 3.4 Power Control

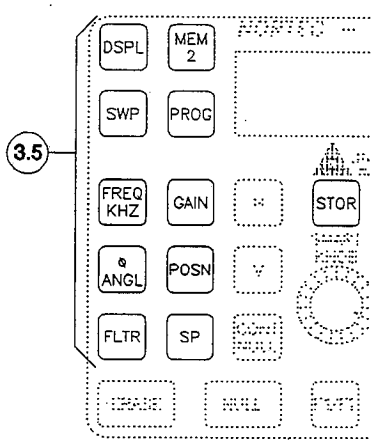
The power control group consists of an [ON] and [OFF] buttons, an *ON* indicator that is illuminated whenever the instrument is turned on, and an *AC* indicator that is lit whenever the instrument is receiving power from an external Battery Charger/Eliminator.




Pressing the [ON] button turns the instrument on and lights the ON indicator. Pressing the [OFF] button turns the instrument off. Pressing the decimal point key [•] while powering-up the unit resets the instrument. To connect the battery charger/eliminator, refer the Section 6, *Rear Panel Connections*.

## 3.5 Function Keys

The function keys are used to select an operating function of the instrument. These keys are normally pressed first before changing values using the SmartKnob™, numeric keypad, and parameter keys.




The most commonly used functions are direct entry functions. This means that when the key is pressed, the parameter may be updated immediately by simply rotating the SmartKnob™ or entering the value on the numeric keypad. Other functions, such as SP, are used to gain access to many instrument operating parameters. These parameters are less often used functions.

The functions described by each key are as follows:

[DSPL] Sets the display mode on dual frequency instruments. This can be *F1*, *F2*, *F1+F2*, or *F1-F2*.

[MEM 2] Turns the non-erasable reference screen on and off, and allows selection of any of the 20 memory locations for the reference screen.

[SWP] Changes the operating mode of the instrument between impedance plane and auto triggered or externally triggered sweep.

[PROG] Allows access for storage and recall of 100 test setups, and recall of the test setups used when recording to the 20 memory locations.

[FREQ KHZ] Sets the operating frequency of the instrument. On dual frequency instruments, will set the frequency of F1 or F2, depending upon which one is selected with the [F1/F2] key.

[GAIN] Sets the gain of the instrument. On dual frequency instruments, will set the gain of F1 or F2, depending upon which one is active using the [F1/F2] key.

[$\phi$ ANGL] Sets the phase angle (rotation) of the signal. On dual frequency instruments, will set the phase angle of the active frequency.

[POSN] Sets the null position of the eddy current signal.

[FLTR] Enables setting of the low pass and high pass filters.

[SP] Allows access to the Special functions of the instrument. Many of the features for the Nortec-19e$^{II}$ SPO 3196 are available through the special functions. A brief listing of those functions is given below.

| | |
|---|---|
| SP1 | Capture time for capture/replay feature of stored data |
| SP2 | Probe drive level |
| SP3 | Load default parameters for handheld scanner |
| SP4 | Variable persistence |
| SP5 | Auto erase for sweep |
| SP6 | LCD Backlight |
| SP7 | CRT Erase (timed erase) |
| SP8 | Alarm type |
| SP9 | Alarm dwell |
| SP10 | Alarm horn |
| SP11 | Alarm latch |
| SP12 | Graticule |

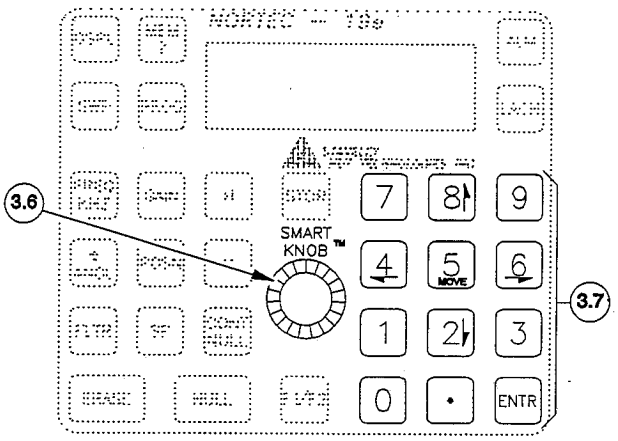
SP13 Time
SP14 Date
SP15 Report (printer report text setup)
SP16 Priority
SP17 Good zone
SP18 X-Y averaging
SP19 High Pass Filter (pole position)
SP20 Flying Dot
SP21 Waterfall Display
SP22 Scanner RPM
SP23 Max Sweeps
SP24 Points/Sweep
SP25 Scan pitch
SP26 Baud Rate
SP27 Slow Scan
SP28 Scan Zero
SP29 Print Sel
SP30 Sweep Avg
SP90 Diagnostics
SP96 Clear program settings
SP97 Clear stored data
SP98 Clear complete instrument
SP99 Load default settings

[STOR] Allows access to functions to save, recall, name, and print stored data and settings. Up to 20 separate sets of data may be accessed for review or use as reference in conjunction with the [MEM2] function.

## 3.6 SmartKnob™

The SmartKnob™ is a multipurpose control that is normally used to change values or parameters for a particular function. For instance, to change the operating frequency of the probe on a single frequency version of the instrument, press [FREQ], then rotate the SmartKnob™ until the desired frequency is displayed on the LCD.

The SmartKnob™ will also change parameters for functions that are in fixed steps. For instance, to change the high pass filter from 16Hz to 10Hz, press [FLTR] until *FILTER HI* is displayed on the LCD, then turn the SmartKnob™ counterclockwise until *30* is displayed on the LCD.



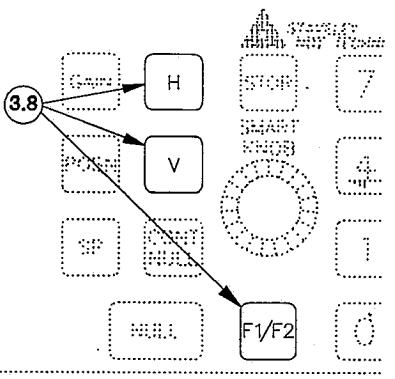

## 3.7 Numeric Keypad

The numeric keypad consists of the numeric keys [0] through [9], the decimal point ([.]) and [ENTR] keys. This keypad serves two purposes:

When entering numeric parameters, the numbers may be entered directly. For example, to enter a frequency of 10 KHz on a single frequency instrument, press [FREQ KHZ], then on the numeric keypad press [1], [0], and [ENTR].

The numeric keypad is also used to select parameters when adjusting alarms, depending upon the type of alarm. Note that there is an arrow printed on each of the [8], [2], [4] and [6] keys, and that the word *MOVE* is printed on the [5] key. These keys are used together with the SmartKnob™ to adjust the characteristics of any of the alarms. (Refer to Section 4.6, Alarm Operation)

## 3.8 Parameter Keys

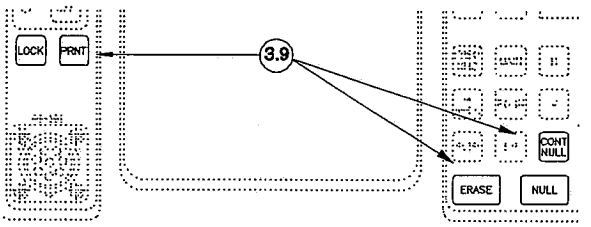



Parameter keys change an operating parameter of a selected function. 3 keys are used for this purpose: the [H] (horizontal) key, [V] (vertical) key, and the [F1/F2] key.

The [H] and [V] keys are used to select the axis in which the Smart Knob™ moves the position of the dot, alarm parameters, and polygon vertex adjust parameters.

The [F1/F2] key is used only in dual frequency instruments. When pressed, it will toggle the current frequency for adjustment from F1 to F2 and vice-versa. Functions that pertain to each of the two frequencies will have their current frequency number displayed on the LCD whenever they are selected, such as *GAIN2* for gain adjustment on frequency 2.

## 3.9 Immediate Execution Keys



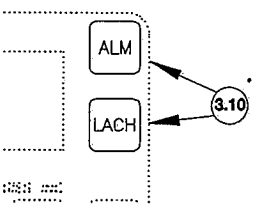

Immediate execution keys perform a specific function as soon as the key is pressed. For instance, as soon as the [NULL] key is pressed, the instrument will move the live impedance signal to the currently selected null position.

The [ERASE] key erases the data from the CRT display.

The [PRNT] key will print out the current CRT display onto an attached serial printer.

[LOCK] and [CONT NULL] (continuous null) keys are on/off functions. Pressing these keys will turn their respective functions on and off. The [LOCK] key prevents the operator from inadvertently altering other functions by locking out the keypad and SmartKnob™. The [CONT NULL] key will gradually and continuously return the impedance signal to the selected null position, canceling any drift due to slowly occurring changes in the eddy current signal.

## 3.10 Alarm Control Keys




The alarm control keys regulate the basic operation of the alarms. The [ALRM] function key selects the alarm number to be adjusted and places the instrument in a mode where the size and dimensions of the alarm may be set. This key is used in conjunction with the red arrow and MOVE keys on the keypad to adjust the individual alarms.

The [LACH] key simply has the function of resetting a latched alarm. When pressed, the on-screen alarm annunciator and the buzzer (if selected) will be turned off, provided the condition that caused the alarm has ended.

# 4.0 Instrument Operation

## 4.1 Introduction

This section details operation of each function of the Nortec-19e$^{II}$ SPO 3196 Eddyscope. Examples of front panel control operation are also given, in order to help familiarize the operator with the instrument. In addition, general operating philosophy for some of the more involved functions is explained.

Each function is described in sufficient detail to enable the operator to perform the required steps without referencing other material and provides the information in its most complete form. It is suggested that a new user should scan this section to become acquainted with the operation and features of the Nortec-19e$^{II}$ SPO 3196.

There are 9 basic functional groupings in the Nortec-19e$^{II}$ SPO 3196:

- **Basic functions.** These are the functions that affect the basic eddy current operation of the instrument, such as gain, frequency, and phase angle (rotation).

- **Dual frequency.** These functions pertain to the operation of the dual frequency version of the Nortec-19e$^{II}$ SPO 3196.

- **Display control.** These functions control the way in which the eddy current information is displayed on the CRT and LCD.

- **Alarm operation.** All functions related to the instrument alarm setup are grouped here.

- **Program storage.** These functions pertain to the ability of the instrument to store and recall instrument settings.

- **Data storage.** The functions grouped here relate to the storage and retrieval of actual eddy current test data.

- **Printer functions.** Many of the settings and data contained within the instrument may be printed out on an external printer using these functions.

- **Scanner operation.** Operation of the optional PS-5 and 19/RA handheld scanner are described here.

- **Date and time.** The date and time may be entered and changed from the front panel using the functions grouped here.

- **Reset and clear functions.** These functions can be used to clear all or part of the instrument settings, data storage areas, programs, and custom report text.

- **Waterfall functions.** These functions control the waterfall display parameters.

Many of the examples listed assume that the instrument has been reset (*SP99*, in *Reset and Clear Functions*) in order for them to function as expected. If there is difficulty in performing the examples, the instrument should be cleared ([SP], [9], [9], [ENTR], then [ENTR]) before trying again.

## 4.2 Instrument Features

Listed below (by manual section number) are the instrument features that are described in each functional group. Following this is a list of the special (SP) functions and the sections where more information may be found.

**4.3 Basic Functions**
GAIN
FREQUENCY
$\phi$ ANGLE
FILTER
PROBE DRIVE

**4.4 Dual Frequency**
FREQUENCY
GAIN
$\phi$ ANGLE
MIXING DISPLAY (DSPL)

**4.5 Display Control**
NULL
ERASE
POSITION
GRATICULE
VARIABLE PERSISTENCE
CRT AUTO ERASE
SWEEP
SWEEP AUTO ERASE
LCD BACKLIGHT

**4.6 Alarm Operation**
ALARM TYPE
BOX ALARM
POLAR ALARM
PIE ALARM
POLYGON ALARM
SORTING GATE
SWEEP ALARM
ALARM HORN
ALARM DWELL
ALARM LATCH

**4.7 Program Storage**
STORE
RECALL
ERASE
NAME
PRINT

**4.8 Data Storage**
FREEZE
CAPTURE TIME
CAPTURE ONCE
CAPTURE CONTINUOUS
RECALL
ERASE
NAME
PRINT
MEMORY 2

**4.9 Printer Functions**
SCREEN PRINT
PROGRAM PRINT
DATA PRINT
CUSTOMIZE REPORT

**4.10 PS-5 Scanner Operation**
AUTOMATIC SCANNER SETUP
MANUAL SCANNER SETUP
ALARM OPERATION

**4.11 19/RA Handheld Scanner Operation**
AUTOMATIC SCANNER SETUP
MANUAL SCANNER SETUP

**4.12 Date and Time**
DATE
TIME

**4.13 Reset and Clear Functions**
CLEAR PROGRAMS
CLEAR DATA
CLEAR ALL
LOAD DEFAULT

**4.14 Waterfall Display Functions**
SP21 WATERFALL DISPLAY
SP22 SCANNER RPM
SP23 MAXIMUM SWEEPS
SP24 POINTS/SWEEP
SP25 SCAN PITCH
STORING A WATERFALL DISPLAY
RECALLING A WATERFALL DISPLAY
MEM 2

## Special Functions

The special (SP) functions are listed below in numerical order, together with the sections that provide details for their use.

| SP No. | Section | Description |
|---|---|---|
| SP1 | 4.8 | Capture time for capture/replay feature of stored data |
| SP2 | 4.3 | Probe drive level |
| SP3 | 4.11 | Load default parameters for handheld scanner |
| SP4 | 4.5 | Variable persistence |
| SP5 | 4.5 | Auto erase for sweep |
| SP6 | 4.5 | LCD Backlight |
| SP7 | 4.5 | CRT Erase (timed erase) |
| SP8 | 4.6 | Alarm type |
| SP9 | 4.6 | Alarm dwell |
| SP10 | 4.6 | Alarm horn |
| SP11 | 4.6 | Alarm latch |
| SP12 | 4.5 | Graticule |
| SP13 | 4.6 | Time |
| SP14 | 4.6 | Date |
| SP15 | 4.9 | Report (printer report text setup) |
| SP16 | 4.6 | Priority |
| SP17 | 4.6 | Zone |
| SP18 | 4.5 | X-Y Averaging |
| SP19 | 4.3 | High Pass Filter Pole Position |
| SP20 | 4.5 | Flying Dot |
| SP21 | 4.13 | Waterfall Display |
| SP22 | 4.13 | Scanner RPM |
| SP23 | 4.13 | Max Sweeps |
| SP24 | 4.13 | Points/Sweep |
| SP25 | 4.13 | Scan Pitch |
| SP26 | 4.9 | Baud Rate |
| SP27 | 4.10 | Slow Scan |
| SP28 | 4.10 | Scanner Zero Angle Setting |
| SP29 | 4.9 | Printer Selection |
| SP30 | 4.10 | External Sweep Averaging |
| SP90 | N.A. | Diagnostics (Not recommended except for factory calibration) |
| SP96 | 4.12 | Clear program settings |
| SP97 | 4.12 | Clear stored data |
| SP98 | 4.12 | Clear complete instrument |
| SP99 | 4.12 | Load default settings |

## 4.3 Basic Functions

The basic functions control the primary parameters of the eddy current test.

**GAIN**

Gain of the instrument is adjustable from 0.0 to 90.0 dB. The displayed gain setting is adjusted in 0.1 dB steps. At full gain (90.0dB), instrument sensitivity is 100 volts/ohm as measured on the rear panel horizontal and vertical outputs, or 100 screen divisions per ohm on the CRT display.

Gain may be adjusted in the horizontal or vertical directions, or both together. Regardless of which gain parameters are being entered, the gain is adjusted by turning the SmartKnob™ or entering the desired gain from the numeric keypad, followed by [ENTR].

To adjust both horizontal and vertical gain, press the [GAIN] key, then adjust. The selected value will be applied to the horizontal GAIN and the difference between horizontal and vertical gains will remain the same. The instrument will not accept an entry which would drive either horizontal or vertical GAIN over 90.0 or under 0 dB.

To adjust the horizontal gain without changing the vertical gain, press the [GAIN] key then the [H] key. Now, any parameters entered will adjust only the horizontal gain. Likewise, to adjust only the vertical gain, press the [GAIN] then [V] keys, then adjust parameters.

**Note**

The gain values that will be adjusted are highlighted on the CRT and also shown on the top line of the LCD display.

*Examples:*

If (in this example) the existing gain settings are 43.0 (horizontal) and 49.0 (vertical), to adjust both gains 6 dB higher, perform the following:

> Press the [GAIN] key. Both gains will be highlighted on the CRT. Rotate the SmartKnob™ clockwise until the HdB setting is 49.0 and the VdB setting is 55.0 dB, or press the [GAIN] key, then enter [4], [9], and [ENTR] on the numeric keypad, which is the desired horizontal gain setting. The horizontal gain will now read 49.0, while VdB will read 55.0.

To set only the vertical gain to 60.0 dB, perform one of the following:

> Press the [GAIN], then the [V] keys. Rotate the SmartKnob™ until the LCD display shows V60.0, or press the [GAIN], then the [V] keys. Enter [6], [0], and [ENTR]. The vertical gain will now change to 60.0 dB.

**FREQUENCY**

The frequency setting determines the frequency of the eddy current probe drive signal. This is adjustable from 0.1 kHz (100 Hz) to 6000 kHz (6 MHz). Only 2 significant digits are accepted by the instrument for frequency setting values.

Frequency may be entered into the instrument by either rotating the SmartKnob™ or entering the desired value (in kHz) on the numeric keypad, following with [ENTR].

To adjust the frequency, simply press the [FREQ KHZ] key, then enter the desired value.

*Example:*

To set the frequency to 1 MHz (1000 kHz):

Press the [FREQ KHZ] key, then rotate the SmartKnob™ until the LCD display reads 1000, or press the [FREQ KHZ] key, then enter [1], [0], [0], [0], and [ENTR] on the numeric keypad.

**$\phi$ ANGLE** The phase angle, or rotation, of the eddy current signal is set using this function. Rotation may be set in 1 degree increments from 0 through 359 degrees. The Smart Knob™ or the numeric keypad may be used to set rotation.

Rotation is often set so that a desired signal appears on screen. For this reason, the SmartKnob™ is set to adjust the phase angle in the same direction that the knob is turned.

To adjust phase angle, simply press the [$\phi$ ANGL] key, then enter the desired value.

*Example:*

To set rotation to 130 degrees (on frequency 1):

Press the [$\phi$ ANGL] key, then rotate the SmartKnob™ until the LCD display reads **PHASE 1 130°**, or press the [$\phi$ ANGL] key, then enter [1], [3], [0], and [ENTR] on the numeric keypad.

**FILTER** The filter function sets either the high or low pass filters. Low pass filters may be set from 10 Hz to 500 Hz with 1 Hz increments. High pass filters may be set from 0 Hz to 500 Hz with 1 Hz increments.

| | |
|---|---|
| High pass: | 0 Hz, 1 Hz, 2 Hz, 3 Hz, ... 500 Hz |
| Low pass: | 10 Hz, 11 Hz, 12 Hz, 13 hz, ... 500 Hz, WB (Wideband) |

Filter settings may be entered using either the SmartKnob™ or the numeric keypad. Values entered into the numeric keypad will be rounded to the nearest filter setting.

The [FLTR] key selects either filter. The LCD will display whether the filter being adjusted is low pass (**FILTER LO**) or high pass (**FILTER HI**). Repeatedly pressing the [FLTR] key will change between high and low pass filters.

Once the filter to be adjusted has been selected, the SmartKnob™ or the numeric keypad and [ENTR] key may be used to select the desired value.

*Example:*

To set the low pass filter to 100 Hz:

Press the [FLTR] key. If the LCD display does not read **FILTER LO**, then press [FLTR] again. Once the LCD displays the current low pass filter setting, rotate the SmartKnob™ until 100 is displayed on the right side of the LCD, or press the [FLTR] key as necessary until the LCD display reads **FILTER LO**, then enter [1], [0], [0], and [ENTR] on the numeric keypad.

**HPF POLE** The HPF POLE function allows the operator the opportunity to select the roll-off rate of the high-pass filter. This selection is made using the SP19 special function. To access the SP19 function press **[SP], [1], [9], [ENTR].** The LCD then displays **HPF POLE.** Press **[ENTR]** to select the function. When selected the LCD screen displays **HPF 2-POLE** which is the default value and the broad selection.

Adjust the SmartKnob™ to select the 4-POLE range which is the sharper filter. Various testing conditions determine which type of filter should be selected.

**PROBE DRIVE** The Nortec-19e$^{II}$ SPO 3196 has 3 levels of probe drive that are operator selectable. These levels are denoted as *LOW*, *MID*, and *HI*. The approximate peak to peak voltages for each are 2, 6, and 12 volts.

Probe drive is normally set to the highest level possible in a particular probe without causing saturation. This gives the best signal to noise ratio for the eddy current indication. Saturation may be detected in one of two ways. If, as the probe is moved onto a part, the signal suddenly deviates from a smooth curve or line, then saturation has occurred. Or, if reducing the probe drive to the next lower level does not appreciably change the amplitude, the signal was saturated at the higher probe drive level.

To set the probe drive level, select SP2 by pressing [SP], the rotating the SmartKnob™ until **SP 2 PR. DRIVE** is displayed on the LCD, then pressing [ENTR], or by pressing [SP], [2], [ENTR].

Once the probe drive function is selected, it may be changed by rotating the SmartKnob™ to the desired level.

*Example:*

To set the probe drive to LOW, perform the following steps:

Press [SP], then rotate the SmartKnob™ until the LCD display reads **SP 2 PR. DRIVE**, press [ENTR], or press [SP], [2], [ENTR].

Rotate the SmartKnob™ until the LCD display reads **PROBE DRIVE LOW.**

## 4.4 Dual Frequency

The operation of a dual frequency Nortec-19e$^{II}$ SPO 3196 is an extension of single frequency operation. Parameters that are adjustable for the second frequency (*F2*) are frequency, gain and rotation. Even when frequency 2 is turned on, the display may be selected to show frequency 1 by itself (F1), frequency 2 by itself (F2), the sum of the signals from both frequencies (F1 + F2), or their difference (F1-F2).

When the instrument is set to its default parameters, F2 will be disabled (OFF). F2 is turned on by selecting the frequency function and then pressing the F1/F2 key to toggle between F1 and F2. Once turned on, the sidebar on the right side of the CRT will show the current settings for both frequencies.

**FREQUENCY** The frequency of F2 must be a fraction of F1 (1/2, 1/4, 1/8, or 1/16). The instrument automatically calculates appropriate values for frequency 2. Once F2 has been set, if F1 is varied, F2 will vary at the appropriate fraction of F1. Thus, if F1 is set to 100 kHz and F2 is 25 kHz (1/4), then when F1 is changed to 200 kHz, F2 will change to 50 kHz.

To set the frequency on a dual frequency instrument, first press the [FREQ KHZ] key. The LCD display will read either **FREQUENCY** 1 or **FREQUENCY 2** on the top line. If it is desired to adjust the other frequency, press [F1/F2]. Once the frequency of adjustment is selected, rotating the SmartKnob™ or entering on the numeric keypad will change the frequency to the desired value.

Once F2 is turned on, the parameters for it will appear in the sidebar on the CRT display. Rotating the SmartKnob™ through the available values of F2 will pass through *OFF*, enabling the operator to disable F2.

*Examples:*

To set F1 to 800 kHz, and F2 to 100 kHz:

Press [FREQ KHZ]. If **FREQUENCY** 1 is not displayed on the LCD, press [F1/F2].

Rotate the SmartKnob™ until the LCD display indicates 800, or press [8], [0], [0], [ENTR] on the numeric keypad.

Press the [F1/F2] key. The LCD should display **FREQUENCY 2.**

Rotate the SmartKnob™ until the LCD display indicates 100, or press [1], [0], [0], [ENTR] on the numeric keypad.

To change the instrument from the above settings to F1 of 100 kHz and F2 OFF:

Press [FREQ KHZ]. If **FREQUENCY 2** is not displayed on the LCD, press [F1/F2].

Rotate the SmartKnob™ until the LCD display indicates OFF.

Press the [F1/F2] key. The LCD should display **FREQUENCY** 1.

Rotate the SmartKnob™ until the LCD display indicates **FREQUENCY 1 100**, or press [1], [0], [0], [ENTR] on the numeric keypad. Selecting values for frequency 2 other than exact fractions of frequency 1 will yield an exact fraction entry closest to the selected value.

**GAIN**

Dual frequency gain is adjusted in the same fashion as single frequency gain. The only difference is that frequency F1 or F2 must be selected before changing gain.

To change the gain of either frequency, press the [GAIN] key. If the LCD does not display the desired active frequency ( **GAIN1** or **GAIN2** ) in the upper left corner, then press the [F1/F2] key to select the other frequency.

Once the gain function for the appropriate frequency has been selected, the SmartKnob™ or numeric keypad entry will set the gain for both horizontal and vertical, maintaining the separation between these gains as described in the GAIN portion of Section 4.3. To change only horizontal or vertical gain, press the [H] or [V] key, then enter the new gain value.

**Note**

The gain values that will be adjusted are highlighted on the CRT and also shown on the top line of the LCD display as **GAIN 1** or **GAIN 2**.

*Examples:*

Assuming for this example that the gain for frequency 2 is set at 44.0 (horizontal) and 50.0 (vertical), and it is desired to increase the gain by 10 dB, then perform the following steps:

Press the [GAIN] key. If the LCD does not indicate **GAIN2**, then press the [F1/F2] key.

Rotate the SmartKnob™ clockwise until the LCD indicates **H54.0 V60.0**, or enter [5], [4], [ENTR] from the numeric keypad. The horizontal gain will now be set to 54 and the vertical gain will still be 6 dB higher than the horizontal.

To set the gain for frequency 1 to 46.0 (horizontal) and 48.3 (vertical), perform the following steps:

Press the [GAIN] key. If the LCD does not indicate **GAIN1**, then press the [F1/F2] key.

Press the [H] key. Rotate the SmartKnob™ until the LCD display indicates H46.0, or enter [4], [6], [ENTR] from the numeric keypad.

Press the [V] key. Rotate the SmartKnob™ until the LCD display indicates V48.3, or enter [4], [8], [.], [3], [ENTR] from the numeric keypad.

**$\phi$ ANGLE**

Phase angle, or rotation, on a dual frequency unit is very similar to rotation on a single frequency instrument, except that the active frequency (F1 or F2) must be selected before changing this parameter.

To change phase angle, press [$\phi$ ANGL]. The LCD will display either **PHASE 1** or **PHASE 2** in its upper left corner. Pressing the [F1/F2] key will switch between the two. After obtaining the desired active frequency, enter the desired phase angle using either the SmartKnob™ or numeric keypad.

*Example:*

To change the phase angle of frequency 2 to 167°, perform the following steps:

Press the [$\phi$ ANGL] key. If the LCD does not display **PHASE 2**, then press the

[F1/F2] key.

Rotate the SmartKnob™ until the LCD indicates **PHASE 2 167°**, or on the numeric keypad press [1], [6], [7], and [ENTR].

**MIXING DISPLAY (DSPL)**

Mixing display control is active only on dual frequency versions of the Nortec-19e$^{II}$ SPO 3196. This function routes the desired signal to the display for viewing. The operator has four choices when displaying the signal on screen: *F1*, *F2*, *F1+F2*, and *F1-F2*, where F1 stands for frequency 1 and F2 represents frequency 2.

To change the active display, repeatedly press the [DSPL] key until the desired choice is shown on the LCD, or press the [DSPL] key once, then rotate the SmartKnob™ to the desired selection.

*Example:*

To set the display to show the sum of F1 and F2 (*F1+F2*) perform the following steps:

Press the [DSPL] key, repeating until the LCD reads **DISPLAY F1+F2**, or press the [DSPL] key once, then rotate the SmartKnob™ until the LCD shows **DISPLAY F1+F2**.

## 4.5 Display Control

The display control functions regulate the way in which the eddy current signal is presented to the operator. Parameters such as signal position, sweep display, and graticule are included here.

**NULL** The null function moves the dot (impedance plane display) or sweep display to the selected null position, often in the middle of the screen. This function is implemented simply by pressing the [NULL] button. Null should be performed prior to performing a test, and at periodic intervals when performing eddy current tests.

Refer to the test procedures for a specific test to determine whether to null the signal with the probe held in air or on the test part.

**ERASE** The [ERASE] key will perform a screen erase whenever the key is pressed during normal operation. This operation clears all data from the screen and is useful to eliminate screen clutter.

**Note**

The instrument is also capable of automatically erasing the screen by using the auto erase or variable persistence functions.

To erase the screen at any time the eddy current signal is displayed, press the [ERASE] key.

**POSITION** This function controls the position of the eddy current signal display. When the [NULL] key is pressed or the signal is in a null state, the dot or sweep line will be in the null position selected. Position may be controlled in steps of 0.5% of full screen, with the lowest values at the bottom left of the screen.

To change the position, press [POSN]. The LCD will display either **POSN HOR** or **POSN VER**, corresponding to horizontal or vertical position, respectively. If the LCD does not show the desired axis of movement, press the [H] or [V] key as required.

Once the axis has been selected, then either rotate the SmartKnob™ to change position, or enter the desired new position directly through the numeric keypad.

*Example:*

To move the vertical position to 20.0% (near the bottom of the screen), press [POSN]. If **POSN VER** is not displayed on the LCD, press [V]. Then, rotate the SmartKnob™ until the LCD reads 20.0%, or

Press [POSN] and [V] if necessary, as above. Press [2], [0], [ENTR] on the numeric keypad.

**GRATICULE** The 10 X 10 graticule may be set on or off at any time without affecting any eddy current information on the display.

To turn the graticule off, select SP12 by pressing [SP], rotating the SmartKnob™ until **SP 12 GRATICULE** appears, then pressing [ENTR], or by pressing [SP], [1], [2], [ENTR].

After SP12 has been selected rotate the SmartKnob™ counterclockwise until the LCD display reads **GRATICULE OFF.**

To turn the graticule back on, select SP12 as above. Then turn the SmartKnob™ clockwise until the LCD reads **GRATICULE ON.**

**VARIABLE PERSISTENCE** Variable persistence allows the operator to set an impedance plane (not sweep) display so that the stored information on the screen will be erased after a selected amount of time. This time may be set from 1 to 20 seconds, in 1 second increments.

**Note**

The variable persistence will erase the information at a particular point after the time has expired, even if more information was displayed there at a later time. The result of this is that the display may appear somewhat broken where eddy current signals intersect those being erased. Despite this, the resultant display is very useful for repetitive testing, averting the need for manual erasure of the screen.

This function is not allowed when CRT auto erase (below) is activated.

To select the variable persistence function, select SP4 by pressing [SP] and rotating the SmartKnob™ until **SP 4 PERSIST** appears on the LCD, then pressing [ENTR]; or by pressing [SP], [4], [ENTR].

After selecting SP4, the desired value should be entered by rotating the SmartKnob™ or entering the value from the numeric keypad.

Variable persistence may be turned off by rotating the SmartKnob™ counterclockwise until **PERSISTENCE OFF** is displayed on the LCD, or by entering 0 through the numeric keypad.

*Examples:*

To set variable persistence to 11 seconds, perform the following steps:

Press [SP], rotate the SmartKnob™ until **SP 4 PERSIST** appears on the LCD, then press [ENTR]; or enter [SP], [4], [ENTR].

Rotate the SmartKnob™ until **PERSISTENCE 11sec** is displayed on the LCD, or enter [1], [1], [ENTR] on the numeric keypad.

To turn off variable persistence:

Select SP4 as above, then rotate the SmartKnob™ counterclockwise until **PERSISTENCE OFF** is displayed on the LCD, or select SP4 as above, then press [0], [ENTR] on the numeric keypad.

**CRT AUTO ERASE** CRT auto erase is a function that will erase the eddy current display at intervals set by the operator. The available range for the CRT erase function is from 1 to 60 seconds in 1 second intervals. This function differs from variable persistence in that the screen is

completely erased at each interval, rather than incrementally erased as in variable persistence.

This function is not allowed when variable persistence (above) is turned on.

CRT auto erase is controlled through SP7. Select SP7 by pressing [SP] and rotating the SmartKnob™ until **SP 7 CRT ERASE** appears on the LCD, then pressing [ENTR], or by pressing [SP], [7], [ENTR].

After selecting the CRT auto erase function, the desired value may be entered by rotating the SmartKnob™ until the value appears on the LCD, or by entering the value through the numeric keypad.

CRT auto erase may be turned off by rotating the SmartKnob™ counterclockwise until **CRT ERASE OFF** appears on the LCD display, or by entering a value of 0 through the numeric keypad.

*Example:*

To set CRT auto erase to 23 seconds:

Press [SP], then rotate the SmartKnob™ until **SP 7 CRT ERASE** appears on the LCD, or enter [SP], [7], [ENTR].

Rotate the SmartKnob™ until **CRT ERASE 23sec** is displayed on the LCD, or press [2], [3], [ENTR].

**SWEEP**

Sweep operation of the Nortec-19e$^{II}$ SPO 3196 Eddyscope is controlled through the [SWP] key. There are two sweep modes, auto and externally triggered.

Auto sweep moves the signal horizontally at a fixed rate selected from the front panel, continually retracing across the screen.

Externally triggered sweep synchronizes the screen so that it starts and ends at a trigger point. This mode is valid for trigger pulses in the 6 to 3000 RPM range. Externally triggered sweep is normally used with the PS-5 and 19/RA handheld scanners. When sweep is turned off, the display reverts to the impedance plane mode of operation.

Auto sweep may be set in the range from 0.005 seconds (5 milliseconds) per division to 4 seconds per division. At sweep time periods of 0.015 seconds/division and longer the display will update in an incremental fashion, that is, only the part of the screen that is about to be overwritten will be erased prior to drawing the new data.

To change to the appropriate sweep mode, repeatedly press the [SWP] key until the LCD display reads either **SWEEP AUTO, SWEEP OFF, SWEEP EXTERNAL**, or **SWEEP WATERFALL.** In the auto sweep mode, the time per division may be adjusted by turning the SmartKnob™ or entering the new value using the numeric keypad.

*Example:*

To set the sweep for auto sweep, with 0.100 seconds per division, perform the following steps:

Repeatedly press the [SWP] key until the LCD display reads **SWP AUTO.**

Rotate the SmartKnob™ until the top right of the LCD display reads 0.100, or enter [.], [1], [ENTR] from the numeric keypad.

**SWEEP AUTO ERASE**

The sweep auto erase function erases the sweep display once per trace. On auto sweep, traces that are set for 0.015 seconds (15 milliseconds) per division or longer, the display will erase incrementally as each new set of data is drawn to the screen. Thus, all data will be on the screen for the same amount of time, regardless of its horizontal position on the sweep display.

The auto erase function only applies to the sweep modes of display (auto sweep and external sweep). Refer the above explanation of *SWEEP* for further information on these functions, and how to activate them. When the auto erase function is turned off, the sweep displays will have to be erased manually.

When the instrument is loaded with its default settings (SP99), the auto sweep function is already on, which is the normal mode of operation. This function may be turned on and off using SP5.

To turn the auto sweep erase function on or off, select SP5 by pressing [SP], then rotating the SmartKnob™ until the LCD reads **SP 5 AUTO ERSE**, then pressing [ENTR], or pressing [SP], [5], [ENTR].

Once SP5 has been selected, the auto sweep erase function may be selected by rotating the SmartKnob™.

*Example:*

To turn the auto sweep erase function off, first set the instrument to one of the sweep modes outlined in *SWEEP* above. Then, perform the following steps:

Press the [SP] key, then rotate the SmartKnob™ until the LCD reads **SP5 AUTO ERASE**, then press [ENTR], or press the [SP], [5], and [ENTR] keys in sequence.

Rotate the SmartKnob™ counterclockwise until the LCD display reads **SWEEP ERASE OFF.** The sweep display must now be erased by manually pressing the [ERASE] key.

**LCD BACKLIGHT**

The LCD backlight may be used in low light conditions in order to make it easier to view the settings displayed on it.

Backlight is turned on and off using SP6. To change the state of the backlight, select SP6 by pressing [SP], then rotating the SmartKnob™ until the LCD reads **SP 6 BACKLIGHT**, then pressing [ENTR], or by pressing [SP], [6], [ENTR].

Once SP6 has been selected, the backlight function may be selected by rotating the SmartKnob™.

**X-Y AVERAGING**

X-Y average is the number of points averaged to obtain the X,Y value. It is displayed on the LCD. X-Y AVERAGING is accessed using the special function SP18. X-Y AVERAGING expresses the average result of the samples taken by the A/D converters in the instrument.

To access the X-Y AVERAGING press **[SP], [1], [8], [ENTR].** The LCD then displays **SP 18 X-Y AVG.** Press **[ENTR].** The LCD then displays **X-Y AVERAGE 2.** The number **2** indicates that two points were used in the averaging. Rotating the SmartKnob™ increases the accuracy of the results by increasing the number of calculations. The choices are 2, 4, 8, 16, and 32. Pressing **[ENTR]** displays the current X and Y position of the dot on the lower line of the LCD.

**FLYING DOT**

This feature allows the operator to change the shape of the DOT on the CRT. The default is the larger square dot. A smaller dot is also obtainable by utilizing the SP20 special function.

The SP20 function is accessed by pressing **[SP], [2], [0], [ENTR].** The LCD then displays **SP20 FLYING DOT.** Press **[ENTR]** and the LCD displays **FLYING DOT BOX.** Adjust the SmartKnob™ to select between a larger box, and a smaller dot.

## 4.6 Alarm Operation

The Nortec-19e$^{II}$ SPO 3196 will operate using one of 5 alarm types in the impedance plane mode. These alarms are box, polar (circular), pie, polygon, and sorting gate. In the sweep modes, the alarm is a threshold alarm that senses a crossing in the vertical direction.

All alarms respond to the eddy current signal as it is being processed, and therefore react rapidly. The operation of the alarms may be dwelled, which is a function that forces the alarm to be on for a minimum amount of time. Alarms also may be latched, leaving the alarm in the on condition once activated until the front panel [LACH] key is pressed. An internal audible alarm horn may be turned on, and will respond to the alarm condition subject to the dwell and latch function settings. Finally, a CRT annunciator message will also display in concert with the alarm condition.

Only one alarm type may be used at a time. 3 simultaneous box alarms may be used and the sorting gate function will denote one of nine possible gates, but only one alarm is available for the other types. When the instrument is placed into the sweep mode, only a threshold (high-low) alarm is available.

With the exception of the sorting gate, all alarms may be set individually to positive or negative polarity. Positive polarity forces the alarm to be on whenever the eddy current signal is inside the alarm threshold, while negative polarity activates the alarm whenever the eddy current signal is outside the alarm threshold.

All alarm types use the same keys to control their operation. These keys are shown in *Figure 1*. The [ALM] key enables the user to turn the alarm on and off and set its polarity. It also facilitates alarm number selection when in the box alarm mode. The arrow keys are used to select an alarm parameter for adjustment. The [MOVE] ([5]) key, when used in conjunction with the [H] and [V] keys, allows movement of the entire alarm in the horizontal and vertical directions. The SmartKnob™ is used to change actual numeric values for the alarm thresholds.

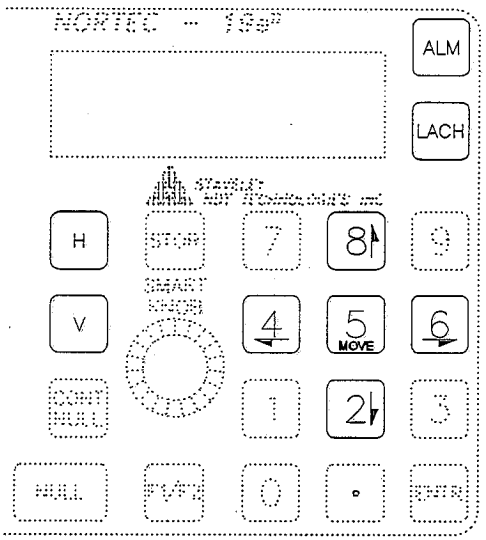


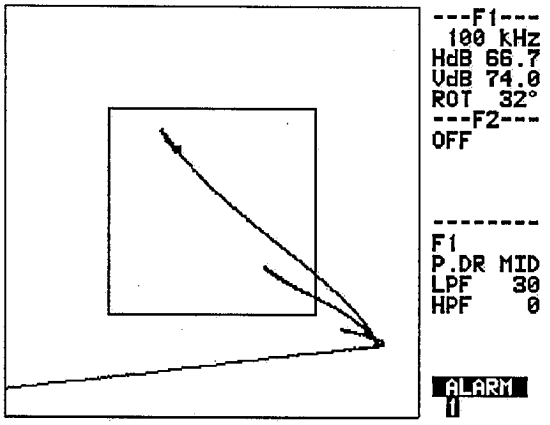

**Figure 4-1** *Alarm Adjustment Keys*

For information regarding rear panel alarm connections, refer to Section 6, *Rear Panel Connections*. Information regarding data rates and maximum response times to alarm conditions may also be found in this section.

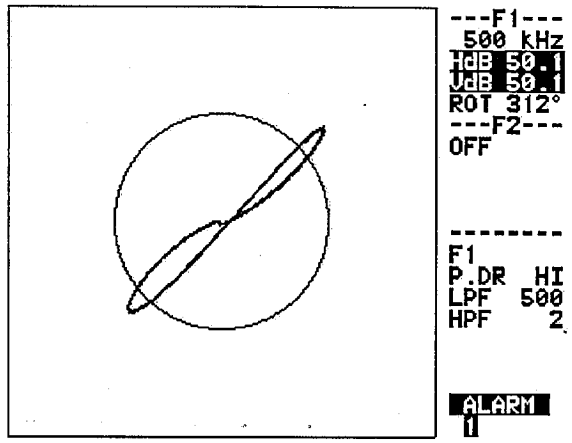
**ALARM TYPE** Prior to adjusting the alarm, the proper alarm type needs to be selected. The available alarm types are the box, polar (circular), pie, polygon, and sorting gate. These alarms are described in detail in the sections that follow.

SP8 is dedicated to the alarm type function. To select this feature, press [SP], then rotate the SmartKnob™ until **SP 8 ALM TYPE** shows on the LCD, then press [ENTR], or press the [SP], [8], and [ENTR] keys. Once the alarm type has been selected, rotation of the SmartKnob™ will cycle through the alarm types.

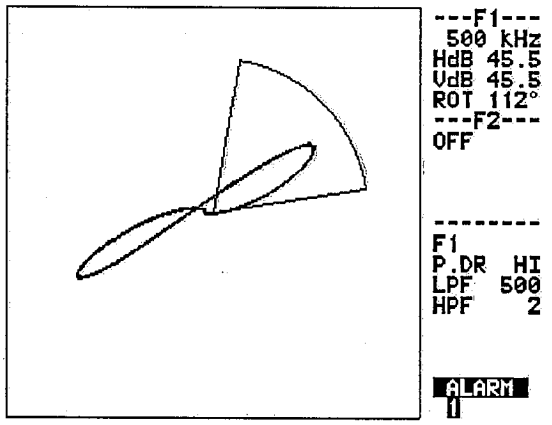
Each alarm is turned on and off separately. Therefore, if the alarm type is changed it will have to be activated if it was previously turned off. Once the alarm type is selected, it may be turned on and off and set to positive or negative polarity through the [ALM] key. For further details refer to the individual alarm functions below.



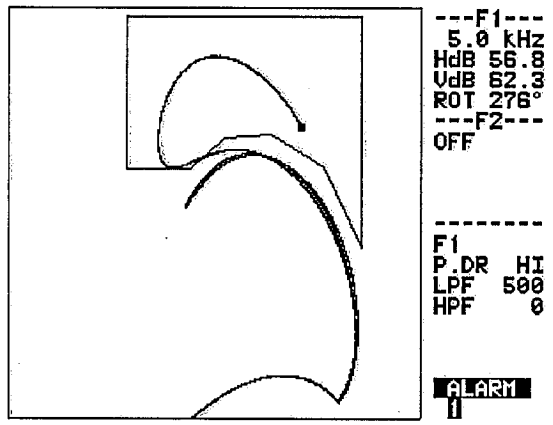

Box Alarm



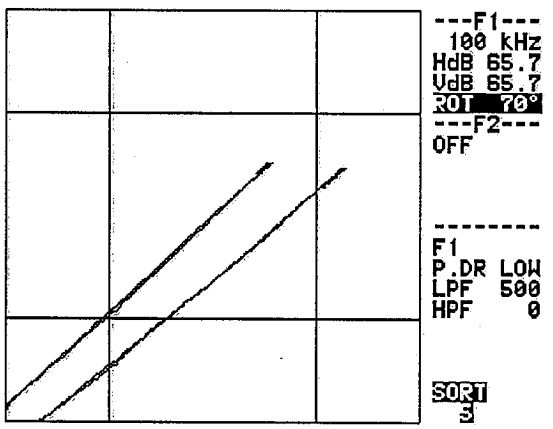

Polar Alarm



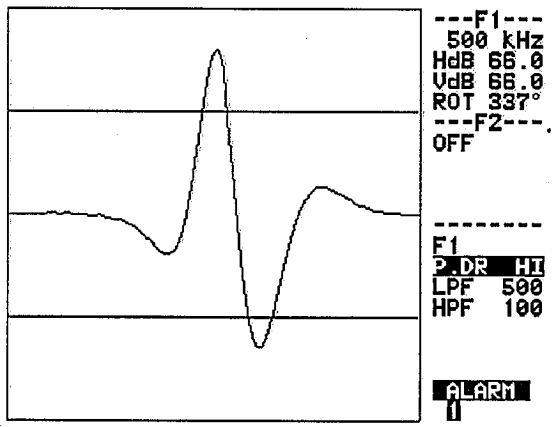

Pie Alarm




Polygon Alarm




Sorting Gate




Sweep Alarm

**Figure 4-2** *Types of Alarms*

*Example:*

To set the alarm type to polar alarm, perform the following steps:

Press [SP], then rotate the SmartKnob™ until **SP 8 ALM TYPE** is displayed on the LCD, then press [ENTR], or press [SP], [8], and [ENTR].

Rotate the SmartKnob™ until **ALARM TYPE POLAR** is displayed on the LCD

The polar alarm may now be activated using the [ALM] key and SmartKnob™. It may be adjusted using the [arrow] and [MOVE] keys and SmartKnob™.

**BOX ALARM** The box alarm is a rectangular box that represents limits to the allowable signal excursion before an alarm threshold setting is crossed. The box alarm is the most commonly used alarm and is specified in many test procedures.

The box alarm on the Nortec-19e$^{II}$ SPO 3196 has the additional feature in that if it should touch the edge of the screen, the alarm box will be considered to extend beyond the edge of the screen, allowing the setup of a *quadrant alarm*.

Up to three box alarms may be used at one time. The alarm that is currently being adjusted will be displayed in solid lines while the adjustment is taking place, while alarms not being adjusted will be displayed as dotted lines. Once another function is selected, all alarms will be displayed using solid lines.

To select the alarm that will be adjusted, make sure the alarm type is set as stated above, then press the [ALM] key repeatedly until the LCD display indicates the desired alarm number (1, 2, or 3). Once the proper alarm has been selected, it may be turned on to positive or negative polarity by adjusting the SmartKnob™. The side to be adjusted should be selected by using the arrow keys [↑], [↓], [→], and [←] on the numeric keypad, which correspond to the top, bottom, right, and left sides of the alarm box.

Once the side to be adjusted has been selected, the SmartKnob™ will allow movement of that side.

**Note**

The instrument will prevent adjustment of the top and bottom or left and right sides to less that 5% of the screen of each other.

The entire alarm box may be moved by using the [MOVE] key. When this key has been pressed after selecting [ALM], the LCD will display **ALARM1 MOVE VER** or **ALARM1 MOVE HOR**, for vertical and horizontal alarm movement, respectively. If the desired direction of movement is displayed, rotate the SmartKnob™ until the alarm box is positioned as desired. The axis of movement may be changed by pressing the [V] or [H] as needed. These keys may be used alternatively when moving the alarm.

*Examples:*

With all alarms off, and box alarm mode selected (see Alarm Mode above), turn on alarm 2 to the negative alarm mode, and set the value for the top to 72.5%, bottom to 33.0%, right to 80.0%, and left to 43.0%.

Repeatedly press the [ALM] key until the upper left side of the LCD display reads **ALARM2**. Rotate the SmartKnob™ until the LCD reads **ALARM2 NEGATIVE.**

Press the [↑] key. Rotate the SmartKnob™ so that the LCD display reads **ALM2TOP 72.5%**

Press the [↓] key. Rotate the SmartKnob™ so that the LCD display reads **ALM2 BOTTM 33.0%.**

Press the [→] key. Rotate the SmartKnob™ so that the LCD display reads **ALM2 RIGHT 80.0%.**

Press the [←] key. Rotate the SmartKnob™ so that the LCD display reads **ALM2 LEFT 43.0%.**

With alarm 3 turned on and adjusted to an appropriate size, move it to the upper left corner of the screen to set up as a quadrant alarm:

Repeatedly press the [ALM] key until the LCD display reads **ALARM3** in the upper left corner. Since the alarm was turned on, the display should read either **ALARM3 POSITIVE** or **ALARM3 NEGATIVE.**

Press the [MOVE] key, then press the [H] key. Rotate the SmartKnob™ counterclockwise until the alarm is against the left side of the screen.

Press the [V] key. Rotate the SmartKnob™ clockwise until the alarm is at the top of the screen.

**POLAR ALARM**

The polar alarm is a circular alarm that is normally used to detect only a magnitude change beyond a certain threshold for the eddy current signal. The operator may vary the size and position of the polar alarm, although its default position at the center of the screen is normally the best position.

Short pauses may be noticed occasionally while adjusting the polar alarm. This is normal operation for the instrument since it must configure itself for each new alarm position.

To activate the polar alarm, make sure the alarm type is set to polar as described above. Press the [ALM] key, then rotate the SmartKnob™ to select positive or negative polarity as desired.

Once the alarm appears on the screen, its size may be adjusted by selecting the radius function through the [↑] or [↓] keys, then rotating the SmartKnob™ until the alarm is the desired size. The alarm may be moved by first pressing the [MOVE] key, selecting the direction with the [H] or [V] keys, then turning the SmartKnob™ to move it.

*Example:*

To set the polar alarm to positive polarity, with radius set to 20% of full screen, and centered at 40% horizontal and 60% vertical, perform the following steps:

Make sure the alarm type is set to polar as described in *ALARM TYPE* above.

Press the [ALM] key and rotate the SmartKnob™ until the LCD reads **ALARM POSITIVE.**

Press the [↑] key (any one of the arrow keys may be pressed here). Adjust the SmartKnob™ until the LCD display reads **RADIUS 20.0.**

Press the [MOVE] key, then the [H] key. Rotate the SmartKnob™ until the center of the alarm is at the 40% level of the screen horizontally, one division to the left of the center of the screen.

Press the [V] key. Adjust the SmartKnob™ so that the center of the alarm is at the 60% level vertically, one division above the middle of the screen.

**PIE ALARM** The pie alarm is a portion of a polar alarm that has a starting and ending radial position. Its shape is similar to a section of a pie, thus the name. It is useful when the desired alarm is primarily magnitude dependent, but has certain phase values that are also significant.

Short pauses may be noticed occasionally while adjusting the polar alarm. This is normal operation for the instrument since it must set itself up for each new alarm position or size.

The pie alarm is set by first making sure the alarm type is set to pie alarm as described in *ALARM TYPE* above. Once this is done, the [ALM] key is pressed, and the SmartKnob™ rotated until the LCD reads **ALARM POSITIVE** or **ALARM NEGATIVE** as desired.

Once the alarm has been set, the size, shape, and position may be selected using the arrow and [MOVE] keys on the numeric keypad. The [↑] and [↓] keys select the radius of the alarm, the [←] key selects the starting phase angle, and the [→] key selects the ending phase angle. Rotating the SmartKnob™ adjusts these values.

Movement of the pie alarm is accomplished using the [MOVE] key and SmartKnob™, but is restricted by considering the alarm to be a complete circle. Thus, the alarm will be prevented from moving close to the edge of the screen in some cases. This is done to allow the full range of adjustment of the starting and stopping angles no matter where the alarm is positioned. In addition, starting and stopping angles are limited to no closer than 30 degrees of each other.

*Example:*

To activate the pie alarm with positive polarity, radius of 20.0%, starting angle at 50°, stopping angle at 295°, and centered at a horizontal position of 70% and a vertical position of 40%, perform the following steps:

Make sure the alarm type is set to pie as described in *ALARM TYPE* above. Press the [ALM] key and rotate the SmartKnob™ until the LCD display reads **ALARM POSITIVE.**

Press the [↑] key, and rotate the SmartKnob™ until the LCD reads **RADIUS 20.0.**

Press the [←] key, and rotate the SmartKnob™ until the LCD reads **START ANGLE 50°.**

Press the [→] key, and rotate the SmartKnob™ until the LCD reads **STOP ANGLE 295°.**

Press [MOVE], then the [H] key. Rotate the SmartKnob™ until the center of the alarm (where the start and stop lines intersect) is located at the 7th division from the left of the screen (70%).

Press the [V] key. Turn the SmartKnob™ until the center of the alarm is located at the 4th division from the bottom of the screen (40%).

**POLYGON ALARM**

The polygon alarm is a versatile, 8 sided arbitrary figure that may be adjusted to closely approximate any on-screen eddy current pattern by tracing around that pattern when setting up the alarm. Once adjusted, the alarm polygon may then be slightly offset or expanded, and then used for a very accurate and reliable alarm for difficult inspections such as sliding probe tests where signals which should trip alarms differ only slightly from a complex reference signal.

Adjustment of this alarm is done by moving one of the 8 vertices of the polygon at a time. Vertices may be moved horizontally or vertically using SmartKnob™ adjustment. The instrument checks the movement of each vertex and will limit adjustment to prevent lines from crossing or vertices from getting too close to one another.

The instrument will pause occasionally while the alarm is being adjusted. This is normal operation since the instrument must reconfigure itself each time the alarm thresholds are changed. Once set up, the alarm reacts quite rapidly to alarm conditions.

Once the alarm type is selected the alarm is activated by pressing the [ALM] key, then rotating the SmartKnob™ until the LCD reads either **ALARM POSITIVE** or **ALARM NEGATIVE.** The arrow keys on the numeric keypad select the vertex for adjustment. Repeatedly pressing the [↑] or [→] keys will increment (clockwise) the vertex to be adjusted. Repeatedly pressing the [↓] or [←] keys will decrement (counter clockwise) the vertex to be adjusted.

While moving a vertex, the CRT will display the polygon with the two lines attached to the vertex highlighted. The LCD will also show the vertex number (1 through 8) and the vertical or horizontal position in percent of screen. The axis of movement is selected by pressing the [H] or [V] key.

Pressing the [MOVE] key will permit movement of the entire alarm. After the move function is selected, the [H] or [V] key is pressed to select direction of movement, then the SmartKnob™ is rotated to move the alarm.

*Example:*

Set the polygon alarm to negative, with the vertices positioned at the following locations:

Vertex 1: horizontal 23.5%, vertical 54.0%
Vertex 2: horizontal 37.0%, vertical 74.0%
Vertex 3: horizontal 66.0%, vertical 71.0%
Vertex 4: horizontal 70.5%, vertical 51.5%
Vertex 5: horizontal 80.5%, vertical 15.0%
Vertex 6: horizontal 60.0%, vertical 32.0%
Vertex 7: horizontal 50.0%, vertical 32.0%
Vertex 8: horizontal 40.0%, vertical 50.0%

Perform the following steps:

Make sure the instrument is set to impedance plane, and the alarm type to polygon. Then press the [ALM] key, and rotate the SmartKnob™ until the LCD reads **ALARM NEGATIVE.**

Press the [↑] key. Repeat pressing the key until the upper left of the LCD reads **POLY1.** Then press the [H] key, and turn the SmartKnob™ until the LCD reads **POLY1 HOR 23.5.** Press the [V] key and rotate the SmartKnob™ until the LCD reads **POLY1 VER 54.0.**

Press the [↑] key again. The upper left of the LCD display should read **POLY2.** Adjust the horizontal and vertical components for the vertex to the values desired.
Repeat the adjustment of each vertex to the values desired. Remember that the [↑] or [→] key steps to the next vertex, and the [H] and [V] keys will select the axis of movement. If there is a need to step back one vertex, press the [↓] or [←] key.

**SORTING GATE**

The sorting gate divides the screen into 9 areas, or zones, and tracks the movement of the eddy current signal, performing special latching functions that are very useful for manual or automated sorting of parts.

**PRIORITY**

Each zone is numbered in sequence from the lower left to the upper right. The lower left of the screen is zone 1, the lower right is zone 3, middle of the screen is zone 5, the upper right is nine, and so on. These zones have a latching priority that can be changed through serial port commands (see Section 7, *Computer Interface*). The default priority is:

Zone 1 (lowest)
Zone 2
Zone 4
Zone 3
Zone 5
Zone 7
Zone 6
Zone 8
Zone 9 (highest)

There are nine numbers available for each sorting gate zone. Priority levels may be duplicated in multiple zones.

The alarm is latched to the highest zone the eddy current signal enters after coming on screen. This zone will be retained, or latched, until the signal goes off screen, then on screen again. Each time the signal enters the screen, the alarm resets.

An on-screen annunciator displays the current latched zone. In addition, this zone is available as a BCD coded signal on the rear panel. The rear panel also contains an on screen/off screen signal that is only active in the sorting gate. Refer to Section 6, *Rear Panel Connections*, for further information.

To set the instrument for sorting gate operation, first select the sorting gate as described in *ALARM TYPE*. Then, press the [ALM] key and rotate the SmartKnob™ until the LCD readout displays **ALARM ON.**

To set the sorting zone, the keypad is used followed by the [ENTER] key. Select SP16 to set the priority for the desired sorting gate zone. The SmartKnob™ is used to set the priority #.

**GOOD ZONE**

The sorting levels are then adjusted using the arrow keys ([↑], [↓], [→], and [←]) and the SmartKnob™.

**Note**
There is no polarity on the sorting gate.

When using the sorting gate, remember that the gate will not reset unless the eddy current signal is off screen. The normal usage of this gate would be to use a known

good part to set the instrument so that it is measured at zone 5 (middle). Liftoff should be set for the lower left of the screen to make best use of the default priority, and the signal should be off screen in air. Parts that are known bad should make the signal go into the other zones of the screen.

One other feature to be considered when using this gate is that the instrument has a maximum low pass filter setting. Because of this, high speed tests may have to be set up dynamically, with parts passed through the test apparatus at normal speeds, since the signal may be rate sensitive due to the influence of the filter.

The digital sample update rate of the sorting gate is 3000 samples per second.

*Example:*

Activate the sorting gate, setting the top threshold to 80%, bottom to 18.5%, left to 28.5%, right to 70%.

Make sure the instrument is set up for impedance plane operation, and set the alarm type to sorting gate. Then press the [ALM] key and rotate the SmartKnob™ until the LCD reads **ALARM ON.**

Press the [↑] key, then rotate the SmartKnob™ until the LCD reads **ALM TOP 80.0%.**
Press the [↓] key and turn the SmartKnob™ for an LCD readout of **ALM BOTTM 18.5%.**

Press the [←] key and turn the SmartKnob™ for an LCD readout of **ALM LEFT 28.5%.**

Press the [→] key and turn the SmartKnob™ for an LCD readout of **ALM RIGHT 70.0%.**

**SWEEP ALARM**

When the instrument is operated in one of the sweep modes, the only alarm available is a simple high/low threshold alarm. This alarm is automatically selected whenever the display mode is set to *AUTO SWEEP* or *EXTERNAL SWEEP*.

The polarity of the sweep alarm may be positive or negative. The negative alarm is normally used, triggering the alarm whenever one of the thresholds is exceeded. The positive alarm may be used when it is desired to have an alarm in only one direction.

When this alarm is used with the PS-5 or 19/RA Scanner, the alarm dwell (below) should be set to 0.1 seconds or longer for reliable alarm operation.

The [ALM] key allows the operator to turn the alarm on and off and set its polarity. To activate the alarm, press [ALM], then rotate the SmartKnob™ until the LCD readout displays **ALARM POSITIVE** or **ALARM NEGATIVE** as appropriate.

The [↑] key allows the operator to adjust the top threshold, while the [↓] key invokes adjustment of the bottom threshold. Pressing one of these keys followed by rotation of the SmartKnob™ will change the selected threshold.

*Example:*

Set the sweep alarm to negative polarity, and adjust the top threshold to 62.5%, and the bottom threshold to 22.0%. First make sure the instrument is set to **AUTO SWEEP** or **EXTERNAL SWEEP** as outlined in section 4.5. Then, perform the following steps:

Press the [ALM] key, then rotate the SmartKnob™ until the LCD displays **ALARM NEGATIVE.**

Press the [↑] ([8]) key, and turn the SmartKnob™ for an LCD readout of **ALM TOP 62.5%.**

Press the [↓] ([2]) key, then rotate the SmartKnob™ until the LCD displays **ALM BOTTM 22.0%.**

**ALARM HORN**

The alarm horn is an audible annunciator. This horn is internal to the instrument and is best used when background noise in the testing area is low. The horn is not used in sorting gate operation.

The alarm horn is turned on and off through SP10. To turn the horn on, select SP10 by pressing [SP], then rotating the SmartKnob™ until the LCD reads **SP 10 ALM HORN**, then pressing [ENTR], or by pressing [SP], [1], [0], [ENTR].

After SP10 has been selected, rotate the SmartKnob™ clockwise until the LCD display reads **HORN ON.**

To turn the horn back off, select SP10 as above. Then turn the SmartKnob™ clockwise until the LCD reads **HORN OFF.**

**ALARM DWELL**

Alarm dwell is used to keep the alarm on for a set period after the event that caused the alarm has ended. Thus, if alarm dwell is set for 1 second and an alarm occurs, the instrument will continue to alarm for a period of 1 second after the alarm condition is over.

Alarm dwell may be set in increments of 0.1 second from 0.0 to 10.0 seconds.

Dwell applies to the annunciator in the lower right corner of the CRT, the alarm horn (if on), and the rear panel alarm outputs. Dwell is applied independently to each alarm when multiple box alarms are selected.

To change alarm dwell, select SP9 by pressing [SP], then turning the SmartKnob™ until the LCD readout displays **SP 9 ALM DWELL**, then pressing [ENTR] or by pressing [SP] [9], and [ENTR].

Once SP9 is activated, the value may be entered by rotating the SmartKnob™ or to entering the value through the numeric keypad.

*Example:*

To set the Dwell to 3.4 seconds, perform the following steps:

Select SP9 by pressing [SP], turning the SmartKnob™ until the LCD display reads **SP 9 ALM DWELL**, then pressing [ENTR], or by pressing [SP], [9], and [ENTR].

Turn the SmartKnob™ until the LCD readout displays **ALARM DWELL 3.4** or press [3], [.], [4], and [ENTR].

**ALARM LATCH**

The alarm latching function keeps an alarm on until alarm condition is ended and the front panel [LACH] key is pressed. It may be used to be certain an operator has confirmed that an alarm occurred before continuing the test. Alarm latch will override any alarm dwell setting.

The alarm latch applies to the alarm annunciator in the lower right of the CRT, the rear panel alarm outputs, and the alarm horn, if activated.

The alarm latch is turned on and off through SP11. To turn on the latch, select SP11 by pressing [SP], then rotating the SmartKnob™ until the LCD display reads **SP 10 ALM LATCH**, then pressing [ENTR], or by pressing [SP], [1], [1], [ENTR].

After SP10 has been selected, rotate the SmartKnob™ clockwise until the LCD display reads **LATCH ON.**

To turn the horn back off, select SP11 as above, then turn the SmartKnob™ clockwise until the LCD reads **LATCH OFF.**

When an alarm occurs with the latch activated, first make sure that the condition that caused the alarm has ended, then press the [LACH] key to reset the alarm.

## 4.7 Program Storage

The Nortec-19e$^{II}$ SPO 3196 is capable of storing and retrieving 100 complete instrument setups. These setups are recorded with date and time, and may be named using up to 26 alphanumeric characters. These names are input directly from the front panel of the instrument.

Whenever a program setting is recalled, the currently active instrument settings are overwritten and cannot be recovered unless these settings were previously stored in another program location.

Functions pertaining to program storage are store, recall, erase, name, and print. *STORE* saves the current instrument settings to the selected program location. *RECALL* programs the instrument settings with the selected program number. *ERASE* erases the selected program number. *NAME* allows the operator to set a name to the program for easier reference. *PRINT* allows printout of all the program settings to a serial printer.

Program storage locations are numbered from 1 to 100 and are accessed using the [PROG] function. Additional storage locations numbered #101 to #120 are actually settings saved using the data storage ([STOR]) function. These are listed with the stored programs to make it convenient to recall the instrument settings used when data was stored. These listings are preceded by a # mark to avoid confusing them with regular program settings. These special locations may be recalled and printed from the program menu, but must be stored, named, erased from the storage ([STOR]) function.

To utilize any of the program features, the program location must be selected first. To do this, first press the [PROG] key, which will bring up a list of available program settings on the CRT display. The asterisk (*) on the left side of the screen marks the current setting, which is also shown on the LCD. On the LCD an "E" means the location is empty, and an "F" means the location is full. Since there are a large number of storage locations, multiple screens are required to list them all. Entering the number of the stored program location through the numeric keypad will cause the instrument to jump to it, while rotating the SmartKnob™ will page through the available selections. Locations that have nothing in them will be listed as *EMPTY*. EMPTY locations allow only *STORE* functions to be performed to them. Full program storage locations will either be blank (unnamed) or have an entry for the name of the program setting. Functions that apply to full program storage locations are *RECALL*, *ERASE*, *NAME*, and *PRINT*.

Once the program storage number has been selected, the appropriate function should be selected by repeatedly pressing the [PROG] key until the LCD readout displays the desired function.

After performing the desired operation, one of the function keys such as [GAIN], [FREQ KHZ], or [POSN] will return the instrument to normal operation.

**STORE**

**STORE** records the instrument settings currently in use to a storage location. All instrument settings, including alarm, are saved to the program. Once a program is stored, it may be named using the *NAME* program function.

To store a setup, make sure that the settings the instrument is currently using are the desired ones. Then press the [PROG] key and selected the desired program number as described above. The selected location must be listed as *EMPTY* in order to be used. If not, choose another location or perform an *ERASE* function as outlined below.
Once the desired location is selected, press the [ENTR] key to store the program. The CRT screen will be re-drawn and the selected location will be listed with no name (blank) and the date on the far right of the CRT. Following this, if it is desired to name the program setting, perform the *NAME* function in this section.

*Example:*

To store the current instrument settings in location 35, first make sure this location is empty (see *ERASE* below), then perform the following procedure:

Repeatedly press the [PROG] key until the LCD readout displays **PROG STORE** in the upper left area.

Rotate the SmartKnob™ until the LCD reads **PROG STORE 35E**, or press [3], [5], [ENTR] on the numeric keypad.

Press the [ENTR] key to save the program. The bottom of the LCD display will read ***** STORING ***** momentarily, then the CRT display will be redrawn, with the name of location 35 blank.

**NAME**

The name function allows the operator to enter a name of up to 26 characters for a stored program. Names may be used to describe the test settings that are stored, reference a written test procedure, and so on. Only programs that are not empty may be named.

All capital letters may be used, together with the digits 0 through 9 and several special characters (. - / # %) and blanks.

When the name feature is selected, a screen similar to *Figure 3* will appear, displaying a list of available characters, the options *SAVE* and *QUIT*, and a highlighted entry line with an asterisk (*) used to point to the current character being entered. The right and left arrow keys ([→], [←]) are used to move the asterisk along the entry line. The [ERASE] key will clear the entire line, so new text may be entered. Rotating the SmartKnob™ moves the selection highlight from character to character, and through the *SAVE* and *QUIT* options. Pressing [ENTR] selects the character and moves the asterisk on the entry line to the right one character.

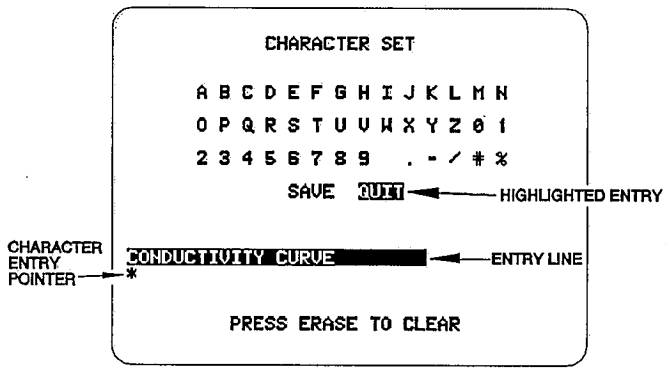



**Figure 4-3** *Alphanumeric Entry Screen*

The *SAVE* option will record the name changes made into the current program setting. The *QUIT* option will reset the name to its original value prior to selecting this function.

*Example:*

Save the current instrument settings to program number 12, then name it "TEST SETTINGS". First perform program *STORE* as outlined in the appropriate section above. Then,

Repeatedly press [PROG] until the LCD reads **PROG NAME** in the upper left area.

Rotate the SmartKnob™ until the LCD reads **PROG NAME 12F**, or press [1], [2], [ENTR] on the numeric keypad.

Press [ENTR] to name the program. The entry line should be blank. If it isn't, press [ERASE] to clear it.

Rotate the SmartKnob™ until the letter "T" is highlighted, then press [ENTR]

Rotate the SmartKnob™ until the letter "E" is highlighted, then press [ENTR]

In a similar manner, enter the rest of the text "TEST SETTINGS". The blank space can be done either by highlighting the blank space with the SmartKnob™, then pressing [ENTR] or by pressing the [→] key once to skip over the space. If a mistake is made, press the [←] key and repeat the entry.

When all the text is entered, rotate the SmartKnob™ until *SAVE* is highlighted, then press [ENTR].

Press any one of the basic function keys ([GAIN], [FREQ KHZ], [POSN], etc.) to return the instrument to normal operation.

**RECALL**

**RECALL** changes the current instrument settings to those stored in the selected program storage location. Any settings used by the instrument prior to performing this function are overwritten.

To recall a setting from the instrument, repeatedly press the [PROG] key until the upper left of the LCD reads **PROG RECALL**. Then rotate the SmartKnob™ until the CRT display shows an asterisk (*) next to the desired setting. The LCD should indicate that this location is full by showing an "F" at the right side of the readout.

Once the location has been selected, then press [ENTR] to read the program settings into the instrument.

*Example:*

To recall the setting from location 35, first make sure this location is full (see *STORE* above), then perform the following steps:

Repeatedly press the [PROG] key until the LCD readout displays **PROG RECALL** in the upper left of the LCD.

Rotate the SmartKnob™ until the LCD reads **PROG RECALL 35F**, or press [3], [5], [ENTR] on the numeric keypad.

Press the [ENTR] key to recall the stored program. The bottom line of the LCD will display *** **READING** *** for a moment.

The function settings are now programmed into the instrument. To return to normal operation, press one of the basic function keys, such as [GAIN], [FREQ KHZ], or [POSN].

**ERASE**

The erase program function allows the operator to erase the selected program setting. This is normally done before saving a new program to that location. If it is desired to erase all program settings, *SP96* should be used (see Section 4.13, *Reset and Clear Functions*).

In order to erase a program setting, the [PROG] key is pressed until the LCD readout displays **PROG ERASE** in the upper left area. The SmartKnob™ is then rotated until the LCD reads the proper storage number at the upper right side, or the location number

may be entered from the numeric keypad. Once this is done, the [ENTR] key is pressed to actually erase the location.

*Example:*

To erase the setting at location 35, perform the following steps:

Repeatedly press the [PROG] key until the LCD displays **PROG ERASE** in the upper left corner.

Rotate the SmartKnob™ until the LCD readout displays **PROG ERASE 35F**, or press [3], [5], and [ENTR] on the numeric keypad.

Press the [ENTR] key to erase the program setting. The bottom line of the LCD will display ***** ERASING ***** for a moment, then the CRT display will be redrawn with location 35 listed as *EMPTY*.

**PRINT**

The program print function uses the optional external serial printer option to make a hard copy of the currently selected program settings, listing all settings including alarm levels and status.

To use this feature, a serial printer must be properly attached and operating. See Section 6, *Rear Panel Connections* for further serial printer connecting information. If a printer is not properly connected, selecting the print function will cause the error message *** PRINT ERROR *** to display on the LCD.

Printing a program setting requires first that the desired program number be selected. Then, simply pressing the [ENTR] key will start the printout.

*Example:*

To print out a program setting previously stored in location 35 (see *STORE* above), perform the following steps:

Press the [PROG] key repeatedly until the LCD reads **PROG PRINT** on the upper left side.

Rotate the SmartKnob™ until the LCD reads **PROG PRINT 35F**, or on the numeric keypad press [3], [5], [ENTR].

Press [ENTR] to print the program settings.

To return to normal instrument operation, press one of the basic function keys ([GAIN], [FREQ KHZ], [POSN], etc.).

## 4.8 Data Storage

The Nortec-19e" SPO 3196 has an extensive selection of data storage capabilities. Data may be stored using one of two different methods, and once stored, the information and instrument setups may be accessed in a variety of ways.

Data may be stored as either *frozen data* or *captured data*. Frozen data captures an image as it is displayed on the screen, "frozen" at that instant of time. Captured data saves data for a period of time from 2.5 to 60 seconds, and can replay this data back to the screen, complete with alarms. Both methods of saving also record the current date and time of storage.

The captured data may be recorded using one of two methods. *Capture once* starts recording the capture as soon as the operation is selected, and will automatically end when the selected time has been reached. *Capture continuous* stops recording data when the operation is ended and automatically stores the preceding data for the allotted time period. This capture is ended manually by pressing the [STOR] key. When the continuous capture is ended, the information stored will be the information that was being recorded at the end of the capture. For example, suppose the capture time is set to 10 seconds, and the continuous capture function is selected. If the instrument is allowed to capture for a period of 25 seconds, then stopped, the data stored will start at 15 seconds from the initiation of the capture and continue to the end of the capture time.

The continuous capture feature is quite useful in determining the events that lead up to an alarm. Once the instrument is set to operate in the continuous capture mode, all operating features of the instrument are still available. Thus, gain, phase angle, frequency, and so on may be changed while the capture is still in progress. When an alarm occurs, the operator simply needs to press the [STOR] key and the instrument will have captured the events leading up to the alarm. These events may then be replayed using the *recall* feature.

Data in sweep modes (auto, external) cannot be captured but can be "frozen" and stored.

Once data has been stored through either the frozen data or capture methods, many things may be done with it:

* Data may be recalled to the screen for viewing
* The data may be printed out on an inspection report
* It may be recalled to Memory 2 (MEM2) for use as a reference signal
* The instrument settings in effect when the data was stored may be reviewed or restored to the instrument as outlined in Section 4.7, *Program Storage*
* The data and/or instrument settings may be downloaded to an external computer for further processing. (See Section 6, *Rear Panel Connections*, and Section 7, *Computer Interface*)

20 data storage locations are available. When any of the storage functions are selected, the upper right side of the LCD readout shows both the storage location number and the status of the storage:

E = Empty
F = Frozen Data is in this location
R = Capture/Replay data is in this location
W = Waterfall Display Data

Functions available through the [STOR] key are *FREEZE*, *CAPT ONCE* (capture once), *CAPT CONT* (capture continuous), *RECALL*, *ERASE*, *NAME*, and *PRINT*.

All data storage may be erased using the *SP97* function explained in Section 4.13, *Reset and Clear Functions* in this section.

**FREEZE**

The screen freeze function will store the information as it exists on the screen. This is analogous to taking a "snapshot" of the screen, as might be done with an oscilloscope camera.

The freeze function may be used to store an impedance plane display, a sweep display, and a complete waterfall display. When this function is selected, the current date and time are recorded in memory.

To invoke the freeze function, first press the [STOR] key repeatedly until the LCD readout displays **FREEZE** in its upper left hand corner. Then rotate the SmartKnob™ until the desired storage location is selected, or enter the location using the numeric keypad. Finally, press [ENTR] to store the screen.

A storage location must be empty before recording new data. To erase the location, refer to *ERASE* below.

*Example:*

To store the current screen data and settings to memory location 6, which should be empty, use the following steps:

Press the [STOR] key as many times as necessary until the upper left of the LCD readout indicates **FREEZE**.

Rotate the SmartKnob™ until the readout displays **FREEZE 6E**, or enter [STOR], [6], [ENTR] from the numeric keypad.

Press [ENTR] to record the data. The bottom line of the LCD will read **Storing...** for a moment. Once this message disappears, the information is stored.

**CAPTURE TIME**

Capture time is set using *SP1*. This sets the time period for the length of the Capture Once and Capture Continuous commands.

The time period available is from 2.5 to 60 seconds in steps of 2.5 seconds. Choosing this time period is based on the time required and the speed of the test data being recorded. Shorter periods of time offer higher resolution, and will capture brief movements of the eddy current signal. Longer periods of time record slow moving data well, but faster data may appear coarse when replayed. Selection of the time period may require some trial and error testing for optimum results.

The default setting for capture time is 10 seconds. Selecting SP99 (default reset) will reset this function back to 10 seconds.

To set the capture time, first press the [SP] key, then rotate the SmartKnob™ until the LCD readout indicates **SP 1 CAPT TIME**, then press [ENTR]; or press [SP], [1], [ENTR].

Once the capture time function is selected, turn the SmartKnob™ or enter from the numeric keypad to select a new length of time.

*Example:*

To set the capture time to 22.5 seconds, perform the following steps:

Press the [SP] key, then rotate the SmartKnob™ until the LCD readout shows **SP 1 CAPT TIME**, then press [ENTR], or press [SP], [1], [ENTR].

Either turn the SmartKnob™ until the LCD indicates **CAPTURE 22.5sec** or press [2], [2], [.], [5], [ENTR] from the numeric keypad.

**Note**

Only intervals of 2.5 seconds will be accepted. Other entries will be rounded to the nearest interval.

**CAPTURE ONCE**

The capture once feature of data storage allows the operator to save data from the time the capture is started until the time period set in *CAPTURE TIME* above has expired.

Only impedance plane data may be captured. The captured data may then be replayed or used as outlined above.

To start the capture, first make sure the capture time is set to the desired interval as described in *CAPTURE TIME* above. Then press the [STOR] key repeatedly until the LCD reads **CAPT ONCE** starting at the upper left side. Following this, select an appropriate empty storage location using the SmartKnob™ or numeric keypad.

To actually invoke the capture, press [ENTR] at this point. The LCD will then display **Storing...** on the bottom line for the duration of the capture. Pressing the [STOR] key during the capture time will stop the capture, but the data will remain valid up that point.

When the capture is complete, the bottom line of the LCD will display ***** WAIT ***** while the data is being recorded to memory. Once this message disappears, the data has been recorded in memory.

*Example:*

To capture a set of data into storage location 12, which is assumed to be empty, perform the following steps, after making sure the capture time is set as described in *CAPTURE TIME* above:

Press the [STOR] key repeatedly until the LCD readout shows **CAPT ONCE** starting at the upper left.

Turn the SmartKnob™ until the LCD reads **CAPT ONCE 12E**, or press [1], [2], [ENTR].

Press the [ENTR] key and start the eddy current test that will be recorded.

After the capture time expires, the instrument will display **Storing...**, then *****WAIT***** on the LCD. Once this message disappears, the data is recorded.

**CAPTURE CONTINUOUS**

Capture continuous records the same data as the Capture Once function. The difference is that the continuous function may be left on for an extended period of time, recording the eddy current signal continuously. Once the continuous capture is stopped, the most recent eddy current data may be recalled for replay on the screen.

Capture is available only in impedance plane mode. After the continuous capture is started, most instrument functions may still be changed, and the capture will continue to record the data. The only functions that are disabled are program ([PROG]) and storage ([STOR]).

To perform a continuous capture function, first repeatedly press the [STOR] key until the LCD reads **CAPT CONT** in the upper left corner. Then turn the SmartKnob™ until the LCD readout indicates the desired storage location number, followed by an "E" indicating

that the location is empty. If not empty, it must be erased. The storage location may also be selected using the numeric keypad.

Once the storage location has been selected, press [ENTR] to start the capture. The capture will then continue until the [STOR] key is pressed. Other functions may be selected while the capture is in progress.

*Example:*

To turn on continuous capture, with capture time at 10 seconds, and record the result to storage location 12: first make sure the storage location is empty and capture time is set to 10 seconds, then perform the following steps:

Repeatedly press [STOR] until the left top of the LCD readout indicates **CAPT CONT.**

Rotate the SmartKnob™ until the LCD reads **CAPT CONT 12E**, or press [1], [2], and [ENTR].

Press [ENTR] again to start the capture. The LCD readout will indicate **Storing...** on its bottom line. Other functions may be performed at this time.

When ready to review the most recent 10 seconds of captured data, press [STOR]. The LCD will indicate *** **WAIT** *** for a short period, after which the data is stored. To review the data, refer to *RECALL* below.

**RECALL**

The data recall function allows review of any stored data. If the data was stored as a frozen screen, this screen will be recalled rapidly for review. If stored as captured data, the eddy current signal will replay at the same speed as it was recorded.

**Note**

The letter after the storage location number in the upper right of the LCD readout indicates the type of data stored, with "E" indicating empty, "F" indicating frozen data, and "R" indicating capture/replay data, and "W" indicating waterfall data.

Regardless of the type of information stored, the sidebar section of the screen will indicate parameters in effect at the time of storage, while alarms that were in effect at that time will also be shown.

If the data being recalled was captured, any alarm conditions that occurred during capture should happen again.

**Note**

The replay captured function does have a couple of limitations with respect to alarms:

* The alarm latch feature is disabled, regardless of the original alarm latch setting.
* Alarms that occur for a very short period of time may be missed, particularly when long capture time periods are selected.

In addition, remember that the replayed data may appear more "coarse" than the original signal. This is more pronounced at the longer capture time settings.

To recall a stored setting, first press the [STOR] key repeatedly until the LCD readout displays **RECALL** at the top left. Then select the desired storage location using either the SmartKnob™ or the numeric keypad.

**Note**

The letter next to the storage location on the LCD should either be "F" (frozen), "R" (replay), or "W" (waterfall) in order to recall data.

Then press [ENTR] to recall the data. Frozen data will be displayed immediately, while captured (replay) data will be displayed at the same rate it was recorded. Once the display is finished, pressing the [ENTR] key will revert the CRT back to the listing of stored data.

*Example:*

If data is recorded as outlined in *CAPTURE ONCE* above, in memory location 12, then it may be replayed by performing the following steps:

Press the [STOR] key repeatedly until the LCD readout indicates **RECALL**. The CRT display will show a list of the storage locations, their names, and the dates that any data was stored.

Rotate the SmartKnob™ until the LCD readout indicates **RECALL 12R**, or press [1], [2], and [ENTR].

Press the [ENTR] key. The lower line of the LCD will momentarily display **Reading...**, then the CRT will switch to the impedance plane display and the data will be replayed.

Once the replay is complete, the LCD readout will indicate **Press ENTR Key.** Pressing the [ENTR] key will return the instrument to displaying the list of stored settings. To return to normal operation from this point, press another function key.

**ERASE**

The data storage erase function provides the operator with the means to clear a single storage location. This is normally done prior to storing new data to a particular location that had already been used.

If it is desired to erase all storage locations, *SP97* may be used instead of erasing them one at a time. *SP97* will clear all storage locations, refer to Section 4.13, *Reset and Clear Functions*.

In order to perform the erase function, press the [STOR] key repeatedly until the LCD reads **ERASE** in the upper left corner. The CRT will display the list of storage locations, with an asterisk (*) indicating the one currently selected. The currently selected location will also be shown in the upper right corner of the LCD readout.

Next, rotate the SmartKnob™ until the desired location is selected, or enter the location from the numeric keypad. Once the location number is selected, press [ENTR] to erase. The LCD readout will momentarily display the message **Erasing...**, then the CRT will redisplay the list with the selected location listed as **EMPTY**.

*Example:*

To erase the data stored in storage location 12, use the following sequence:

Repeatedly press [STOR] until the top left of the LCD readout indicates **ERASE**.

Turn the SmartKnob™ until the upper LCD indicates **ERASE 12F** or **ERASE 12R**, depending upon the type of data stored there, or press [1], [2], and [ENTR] on

the numeric keypad.

Press the [ENTR] key to erase the storage location. The LCD will momentarily display **Erasing...**, then the CRT will redraw, indicating that location 12 is empty. Pressing a function key will return the instrument to normal operation.

**NAME**

The name function for stored data allows the operator to enter a name of up to 26 characters for that data location. Names may be used to describe the test results that are stored, reference a written test procedure, and so on. Only storage locations that have data in them may be named.

When naming storage locations, all capital letters may be used, together with the digits 0 through 9, several special characters (. - / # %) and blanks.

When the name feature is selected, a screen similar to *Figure 4* will appear, displaying a list of available characters, the options *SAVE* and *QUIT*, and a highlighted entry line with an asterisk (*) used to point to the current character space. The right and left arrow keys ([→], [←]) are used to move the current character space. The [ERASE] key will clear the entire line, so new text may be entered. Rotating the SmartKnob™ moves the highlight from character to character, and through the *SAVE* and *QUIT* options. Pressing [ENTR] selects the character and moves the asterisk on the entry line to the right one character.

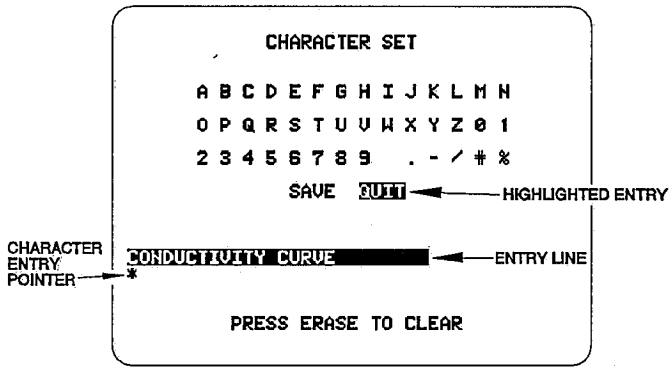



**Figure 4-4** *Alphanumeric Entry Screen*

The *SAVE* option will record the changes made to the current stored data number. The *QUIT* option will return the name to its original value prior to selecting this function.

*Example:*

Save the current data screen as a frozen screen to storage location number 12, then name this "TEST DATA". First perform data storage as a frozen screen as outlined in *FREEZE* above.

Repeatedly press [STOR] until the LCD reads **NAME** in its upper left corner.

Rotate the SmartKnob™ until the LCD reads **NAME 12F**, or press [1], [2], [ENTR] on the numeric keypad.

Press [ENTR] to name the frozen screen. The entry line should be blank. If it isn't, press [ERASE] to clear it.

Rotate the SmartKnob™ until the letter "T" is highlighted, then press [ENTR]

Rotate the SmartKnob™ until the letter "E" is highlighted, then press [ENTR]

In a similar manner, enter the rest of the text "TEST DATA". The blank space can be entered either by highlighting the blank space with the SmartKnob™, then

pressing [ENTR] or by pressing the [→] key once to skip over the space. If a mistake is made, press the [←] key and repeat the entry.

When all the text is entered, rotate the SmartKnob™ until *SAVE* is highlighted, then press [ENTR].

Press any one of the function keys ([GAIN], [FREQ KHZ], [POSN], etc.) to return the instrument to normal operation.

**PRINT**

The data storage print function uses the external serial printer option to make a hard copy of the information in the currently selected data storage location. This printout includes the screen data and all instrument settings that were in effect at the time the data was saved. In addition, this information is presented in an inspection report format that can be customized (see Section 4.9, *Printer Functions*) to suit individual needs.

To use this feature, a serial printer must be properly attached and operating. See Section 6, *Rear Panel Connections* for further serial printer connecting information. If a printer is not properly connected, selecting the print function will cause the error message *** PRINT ERROR *** to display on the LCD.

Printing stored data requires first repeatedly pressing [STOR] until the LCD readout displays **PRINT** in its upper left corner. Then, the desired location number is selected by rotating the SmartKnob™. After this is done, simply pressing the [ENTR] key will start the printout.

*Example:*

To print out a frozen screen previously stored in location 12 (see *FREEZE* above), perform the following steps:

Press the [STOR] key repeatedly until the LCD reads **PRINT** on the upper left side.

Rotate the SmartKnob™ until the LCD reads **PRINT 12F**, or on the numeric keypad press [1], [2], [ENTR].

Press [ENTR] to print the stored data.

To return to normal instrument operation, press one of the basic function keys ([GAIN], [FREQ KHZ], [POSN], etc.).

**MEMORY 2**

The memory 2 (MEM2) feature allows the user to place a reference on the CRT screen for comparison with the present test data. The memory 2 reference will not be erased when the [ERASE] key is pressed. Any frozen or captured signal may be used as a memory 2 reference. Because of this, the memory 2 reference is maintained even when instrument power is turned off.

**Note**

MEM 2 waterfall sweep mode is not compatible with the other MEM 2 modes. Therefore a waterfall MEM 2 cannot be displayed in non-waterfall sweep modes and vise versa.

Memory 2 operates as a toggle function, that is, if the function is selected when it is off, it will turn on the selected memory location. Conversely, if memory 2 is selected when already turned on, it will turn off that particular reference screen.

To turn on memory 2, first press the [MEM2] key. The top line of the LCD will read **MEM2**, then the current selected storage location for memory 2 followed by the location

status letter (**E** = Empty, **F** = Full, **R** = Capture/Replay), then **OFF**. The bottom line of the LCD will read the first 16 characters of any name that the storage location has. Select the storage location by rotating the SmartKnob™ or entering the location number from the numeric keypad. Once the storage location is selected, press [MEM2] again. This will turn the memory on. The LCD will momentarily display **Reading...** on the bottom line, then the stored data will appear.

To turn off memory 2, choose the memory 2 function if not already selected, then press [MEM2] again to turn it off.

The storage location used by memory 2 may only be changed when memory 2 is off.

## 4.9 Printer Functions

The Nortec-19e$^{II}$ SPO 3196 is capable of sending information through its RS-232C serial port to an optional external printer for hard copy records. The printer is connected through the 9 pin rear panel connector (refer to Section 6, *Rear Panel Connections*, for further information).

There are 3 basic types of printouts:

* The screen print. This prints whatever is on the screen at the time the [PRNT] key is pressed.
* Program settings. This lists the settings in any of the programmed instrument setting locations.
* Inspection report. The inspection report lists the contents of a data storage location, printing the eddy current screen together with the instrument settings in effect when the screen was saved.

  An additional feature of the inspection report is that much of the text on the printout may be customized either through the front panel or using serial port commands. Front panel text customization is available through the *CUSTOMIZE REPORT* feature listed below. Serial port commands may be found in Section 7, *Computer Interface*.

**SCREEN PRINT**

The screen print shows data as it is viewed on the CRT display, whether eddy current data or text. It is executed by simply pressing the [PRNT] key.

When the screen print is complete, it will not issue a form feed command to the printer. This allows up to 3 screens to be listed on a single page without changing the position of the paper.

To execute the screen print, make sure the printer is properly connected and that it is on line, then press the [PRNT] key. If the connections are correct, the printout will begin. While the printout is in progress, the CRT display will show the message **PRINTING...** until the printout is complete.

**PROGRAM PRINT**

The program print function uses the external serial printer option to make a hard copy of the currently selected saved program settings, listing all settings including alarm levels and status.

Before performing the program print function, make sure the printer is connected as outlined in Section 6, *Rear Panel Connections*, and is on line.

To print the settings in a particular stored program setting, first press the [PROG] key repeatedly until the LCD reads **PROG PRINT** on the upper left side. Then, select the program number desired by turning the SmartKnob™ or entering the program number from the numeric keypad.

Pressing [ENTR] will perform the print function.

An example of the program print function may be found under Section 4.7, *Program Storage*, earlier in this section.

**DATA PRINT**

The data print function uses the external serial printer option to make a hard copy printout of the information in the currently selected data storage number, including the screen data and all instrument settings that were in effect at the time the data was saved. This is done in an inspection report format that may be customized (see *CUSTOMIZE REPORT* below) to suit individual needs.

Before performing the data print function, make sure the printer is connected as outlined in Section 6, *Rear Panel Connections*, and is on line.

To print out a particular stored data setting, first press the [STOR] key repeatedly until the LCD reads **PRINT** on the upper left side. Then, select the program number desired by turning the SmartKnob™ or entering the program number from the numeric keypad.

Pressing [ENTR] will perform the print function.

An example showing key presses for the data print function may be found in Section 4.8, *Data Storage*.

**CUSTOMIZE REPORT**

The customize report feature of the Nortec-19e$^{II}$ SPO 3196 allows the operator to change the title, headings, and entry fields on the data printout report. Information such as company name, operator name, test procedure used, and so on may be entered so that it prints on every report.

The customize report information is divided into 3 types as shown in *Figure 6*:

* Header. The header is printed in double-width type at the top of the report. The header is printed on all report types.
* Label. A label describes a line of information, such as *COMPANY NAME* or *ADDRESS*. There are 7 available label fields in the report. If a label is left blank, nothing will print at its location.
* Field. A field is the actual information in the report, such as *ABC COMPANY* or *JOHN A. DOE*. There are 7 available fields that information can be placed in, corresponding to the 7 labels above. If a field is left blank, the printout will have an underline (_____) in its place so it can be handwritten.

The header and field may be up to 40 characters long, while the label may be up to 26 characters in length.

The customize report function is selected using *SP15*. To select this feature, press [SP], then rotate the SmartKnob™ until the LCD indicates **SP15 REPORT**, then press the [ENTR] key. SP15 can also be selected by pressing [SP], [1], [5], [ENTR].

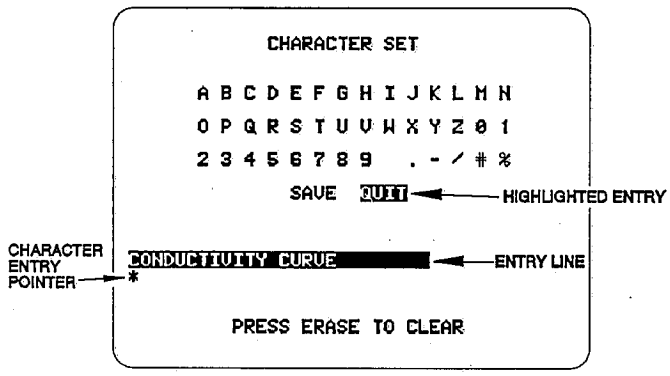



**Figure 4-5** *Alphanumeric Entry Screen*

Once the customize report function is selected, the CRT screen will show the current settings for each item. The LCD will indicate the contents of the highlighted line, such as **REPORT: FIELD 1**. The SmartKnob™ selects an item and highlights it. Once the desired item is selected (highlighted), press the [ENTR] key to enter or change text.

Once an item is selected for editing, an alphanumeric entry screen similar to *Figure 5* appears, showing a list of available characters including all capital letters, the numbers 0 through 9, several special characters (, - / # %), and a blank space. Also appearing are the options *SAVE* and *QUIT*, used to either save the changes after editing or to quit and return the item to the way it was originally. The item to be edited appears in inverse video at the bottom, with an asterisk (*) indicating the character position where the next entry will take place.

The right and left arrow keys ([→],[←]) are used to move the current character being entered. The [ERASE] key will clear the entire line, so new text may be entered. Rotating the SmartKnob™ moves the highlight from character to character, and through the *SAVE* and *QUIT* options. Pressing [ENTR] selects the character and moves the asterisk on the entry line to the right one character.

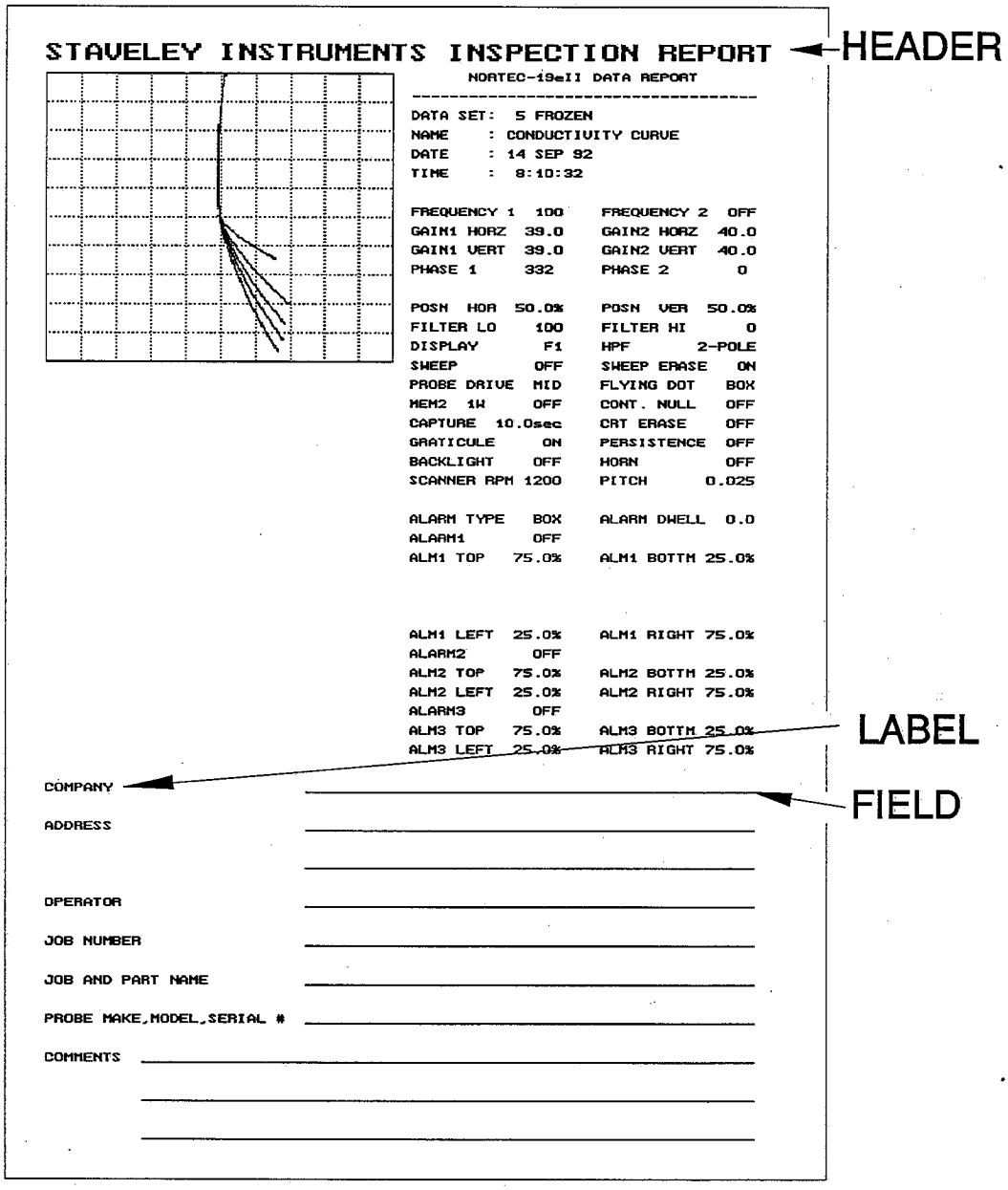



**Figure 4-6** *Sample Data Printout Showing Customized Report Fields*

*Example:*

Starting with the default items, change the header to "ABC COMPANY", label 1 to "DIVISION", and field 1 to "SOUTHEASTERN".

**Note**

SP97, clear stored data, will reset the items to default and clear all 20 stored data areas. See Section 4.13, *Reset and Clear Functions* for more details.)

Press [SP], then rotate the SmartKnob™ until **SP15 REPORT** is on the LCD, then press [ENTR], or press [SP], [1], [5], [ENTR]

Rotate the SmartKnob™ until the LCD reads **REPORT: HEADER**, then press [ENTR].

Press the [ERASE] key to clear the item.

Rotate the SmartKnob™ until "A" is highlighted, then press [ENTR].

Rotate the SmartKnob™ until "B" is highlighted, then press [ENTR].

In a similar manner, enter the rest of the text "ABC COMPANY". The blank space can be entered either by highlighting the blank space with the SmartKnob™, then pressing [ENTR], or by pressing the [→] key once to skip over the space. If a mistake is made, press the [←] key and repeat the entry.

When all the text of "ABC COMPANY" has been entered, turn the SmartKnob™ until *SAVE* is highlighted, then press [ENTR] to record the heading. The CRT display should change back to the list of items.

Rotate the SmartKnob™ until the LCD indicates **REPORT: LABEL 1**, then press [ENTR] to edit this item.

In the same manner as "ABC COMPANY" was entered, first erase the item with the [ERASE] key, then enter the text "DIVISION", then exit the editing function using the *SAVE* option.

Now, turn the SmartKnob™ until the LCD reads **REPORT: FIELD 1**, then press [ENTR].

As before, enter the text "SOUTHEASTERN" into field 1, then *SAVE* this new text.

Once the text is saved, the instrument may be returned to normal operation using any function key. The next time a stored program is printed, these items will appear in their appropriate positions on the test report.

**BAUD RATE** The baud rate of the RS-232 port is defaulted at 9600. The range of options includes 1200, 2400, 4800, 9600, 19200, and 38400. Adjustment is accessed through the special function SP26. To select a different baud rate press **[SP], [2], [6], [ENTR]**. The LCD then displays **BAUD**. Press **[ENTR]** to make an adjustment. The LCD displays the current baud rate which may be adjusted by rotating the SmartKnob™.

**PRINTER SELECTION** Use SP29 to select one of the printers supported by the Nortec 19eII. The printer selection includes Diconix, Epson, HP-PCL, and 24-pin. Each of these selections may be used with a wide range of printers. To use a specific printer it must support or emulate one of the printer selection modes and be configured accordingly. Some printers support several printer modes, so experimentation may be required to determine

which mode provides the best printout. The following paragraphs explain the printer mode for each selection.

**Diconix** may be used with Diconix printers and Epson graphics compatible printers. This printout was designed for printers capable of 180 dpi or greater. The following is a list of printers which have been tested with this selection.

| | |
|---|---|
| Diconix 150 | (see Diconix 150 setup) |
| Diconix 150 Plus | (see Diconix 150 Plus setup) |
| Diconix 180si | (see Diconix 180si setup) |

**Epson** mode was designed to work with Epson graphics compatible printers. This selection should be used for printers which have less than 180 dpi resolution. The following is a list of printers which have been tested with this selection.

| | |
|---|---|
| Epson LX-800 | (use factory configuration) |
| Epson EX-800 | (use factory configuration) |
| Panasonic KX-P1091i | (use factory configuration) |

**HP-PCL** is for HP compatible printers which support the PCL mode of operation. Several printers have been tested with this selection and are listed below.

| | |
|---|---|
| HP Laserjet I | (use factory configuration) |
| HP Laserjet II | (use factory configuration) |
| HP Laserjet III | (use factory configuration) |
| HP Laserjet IV | (use factory configuration) |
| HP Desk Jet 550/550C | (use factory configuration) |
| HP Paint Jet | (use factory configuration) |

The **24-pin** selection is for 24 pin graphics printers which support the AGM (alternate graphics mode). Listed below are the printers tested with this selection.

| | |
|---|---|
| Panasonic KX-P2124 | (use factory configuration) |
| Canon BJ 10ex | (see Canon BJ 10ex setup) |

### Diconix 150 and 150 Plus RS-232 Configuration

The Diconix 150 and 150 Plus printers contain 3 panels of DIP switches (21 switches in all). The ten (10) switches in panel A are used to control the printer set-up. The eleven (11) switches in panels B and C are used to configure the RS-232 interface. The following table describes the DIP switch configuration necessary to use the Diconix 150 and 150 Plus printers with the Nortec 19e$^{II}$ SPO 3196.

**Table 4-1** *Diconix 150/150 Plus DIP Switch Settings*

| PANEL | SWITCH | SETTING | DESCRIPTION |
|---|---|---|---|
| A | 1 | 0 | CR Definition **(CR Only)** |
| | 2 | 1 | LF Definition **(LF Only)** |
| | 3 | 0 | Perforation Skip **(No Skip)** |
| | 4 | 0 | Page Length **(11")** |
| | 5 | 0 | Font Selection **(Draft)** |
| | 6 | 0 | Emulation **(EPSON)** |
| | 7 | 0 | Character Set **(USA)** |
| | 8 | 0 | |
| | 9 | 0 | |
| | 10 | X | Reserved **(DO NOT CHANGE)** |
| | | | |
| B | 1 | 0 | Baud Rate **(9600 bps)** |
| | 2 | 0 | |
| | 3 | 0 | |
| | 4 | 1 | Word Length **(8 bits)** |
| | 5 | 0 | Parity **(None/OFF)** |
| | 6 | 0 | |
| | 7 | 0 | Data Protocol/Handshaking **(RDY/BSY)** |
| | 8 | 0 | |
| | | | |
| C | 9 | 1 | Disable DCD |
| | 10 | 1 | Disable CTS |
| | 11 | 1 | Disable DSR |

### Diconix 180si RS-232 Configuration

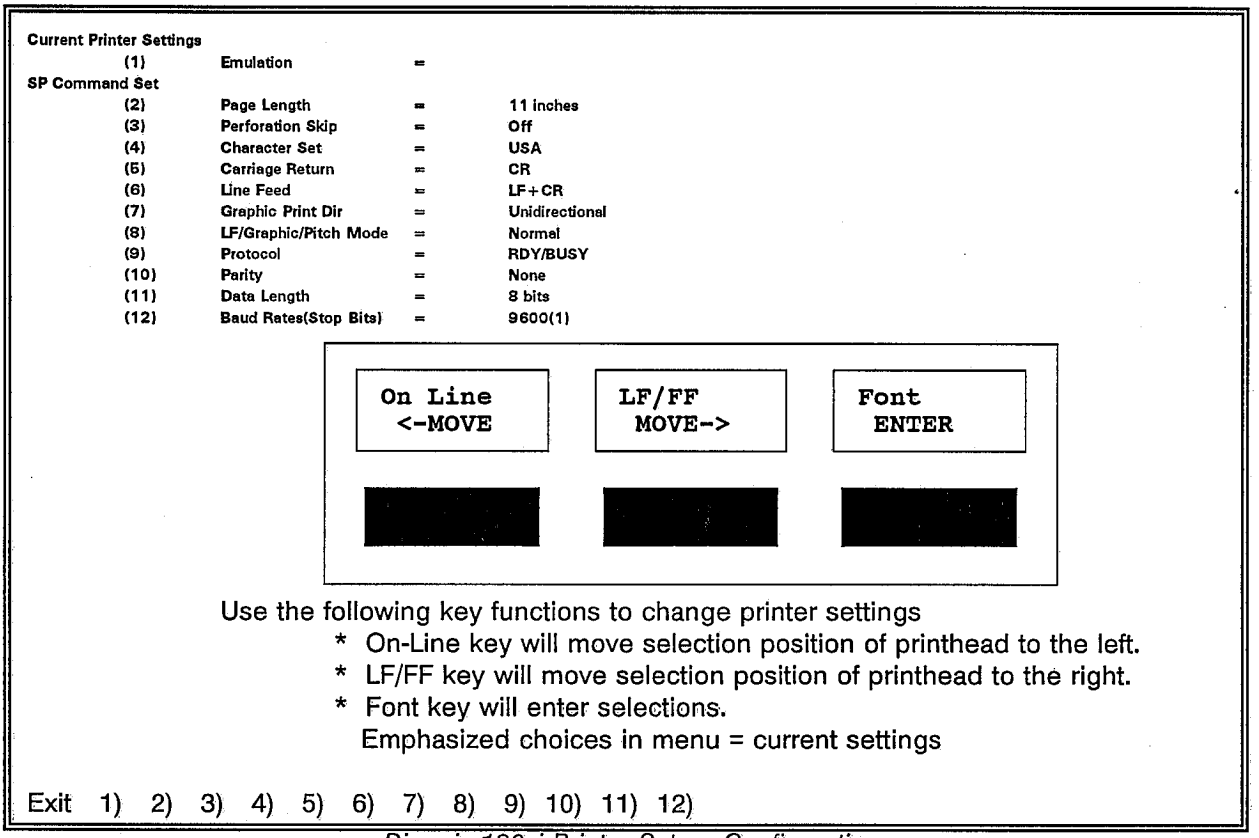
The Diconix 180si printer contains firmware, which when activated allows the operator to establish the printer configuration and RS-232 interface. The following list resembles the Set-Up printout and contains the settings necessary to use the Diconix 180si printer with the Nortec 19e$^{II}$ SPO 3196.

**Table 4-2** *Required Printer Set-up*

| | | | |
|---|---|---|---|
| (1) | Emulation | = | EPSON FX-85 |
| (2) | Page Length | = | 11 inches |
| (3) | Perforation Skip | = | Off |
| (4) | Character Set | = | USA |
| (5) | Carriage Return | = | CR |
| (6) | Line Feed | = | LF |
| (7) | Graphic Print Dir | = | Bidirectional |
| (8) | LF/Graphic/Pitch Mode | = | Normal |
| (9) | Protocol | = | RDY/BUSY |
| (10) | Parity | = | None |
| (11) | Data Length | = | 8 bits |
| (12) | Baud Rates(Stop Bits) | = | 9600(1) |

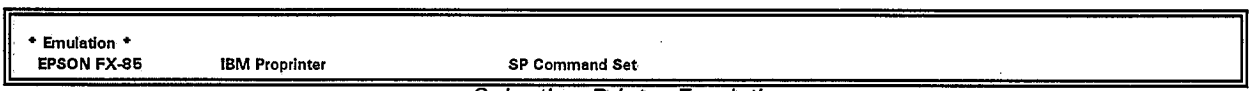
### Preparing the Diconix 180si for setup

To place the printer in "**Set-Up Mode**", press (and hold down) the **On Line** button while turning on the printer. When the **On Line** button is released, the Diconix 180si will print the current Set-Up configuration. The following list shows the printer setup as shipped from the factory:




*Diconix 180si Printer Set-up Configuration*

Using the On-Line or LF/FF button, move the printhead directly below the "**1)**" selection. Press the Font button to change the printer emulation.



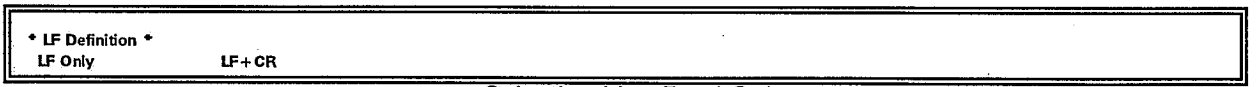

*Selecting Printer Emulation*

Using the On-Line button move the printhead directly below the "**EPSON FX-85**" selection. Press the Font button to select EPSON FX-85 emulation.




*Line-feed Definition*

Using the On-Line or LF/FF button, move the printhead directly below the "**6)**" selection. Press the Font button to change the printer's line feed definition.




*Selecting Line Feed Only*

Using the On-Line button, move the printhead directly below the **"LF Only"** selection. Press the Font button to select line feed only definition.

```
Exit  1)  2)  3)  4)  5)  6)  7)  8)  9)  10)  11)  12)
```

*Selecting Print Direction*

Using the On-Line or LF/FF button, move the printhead directly below the **"7)"** selection. Press the Font button to change the printer's graphic print direction setting.

```
* Graphic Print Direction *
  Uni-Dir                Bi-Dir
```

*Selecting Bi-Directional Print*

Using the LF/FF button, move the printhead directly below the **"BI-Dir"** selection. Press the Font button to select bidirectional graphic printing.

```
Exit  1)  2)  3)  4)  5)  6)  7)  8)  9)  10)  11)  12)
```

*Selecting "EXIT"*

Using the On-Line or LF/FF button, move the printhead directly below the **"Exit"** selection. Press the Font button to Exit the setup mode.

```
New Printer Settings
        (1)   Emulation              =   EPSON FX-85
        (2)   Page Length            =   11 inches
        (3)   Perforation Skip       =   Off
        (4)   Character Set          =   USA
        (5)   Carriage Return        =   CR
        (6)   Line Feed              =   LF
        (7)   Graphic Print Dir      =   Bidirectional
        (8)   LF/Graphic/Pitch Mode  =   Normal
        (9)   Protocol               =   RDY/BUSY
        (10)  Parity                 =   None
        (11)  Data Length            =   8 bits
        (12)  Baud Rates(Stop Bits)  =   9600(1)

Save Changes?
Yes     No      Change another      Reset to defaults
```

*Saving Printer Set-Up*

Using the On-Line or LF/FF button, move the printhead directly below the "**Yes**" selection. Press the Font button to save the printer setup changes.

```
** Just Saved **
```

*Set-up Confirmation*

The new setup is stored (in the printer) in non-volatile memory and the printer returns to normal operation.

**Preparing the Canon BJ 10ex for setup**

An 11 pin DIP switch is located inside the printer. The factory setting has all 11 switches set in the off position. To select the AGM setting, switch 7 must be turned on and all others left in the off position. The printer will then accept standard 24-pin printer graphics input.

## 4.10 PS-5 Scanner Operation

The PS-5 is a compact hand-held eddy current scanner powered by the Nortec-19e$^{II}$ Eddyscope. The PS-5 can be used for bolt hole as well as first layer fastener inspection. A wide selection of probes may be used with the PS-5, including absolute, differential, and reflection probes. Control features include null, erase, forward, reverse, translate/rotate, and rotate only. The motor speed is adjustable from 40 to 200 RPM using the *SP 22* function.

The presentation of the scanner on the screen is a horizontal line. The line will be nearly flat when no flaws are detected. When a flaw is detected, the line will show a vertical displacement. The horizontal position of this indication shows the angular position of that flaw. The left side of the screen (zero degrees) corresponds to the top of the scanner (curved portion); while the middle of the screen (180 degrees) is towards bottom of the scanner.

When using the scanner, only the vertical channel is displayed. Thus, the phase angle should normally be set for maximum displacement of the flaw in the vertical direction on an impedance plane before proceeding to the sweep setting[1]. *SP27* is set up to prompt the operator to set the phase angle before proceeding to sweep.

There are two methods for setting up the scanner, the automatic method using *SP27*, and the manual method using various front panel settings.

**AUTOMATIC SCANNER SETUP**

The automatic approach to using the PS-5 scanner involves using *SP27* to preset the scanning parameters. SP27 sets the gain and frequency to default values, and turns off F2. The display is set for impedance plane, with variable persistence turned on to keep the screen from cluttering. The operator then turns the SmartKnob™, adjusting rotation for maximum vertical flaw signal from the probe while spinning in a hole standard. Once the rotation is set, the operator presses the [ENTR] key to switch the instrument to external sweep mode, and proceeds with testing.

The following default values are loaded when SP27 is selected:

| | |
|---|---|
| RPM: | 100 RPM |
| Frequency: | 200 kHz |
| Gain: | 78 dB (horizontal and vertical) |
| Sweep: | External (after rotation adjustment) |
| F2: | Off |
| Filters: | High Pass - 8 Hz |
| | Low Pass - 40 Hz |

In order to set up the instrument using the automatic scanner setup method, use the following steps:

Insert a probe into the scanner, then connect the scanner to the instrument using the connector cable. Turn the scanner on/off switch (on the scanner) on so that the scanner is rotating. Make sure the shifter is in the ~~translate~~ rotate only position (towards the probe end of the scanner).

Press [SP], then rotate the SmartKnob™ until the LCD indicates **SP 27 SLOW SCAN**, then press [ENTR], or press [SP], [2], [7], and [ENTR] on the numeric keypad.

---

[1]Different probe types and different flaw detection techniques require specific setups. See Section 5.0 *Application Examples*, for a specific setup.

The LCD readout will display **SLOW SCAN RESET, Press ENTR Key** at this point.

Press the [ENTR] key once to confirm the reset.

The instrument will now be set up for scanner operation, but will be in impedance plane mode. The LCD will read **PHASE 1**, then list the current phase angle, as well as the prompt: **ENTR for sweep.** Turn the scanner on and insert the probe into a test standard. Use the shifter until the probe is positioned next to a flaw or notch. Rotate the SmartKnob™ and change the $\phi$ angle until the most signal is in the vertical direction.

Once the angle is set, press [ENTR] to switch to scanner operation. The instrument will now operate normally, allowing the operator to change any operating values to optimize the test. See the specific applications in Section 5.0 for help in these adjustments.

The alarm may be set at this point. Refer to the *Alarm Operation* of this section for more information. Normally, an alarm dwell of at least 0.1 seconds (*SP9*) is desirable for consistent alarm operation using the scanner.

*SP99* is a convenient way to reset the instrument back to normal impedance plane operation. This will return the present operating mode of the instrument to the initial defaults, without affecting stored programs or data settings. Details of SP99 are given in Section 4.13, *Reset and Clear Functions*.

**MANUAL SCANNER SETUP**

The scanner may also be set up manually. This would normally be done when the probe being used or the sensitivity of the test requires substantially different settings from those in the default values in the automatic setup listed above.

The steps used in setting the scanner manually start in the impedance plane mode by optimizing the instrument setup for the best flaw sensitivity in the vertical direction. Then set the frequency, gain, and filters as appropriate. Next, the external sweep function is selected. Any further adjustments are then made, followed by setting the sweep alarm if desired.

*Example:*

To set the 19e$^{II}$ instrument for PS-5 scanner operation, 100 RPM, 200 kHz probe, gain to 78 dB, high pass filter setting to 2 Hz, and probe drive to *HIGH*, perform the following steps. The instrument is assumed to have been set to default (*SP99*):

Set the scanner speed to 100 RPM by pressing the [SP], [2], [2], [ENTR] and rotating the SmartKnob™ until the LCD reads 100.

Set the frequency to 200 kHz by pressing [FREQ KHZ], then rotating the Smart Knob™ until the LCD reads **FREQUENCY 1 200.**

Set the gain to 70 dB by pressing [GAIN] then turning the SmartKnob™ for an LCD readout on the bottom line of **H70.0 V70.0.**

Set the high pass filter to 2 Hz by repeatedly pressing the [FLTR] key until the top right of the LCD reads **FILTER HI**, then rotating the SmartKnob™ for an LCD readout indication of **FILTER HI 2.**

Select SP2 by pressing [SP], [2], [ENTR]. Rotate the SmartKnob™ until the LCD

readout indicates **PROBE DRIVE HI.**

Make sure the scanner is connected properly, attached to the instrument, and an appropriate probe is mounted in the scanner. Turn on the scanner in the rotate mode only, position it in a test standard next to a flaw or notch.

Press [$\phi$ ANGL] and turn the SmartKnob™ until the signal is showing the flaw signal in a vertical direction. The [ERASE] key may have to be used periodically to see the signal more clearly; or the Variable Persistence function (SP4) may be used to clear the screen automatically every few seconds.

Press the [SWP] key repeatedly until the LCD readout displays **SWEEP EXTERNAL.** Minor adjustments may need to be made to optimize the flaw indication. Examples are given for specific settings of flaw detection in Section 5.0, *Application Examples.*

If an alarm is desired, refer to the Alarm Operation section below. Normally, an alarm dwell of at least 0.1 seconds (*SP9*) is desirable for consistent alarm operation using the scanner.

The instrument is now ready for testing.

**ALARM OPERATION**

When the 19e$^{II}$ instrument is operated using a rotating scanner, the only alarm available is a simple high/low threshold alarm. This alarm is automatically selected whenever the display mode is set to *EXTERNAL SWEEP*.

The polarity of the external sweep alarm may be positive or negative. The negative alarm is normally used, triggering the alarm whenever one of the thresholds is exceeded. The positive alarm may be used when it is desired to have the alarm in only one direction.

When this alarm is used with the PS-5 Scanner, the alarm dwell should be set to 0.1 seconds or longer for reliable alarm operation.

The [ALM] key allows the operator to turn the alarm on/off and set its polarity. To activate the alarm, press [ALM], then rotate the SmartKnob™ until the LCD readout displays **ALARM1 POSITIVE** or **ALARM1 NEGATIVE** as appropriate.

The [↑] ([8]) key allows the operator to adjust the top threshold, while the [↓] ([2]) key invokes adjustment of the bottom threshold. Pressing one of these keys followed by rotation of the SmartKnob™ will change the selected threshold.

*Example:*

Set the sweep alarm to negative polarity, and adjust the top threshold to 62.5%, and the bottom threshold to 22.0%. First make sure the instrument is set for scanner operation as outlined above. Then, perform the following steps:

Press the [ALM] key, then rotate the SmartKnob™ until the LCD displays **ALARM1 NEGATIVE.**

Press the [↑] ([8]) key, and turn the SmartKnob™ for an LCD readout of **ALM1 TOP 62.5%.**

Press the [↓] ([2]) key, then rotate the SmartKnob™ until the LCD displays **ALM1 BOTTM 22.0%.**

## 4.11 19/RA Handheld Scanner Operation

The Nortec-19e$^{II}$ will operate in concert with the optional 19/RA handheld scanner. This scanner is constant speed and non-indexing, rotating at the default value of 1200 RPM. It can be used for inspection of fastener holes, and also used to check for first layer flaws using a special surface probe similar to a pencil probe.

The presentation of the scanner on the screen is a horizontal line. The line will be nearly flat when no flaws are detected. When a flaw is detected, the line will show a vertical displacement. The horizontal position of this indication shows the angular position of that flaw. The left side of the screen (zero degrees) corresponds to the top of the scanner (opposite from the handle); while the middle of the screen (180 degrees) is towards the handle.

When using the scanner, only the vertical channel is displayed. Thus, the instrument rotation should normally be set for maximum displacement of the flaw in the vertical direction on the impedance plane before proceeding to the sweep setting. *SP3* is set up to prompt the inspector to set the rotation before proceeding to sweep.

There are two methods for setting up the scanner, the automatic method using SP3, and the manual method using various front panel settings.

**AUTOMATIC SCANNER SETUP**

The automatic approach to using the 19/RA scanner involves using *SP3* to initiate the automatic setup. SP3 sets the gain and frequency to default values, and turns off F2 on dual frequency instruments. The display is set for impedance plane, with variable persistence turned on to keep the screen from cluttering. The operator then turns the SmartKnob™ to adjust the phase angle to achieve maximum vertical signal from the probe while spinning in a hole standard with a flaw. Once the rotation is set, the operator presses the [ENTR] key to switch the instrument to external sweep mode, and proceeds with testing.

The following default values are loaded when SP3 is selected:

| | |
|---|---|
| Frequency: | 500 kHz |
| Gain: | 72 dB (horizontal and vertical) |
| Sweep: | External (after rotation adjustment) |
| F2: | Off |
| Filters: | High Pass - 200 Hz |
| | Low Pass - 500 Hz |

500 kHz is the most common setting for 19/RA scanner probes. The increased gain is necessary for detecting smaller flaws, although only vertical gain matters in the sweep mode. Most scanner testing is done with a single frequency. The default filter settings are usually close to optimum for hole probes.

In order to set up the instrument using the automatic scanner setup method, use the following steps:

Attach the probe to the scanner, then attach the scanner through its cable to the front panel *PROBE* connector. Turn the scanner on/off switch (on the scanner) on so that the scanner is rotating.

Press [SP], then rotate the SmartKnob™ until the LCD indicates **SP 3 SCANNER,** then press [ENTR], or press [SP], [3], and [ENTR] on the numeric keypad.

The LCD readout will show **SCANNER RESET, Press ENTR Key** at this point.

Press the [ENTR] key once to confirm the reset.

The instrument will now be set up for scanner operation, but will be in the impedance plane mode. The LCD will read **PHASE 1**, then list the current rotation value, as well as the prompt: **ENTR for sweep**. Turn on the scanner so that it is rotating, then hold it in a test standard next to a flaw or notch. Rotating the SmartKnob™ will change the $\phi$ angle. The angle should be set at this point for the most signal in the vertical direction.

Once the angle is set, press [ENTR] to switch to scanner operation. The instrument will now operate normally, allowing the operator to change any operating values to optimize the test.

The alarm may be set at this point. Refer to the *Alarm Operation* of this section for more information. Normally, an alarm dwell of at least 0.1 seconds (*SP9*) is desirable for consistent alarm operation using the scanner.

*SP99* is a convenient way of reverting the instrument back to normal impedance plane operation. This will return the current operating mode of the instrument to initial defaults, without affecting stored program or data settings. Details of SP99 are given in Section 4.13, *Reset and Clear Functions*.

**MANUAL SCANNER SETUP**

The scanner may also be set up manually. This would normally be done when the probe being used or the sensitivity of the test requires substantially different settings from those in the default values in the automatic setup listed above.

The steps used in setting the scanner manually start in the impedance plane mode by optimizing the instrument setup for the best flaw sensitivity in the vertical direction. Then set the frequency, gain, and filters as appropriate. Next, the external sweep function is selected. Any further adjustments are then made, followed by setting the sweep alarm if desired.

*Example:*

To set the instrument for 19/RA scanner operation, 500 kHz probe, gain to 60 dB, high pass filter setting to 200 Hz, and probe drive to *HIGH*, perform the following steps. The instrument is assumed to have been set to default (*SP99*):

Set the frequency to 500 kHz by pressing [FREQ KHZ], then rotating the Smart Knob™ until the LCD reads **FREQUENCY 1 500**.

Set the gain to 60 dB by pressing [GAIN] then turning the SmartKnob™ for an LCD readout on the bottom line of **H60.0 V60.0**.

Set the high pass filter to 200 Hz by repeatedly pressing the [FLTR] key until the top right of the LCD reads **FILTER HI**, then rotating the SmartKnob™ for an LCD readout indication of **FILTER HI 200**.

Select SP2 by pressing [SP], [2], [ENTR]. Rotate the SmartKnob™ until the LCD readout indicates **PROBE DRIVE HI**.

Make sure the scanner is connected properly, attached to the instrument, and an appropriate probe is mounted in the scanner. Turn on the scanner so that it is in the rotate mode only, position it in a test standard next to a flaw or notch.

Press [$\phi$ ANGL], then turn the SmartKnob™ until the signal is showing the flaw

signal in a mostly vertical direction. The [ERASE] key may have to be used periodically to see the signal more clearly; or the variable persistence function (SP4) may be used to clear the screen automatically every few seconds.

Press the [SWP] key repeatedly until the LCD readout displays **SWEEP EXTERNAL**. Minor adjustments may need to be made to optimize the flaw indication.

If an alarm is desired, refer to the Alarm Operation in this section. Normally, an alarm dwell of at least 0.1 seconds (*SP9*) is desirable for consistent alarm operation using the scanner.

The instrument is now ready for testing.

## 4.12 Date and Time

Date and time is kept internally in the Nortec-19e$^{II}$ SPO 3196 instrument. This information is shown on program and data printouts, and the date is also shown on the CRT listings of stored programs and eddy current data.

Occasionally, it may be necessary to change the date or time, such as when the instrument is transported across time zones. This section details the functions that allow such changes to be made.

**DATE** *SP14* allows the inspector to change the date entry. Date is kept in the format day, month, year, with the month using 3 letters to designate it, and the last two digits of the year, such as **01 JAN 92**.

To change the date setting, select SP14 by pressing [SP], then rotating the SmartKnob™ until the LCD readout indicates **SP 14 DATE**, then pressing [ENTR]. SP14 may also be selected by pressing [SP], [1], [4], [ENTR].

Once the date function is selected, the bottom line of the LCD will show the date as it is currently in the instrument, while the top left of the LCD will display **DAY** to indicated that the day may be changed. To change the day, simply rotate the SmartKnob™. Note that the instrument will accept dates from 1 to 31 regardless of the month selected, so the operator must put in valid dates.

Once the day is set, press the [ENTR] key. The LCD will now read **MONTH** in the top left corner, and rotating the SmartKnob™ will set the month.

After the month is set, press the [ENTR] key again. The LCD will read **YEAR** in it's top left corner, and turning the SmartKnob™ will change the year.

The day, month, and year settings may be cycled through by repeatedly pressing the [ENTR] key.

*Example:*

Set the date to January 1, 1992.

Select *SP14* by pressing [SP], then turning the SmartKnob™ until the LCD readout indicates **SP 14 DATE**, then pressing [ENTR], or press [SP] then [1], [4], and [ENTR] on the numeric keypad.

With the top left of the LCD indicating **DAY**, rotate the SmartKnob™ until the upper right of the LCD shows **1**.

Press the [ENTR] key. The LCD should now show **MONTH** in the upper left. Rotate the SmartKnob™ until the upper right of the LCD displays **JAN**.

Press the [ENTR] key again. The LCD should now show **YEAR** in the upper left corner. Turn the SmartKnob™ to get a value of **92** in the upper right corner of the LCD.

The date is now set. Normal instrument operation may be continued.

**TIME** *SP13* selects the time change function. The time is kept in hours, minutes, and seconds format, such as *12:58:42*. Hours are in 24 hour format, with numbers greater than 12 indicating afternoon.

To update the currently stored time, press [SP], then turn the SmartKnob™ until the LCD indicates **SP 13 TIME**, then press [ENTR]; or press [SP], [1], [3], [ENTR].

After selecting the time change function, the bottom line of the LCD will show the time as it is currently stored in the instrument, while the top left of the LCD will display **HOUR** indicating that the current hour setting may be changed at this point. To change hours, rotate the SmartKnob™.

Once the hour is set, press [ENTR], which will cause the LCD to indicate **MINUTES** in the upper left corner. Rotate the SmartKnob™ to change the minutes setting.

After setting minutes, press [ENTR] again to set seconds. Rotation of the SmartKnob™ at this point will change the seconds setting.

Note that the value adjusted by the SmartKnob™ is initially set to the value of the clock when the function is first selected. Once the SmartKnob™ is turned, this value is recorded back into the clock.

The hour, minutes, and seconds settings may be sequenced through by repeatedly pressing the [ENTR] key.

*Example:*

Set the clock to 13:21:20 (1:21:20 PM):

Press [SP], then rotate the SmartKnob™ until the LCD indicates **SP 13 TIME**, then press [ENTR], or press [SP], [1], [3], and [ENTR].

Rotate the SmartKnob™ until the top line of the LCD shows **HOUR 13.** Then press [ENTR] to change to the minutes setting.

The LCD should show **MINUTES** in the upper left. Rotate the SmartKnob™ until the LCD indicates **MINUTES 21** on the top line. Then press [ENTR] again.

With the LCD showing **SECONDS** at the top left, rotate the SmartKnob™ until a value of 20 is set for seconds. Note that the clock will continue running immediately from this point.

The time clock is now set.

## 4.13 Reset and Clear Functions

The Reset and Clear Functions allow various degrees of reset for instrument settings and stored information. Four functions are provided to provide a great deal of flexibility when such operations are necessary. These functions occupy the highest SP numbers to separate them from other SP functions, for additional protection against accidental reset.

The four levels of reset are:

* Clear programs (*SP96*). This function clears all 100 stored program settings, resetting them to *EMPTY*.
* Clear data (*SP97*). This function clears the 20 eddy current data storage locations and loads the default values for the custom text report feature.
* Clear all (*SP98*). Invoking this function will clear the entire instrument, including current function settings, programs, stored eddy current data, and the customize report text.
* Load defaults (*SP99*). SP 99 loads the default settings for instrument operation, without affecting stored data or programs, or customized report text. This function is used frequently to change the operating state of the instrument to a known value before changing parameters for a particular test.

**CLEAR PROGRAMS**

The clear program function allows the inspector to remove all 100 stored program settings from the instrument in a single operation. This is useful when it is desired to load a new set of programs or to discard obsolete or superseded eddy current inspection techniques.

This procedure should be done only after carefully examining the information stored in each of the programs to assure that it is not needed any more, or after downloading the stored programs to an external computer (see Section 7, *Computer Interface*).

To clear all stored programs, first select *SP96* by pressing the [SP] key, then rotating the SmartKnob™ until the LCD readout displays **SP 96 CLR PROGS**, then pressing [ENTR]; or pressing [SP], [9], [6], and [ENTR].

Once the clear programs function is selected, the LCD readout will display **CLEAR PROGRAMS, Press ENTR Key.** Pressing the [ENTR] key at this point will clear the program settings, while pressing a function key will abort.

**CLEAR DATA**

This function clears all 20 stored data areas in the Nortec-19e" SPO 3196 and resets any text that may have been entered using the customize report text feature to default (*SP15*, see Section 4.9, *Printer Functions*).

This function should be invoked only after examining the stored data areas to assure that vital information will not be lost, or after downloading the information to an external computer as detailed in Section 7, *Computer Interface*.

To clear all stored data, first select *SP97* by pressing the [SP] key, then turning the Smart Knob™ for an LCD readout of **SP 97 CLR DATA**, then pressing [ENTR]; or by entering [SP], [9], [7], and [ENTR].

After selecting the clear data function, the LCD readout will show the prompt **CLEAR DATA, Press ENTR Key.** Pressing [ENTR] at this point will clear all the stored data and reset the customized report text to default, while the clear data function may be aborted by pressing any function key.

**CLEAR ALL** This function will clear the entire instrument, resetting all stored values to *EMPTY* and setting the instrument operating parameters and the customized report text to default. It is useful when first receiving an instrument to set it to a known state.

The **CLEAR ALL** function should be done after assuring that all stored information is no longer useful or has been recorded to an external computer as explained in Section 7, *Computer Interface*.

In order to clear the instrument, select *SP98* by first pressing the [SP] key, then turning the SmartKnob™ until the LCD readout indicates **SP98 CLR ALL**, then pressing [ENTR]; or pressing [SP], [9], [8], and [ENTR].

After selecting the **CLEAR ALL** feature, the LCD readout will display **CLEAR INSTRUMENT, Press ENTR Key.** Pressing [ENTR] at this point will clear the instrument, while pressing any function key will prevent this from occurring.

**LOAD DEFAULT** The load default settings function, *SP99*, is useful to restore the instrument to a known state before changing instrument parameters for a new test. It assures that all parameters are a constant value before proceeding.

The default settings for the instrument are as follows:

| | |
|---|---|
| Display (DSPL) | F1 only |
| Memory 2 (MEM2) | OFF |
| Sweep | OFF |
| Frequency | F1 = 100 KHz |
| | F2 = OFF (dual frequency instruments) |
| Gain | 40.0 dB, horizontal and vertical, F1 and F2 |
| $\phi$ angle | 0 degrees, F1 and F2 |
| Position | 50 %, horizontal and vertical (middle of screen) |
| Filter | Lowpass = 100 Hz |
| | Highpass = 0 Hz |
| Alarms | All alarms off |
| Sweep alarm | Top threshold set to 75% |
| | Bottom threshold set to 25% |
| Box alarm | Top thresholds set to 75% |
| | Bottom thresholds set to 25% |
| | Left thresholds set to 25% |
| | Right thresholds set to 75% |
| HPF Pole selection | 2 pole |
| Polar alarm | Middle of screen, 25% radius |
| Pie alarm | Middle of screen, 25% radius, starting angle of 0°, ending angle of 90° |
| Polygon alarm | Vertex 1 - 35% (H), 55% (V) |
| | Vertex 2 - 45% (H), 65% (V) |
| | Vertex 3 - 55% (H), 65% (V) |
| | Vertex 4 - 65% (H), 55% (V) |
| | Vertex 5 - 65% (H), 45% (V) |
| | Vertex 6 - 55% (H), 35% (V) |
| | Vertex 7 - 45% (H), 35% (V) |
| | Vertex 8 - 35% (H), 45% (V) |

| | |
|---|---|
| Sorting gate | Thresholds set to 25% and 75%, horizontal and vertical |
| Waterfall trigger | Sync |
| Dot type | Box |
| Scanner RPM | 1200 |
| Scanner pitch | 0.025 |
| Points/sweep | 120 |
| Baud rate | 9600 |
| Max sweep (waterfall) | 32 |
| Scanner Zero | 0 |
| Printer Selection | Diconix |
| External Sweep Averaging | Off |

The load default will replace any parameter settings currently in the instrument with those listed above. It will not affect stored programs, stored data, or customized report text.

To perform the load default function, first select *SP99* by pressing [SP] then turning the SmartKnob™ until the LCD readout displays **SP 99 LOAD DEF**, then pressing [ENTR]; or by pressing [SP], [9], [9], and [ENTR].

Once the SP99 function is selected, the LCD readout will indicate **LOAD DEFAULT, Press ENTR Key.** Pressing the [ENTR] key at this point will load the above settings to the instrument, while pressing any function key will abort the load default operation.

## 4.14 Waterfall Display Functions

The waterfall mode of operation is used in conjunction with a scanner. Scanner operation is discussed in Section 4.10 and 4.11. The term *Waterfall* is descriptive of the type of screen display which appears when this mode is used. It consists of a consecutive series of sweeps across the screen, each vertically offset slightly below the previous sweep. Each sweep represents one rotation of the scanner connected to the instrument, provided a sync pulse is supplied by the scanner in use. *Figure 7* shows a typical waterfall screen resulting when the probe is running in clear air.

The number of sweeps is adjustable from a minimum of 5 to a maximum of 64 using the special function, **SP-23**. The default value is 32 sweeps. A test setup which necessitates the use of more than 32 sweeps automatically places the first 32 lines on one screen display and the remainder on a second. Because only 32 lines may be displayed at one time it is then necessary to use special function, **SP-21** to scan through the entire display.

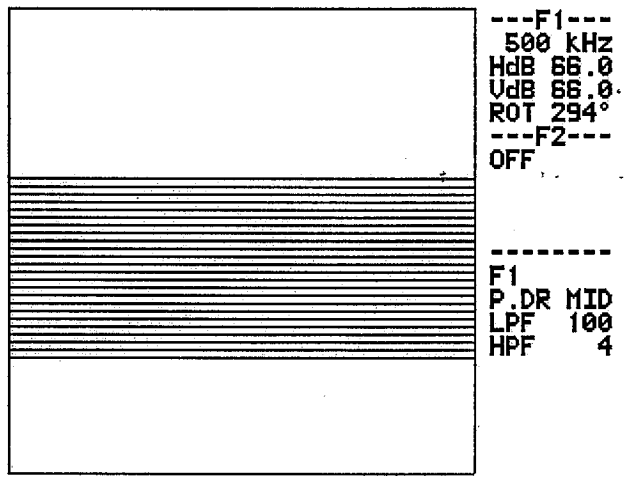



**Figure 4-7** *Clear Waterfall Display*

When a scanner with a fixed pitch is used, such as the PS-5, each sweep represents the forward movement of the probe into the test hole as determined by the pitch of the scanner. When a hand-held scanner is used, such as the Staveley 19/RA and PS-5, the sweep lines only represent the relative forward movement of the probe through a hole.

Each time the **[ERASE]** button is pressed the current waterfall screen is erased and the instrument is prepared to capture a new waterfall.

The special functions, **SP-21** through **SP-25**, which will be discussed in detail, are available to adjust all of the parameters of the Waterfall mode.

All waterfall displays may also be stored in the instrument memory for future use. Once stored, each display can be recalled and analyzed in either the waterfall mode, or one line at a time in the sweep mode, or the impedance plane mode. A side-bar adjacent to the screen display shows the parameters of the stored display including rotation angle, the maximum and minimum depth of the displayed lines, and the depth of the selected line.

Section 4.10 and 4.11 (Scanner Operation) should be read before using the waterfall mode.

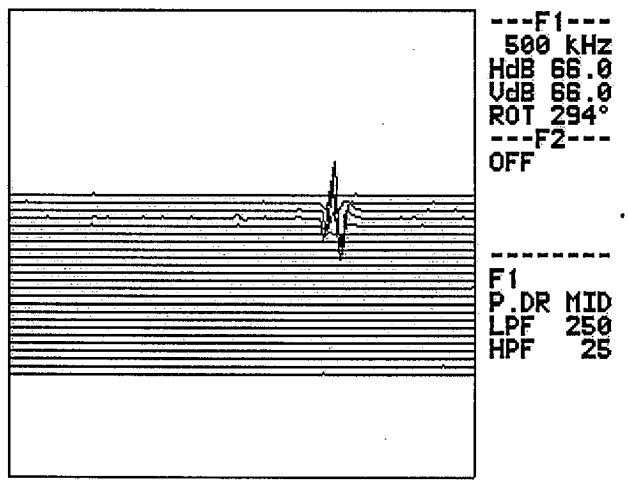



**Figure 4-8** *Vertical Deflection of Waterfall Sweep*

The following steps should be taken to set-up the instrument for operation in the waterfall mode using a fixed-pitch scanner such as the Staveley PS-5:

Position the scanner such that it will enter the test hole without binding. This may require the use of an adjustable vise which maintains alignment of the hole in the test piece with the rotating probe.

Attach the connecting cables between the scanner and the Nortec 19e$^{II}$ SPO 3196. Some scanners such as the Staveley PS-2 require a separate cable for signal and another for sync pulses. The I/O port on the rear-panel can be used for the sync input.

Apply power to the scanner equipment and the instrument.

**Note**

The special function SP27 may be used to set the scanner default values by pressing **[SP], [2], [7], [ENTR], [ENTR].** It may be necessary to adjust some of the values such as HI PASS and LO PASS filters and GAIN after exiting the SP27 function. The SP27 function may be of no value in the set-up of some scanners.

Set the RPM of the scanner to the desired value and then adjust the SCANNER RPM of the instrument to match that of the scanner. Press **[SP], [2], [2], [ENTR].** In the case of the Staveley PS-2 scanner the speed control is located in a separate unit from the scanner. The display on the speed control unit indicates SECONDS PER REVOLUTION. Matching RPM to this value may require some calculating.

*Example:*

If the scanner is rotating at an indicated value of 1.000 (1 sec./rev.) it is turning 60 revolutions per minute. Set the SP22 function to 60.

*Example:*

If the scanner is rotating at an indicated value of 1.5 (1.5 sec./rev.) it is turning 40 revolutions per minute. Set the SP22 function to 40.

Use the special function SP25 to verify that the SCANNER PITCH value of the instrument matches that of the scanner. Press **[SP], [2], [5], [ENTR].** The LCD should display **PITCH 0.025** which is the default value. Rotate the SmartKnob™ to adjust the pitch.

If satisfactory results are not obtained it may be necessary to adjust the following parameters.

**HIGH PASS FILTER** - Press **[FLTR].** Press **[2]** (up) or **[8]** (down) to highlight the **HPF** sidebar. Rotate the SmartKnob™ to decrease the value to as low as 5 or 10.

**ROTATION ANGLE** - Press **[ANGL/$\phi$].** Rotate the SmartKnob™ for the greatest amount of vertical deflection. This is best accomplished with the instrument SWEEP in the impedance plane mode. Use the [SWP] button to select SWEEP OFF for this adjustment.

**GAIN** - Press **[GAIN]**. Rotate the SmartKnob™ to adjust vertical and horizontal gain simultaneously. To adjust only the vertical gain press **[GAIN]**, **[V]**, and rotate the SmartKnob™.

Press **[SWP]** repeatedly until the LCD displays **SWEEP WFALL SYNC.** Start the scanner probe into the test hole and press **[ERASE]** to clear the screen for a fresh waterfall display. With each rotation of the scanner a sweep line appears on the screen vertically offset below the preceding line. Each new line represents the depth to which the probe has progressed into the test hole relative to the pitch of the scanner.

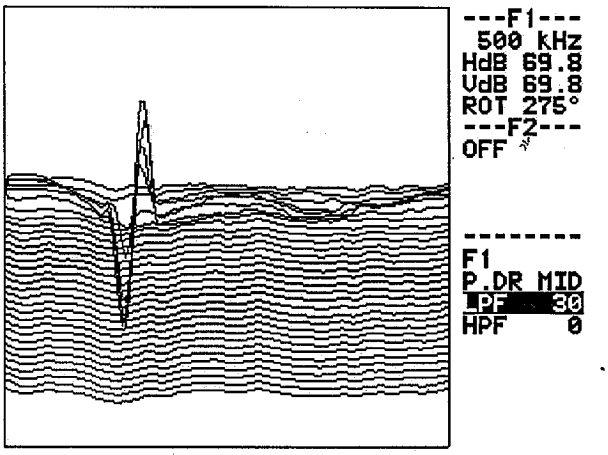



**Figure 4-9** *Sample Defect In A Hole Standard*

The following steps should be taken to set-up the instrument for operation in the waterfall mode using a hand-held scanner:

Attach the probe into the scanner, and then attach the scanner through its cable to the front panel *PROBE* connector.

Select SP3 by pressing **[SP]**, **[3]**, **[ENTR]**. This is the AUTOMATIC SCANNER SETUP function which sets the default values suited for most hand scanner applications. Press **[ENTR]** one more time to select the SP3 function. Turn **ON** the scanner to begin rotation of the probe. Place the probe tip in a hole standard and observe the screen display. Position the probe so that the simulated flaw signal causes detection of the dot. Rotate the SmartKnob™ to obtain the greatest amount of vertical screen deflection. Exit the SP3 mode by pressing **[ENTR]** following the vertical alignment of the screen display.

Press [SWP] as required to enter waterfall mode. The LCD display should read **SWEEP WFALL SYNC** and the screen display begins to fill with the 32 lines of the waterfall display.

Place the rotating probe tip at the entrance of a hole standard. Press **[ERASE]** and immediately begin moving the probe tip into the hole. The screen display should appear similar to that shown in *Figure 10* as the probe detects any flaws in the hole.

The waterfall display can be recreated by placing the probe tip at the entrance of the test hole and repeating the above step as often as necessary.

**NOTE**

Caution should be observed when using a hand-held scanner in order to keep it from binding while being maneuvered in and out of the test hole. This will help prolong the life of the scanner and provide the most accurate waterfall sweeps.

The SP3 function sets the waterfall sweep trigger at SYNC (0%). The value of the trigger setting determines the level of signal required to initiate the first sweep of the waterfall. The trigger value is adjustable using the SmartKnob™ when the waterfall sweep mode is indicated on the LCD (SWEEP WFALL SYNC). If the value is set at SYNC (0%), the waterfall is triggered by the first sync pulse. By adjusting the trigger to some value greater than zero, ie. 5%, it is possible to maintain a clear screen display while the probe is running outside the test hole. As the probe is placed into the hole, a vertical deflection equal to or exceeding the value of the trigger setting starts a waterfall. Pressing the **[ERASE]** key clears the screen and resets the trigger.

Special functions SP21 through SP25 are specifically assigned to the waterfall mode of operation. They are used to adjust such things as scanner RPM, the number of sweeps in a waterfall display, the number of points per sweep, and the scanner pitch. They are selected by pressing **[SP]**, and then the desired digits, and then **[ENTR]**.

The operation of each waterfall SP function is described below.

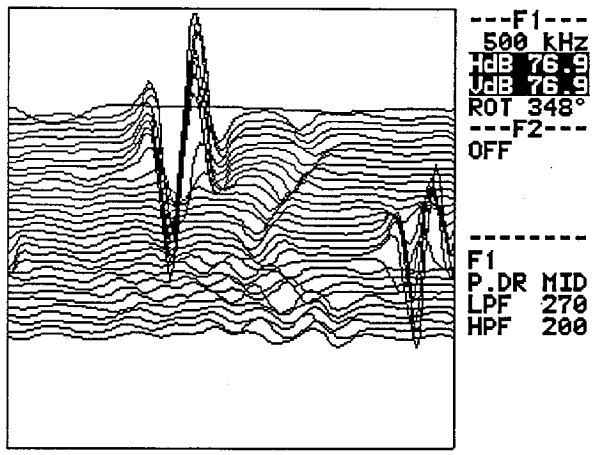



**Figure 4-10** *Defect In Hold Standard Using A Hand-Held Scanner*

**SP21 WFALL DISP** This menu places the instrument into a special mode making it possible to manipulate waterfall data currently captured in a display. To use this special function press **[SP]**, **[2]**, **[1]**, **[ENTR]**. The appearance of the display changes upon entering SP21: All sweep lines appear as dotted lines with the exception of one line. This line appears solid and is referenced to the DEP (depth) side-bar. Items in the side-bar of the display screen include MAX, MIN, ANGL, DEP, and MEM.

MAX and MIN refer to the range of the lines shown in the display. This value is determined by the PITCH of an indexing (translating) scanner. For example, if the pitch is set to 0.025 the MIN side-bar displays 0.025, indicating the most shallow reading made by the probe during its first sweep while entering the test hole. The MAX side-bar displays 0.800 (when using the default of 32 sweeps), indicating the deepest reading made by the probe during its final sweep.

To adjust MAX or MIN press **[2]** (UP), or **[8]** (DOWN) until either the **MAX** or **MIN** side-bar is highlighted. Adjust the SmartKnob™ to change the value. The segment of the display appearing between the MAX value and the MIN value is what will be stored in memory when the SP21 STORE function is used.

DEP indicates the depth of the reference sweep line (solid) shown on the display. This can be varied by turning the SmartKnob™ while the DEP side-bar is highlighted.

ANGL indicates the signal phase rotation angle and can be varied by turning the SmartKnob™ while the ANGL side-bar is highlighted.

MEM is used in conjunction with the MEM 2 feature and designates the sweep line which may be recalled for reference and comparison. It can be varied using the SmartKnob™ when the MEM side-bar is highlighted.

Most of the keys on the instrument are disabled when the SP21 function is selected and the keys remaining active have special meaning. Changes to the side-bar values can be made while the value is highlighted. The UP and DOWN keys (the 2 and 8 key on the keypad) are used to move the highlight bar to the desired menu item. Once the side-bar item has been highlighted its value can be changed using the SmartKnob™. The SP 21 function is most valuable when the range between the MIN and MAX exceeds 32 sweep lines. To view the display of sweep lines beyond the 32nd line the DEP paramenter is adjusted. When the DEP value is increased to the 33rd sweep line and beyond, the display is redrawn to include the higher sweep values as it deletes the lower values, always displaying a maximum range of 32 lines.

When ANGL is highlighted and the SmartKnob™ adjusted, the value of the rotation angle changes. When this occurs the waterfall display is re-computed for the new angle and the display is re-drawn reflecting this change regardless of the sweep mode selected.

The PRNT key on the front of the instrument remains operative during the SP21 mode and may be used to print a screen dump in the normal manner.

The SWP key on the front of the instrument also remains operative during the SP21 mode. It is used to select the mode of display. Map mode is the default which displays up to 32 lines on the screen at one time. The sweep mode displays only the solid line appearing in the map mode. The single line is selected by adjusting the DEP value when it is highlighted. The impedance plane display may also be selected with the [SWP] key. All of the special side-bar values may be adjusted in any of the three sweep modes.

The currently captured display may be stored from within the SP21 mode. This mode allows for storage of the entire display or only a portion of the display. The minimum number of lines in any waterfall display is five. The MIN and MAX values determine the minimum and maximum depth range to be stored. Their values may be changed when they appear highlighted on the CRT side-bar.

Any display may be stored while in SP21. The amount of memory locations needed to store a waterfall display may be determined by following the steps given in the section titled STORING A WATERFALL DISPLAY which follows the SP (Special functions).

**SP22 SCAN RPM**

Special function SP22 is used to adjust the RPM of the scanner connected to the instrument provided the scanner in use has no separate RPM control. The scanner RPM can be adjusted at any time to any value between 6 and 3000 RPM except when a waterfall is being captured. When a scanner having its own external speed control is used, such as the Staveley PS-2, this parameter must be adjusted to match RPM of the selected scanner. If the RPM of the instrument does not match the RPM of the scanner, multiple sweeps may occur on a single screen line, or a single sweep may be spread over several display lines.

To use SP22 press **[SP], [2], [2], [ENTR].** The default value displayed on the LCD is 1200. Turn the SmartKnob™ to adjust the value.

**SP23 MAX SWEEPS**

Special function SP23 is used to control the number of sweeps or scanner rotations captured to complete a waterfall display. The default value is 32 which constitutes one full screen display. The selection ranges from a minimum of 5 to a maximum of 64 sweeps. When more than 32 lines are selected it requires more than one screen display to capture the entire waterfall. In this case it is necessary to use the SP21 function to review all of the sweep lines of a captured display. A recalled waterfall display which contains greater than 32 sweep lines also requires more than one screen display. A recalled display can be reviewed by rotating the SmartKnob™.

The maximum number of sweeps selected determines the MAX value (the maximum depth of scanner penetration). The value of MAX is computed by the instrument and displayed on the CRT screen except when PITCH is set to zero.

To use SP23 press **[SP], [2], [3], [ENTR].** Turn the SmartKnob™ to adjust the number of sweeps to the desired value.

**SP24 POINTS/SWP**

Special function SP24 provides for the selection of the number of points plotted on the display per sweep. There are a total of four possible values (60, 120, 240, 480 points/sweep). The default value is 120. The following table shows the available points/sweep selections for a given range of RPM.

| RPM | POINTS/SWEEP |
|---|---|
| 1600-3000 | 60 |
| 760-1500 | 60, 120 |
| 380-750 | 60, 120, 240 |
| 6-370 | 60, 120, 240, 480 |

The higher the number of points per sweep the greater the screen definition of the sweep lines. As the number of points is reduced the vertical deflection of each sweep appears to be made up of a series of short straight lines rather than one smooth curved line. Greater points per sweep values do require more time to display and require more memory when stored as a waterfall display.

To use SP24 press **[SP], [2], [4], [ENTR].** Turn the SmartKnob™ to adjust the value of points per sweep.

**SP25 SCAN PITCH**

Special function SP25 describes how far the scanner advances during a single rotation. When a scanner with fixed pitch is being used, such as the Staveley PS-2, this value must be adjusted to match the pitch of the scanner. The instrument uses this parameter together with the maximum number of sweeps to determine the maximum depth of the waterfall display. The default value is 0.025 inch. This value may be adjusted from 0.000 to 0.050 inch in steps of 0.005 inch. Above 0.050 inch the value may be adjusted to 1.5 inch in steps of 0.1 inch. When a hand-held scanner is being used, such as the Staveley 19/RA, the pitch setting is only of relative value.

**Note**

When the pitch value is set to 0.000 all of the side-bar values related to pitch are displayed as a sweep count, ranging from SWEEP 1 at the top to MAX SWEEP at the bottom.

To use SP25 press **[SP], [2], [5], [ENTR].** Turn the SmartKnob™ to adjust the value of pitch.

**STORING A WATERFALL DISPLAY**

Any waterfall display may be stored in memory by pressing the **[STOR]** key repeatedly until **FREEZE** is displayed on the LCD. An E appears following the number of the memory location on the LCD when the default memory location is empty. An empty location must be selected or an error will result. Selection is made by rotating the Smart Knob™. Some waterfall displays may require more than one memory location. If this occurs the extra data needs to be placed into the memory location succeeding the location indicated on the LCD. If the succeeding locations contain stored data an error will occur. The status of the succeeding locations can be checked by rotating the Smart Knob™. Once an empty memory location is selected the waterfall display may be stored by pressing **[ENTR].**

More than one storage location may be required for some waterfall displays. The number of locations required may be calculated as follows:

Number of locations = (Points per Sweep * Maximum Sweep) ÷ 3840

*Example:*

The default parameters are 120 points per sweep and 32 sweeps.

(120 * 32) ÷ 3840 = 1 memory location

*Example:*

Doubling the number of points per sweep (240) and selecting the maximum number of sweeps (64).

(240 * 64) ÷ 3840 = 4 memory locations

If more than one memory location is required it is necessary to select an empty location succeeded by enough additional empty locations to contain the display. If an empty memory location is selected but the next succeeding memory location is not empty, an error will occur. The RECALL function may be used to view all of the storage locations and be certain of having enough memory to store a display. To view the storage locations press the **[STOR]** key repeatedly until the LCD readout displays **RECALL.** The screen display lists all of the memory locations. Those which indicate **EMPTY** are available for use. The SmartKnob™ may be used to scroll through the list until a sufficient number of empty locations are found as a group.

Rotate the SmartKnob™ to place the astrict adjacent to the first location of the group (or use the key-pad to enter the number, followed by pressing the **[ENTR]**) and press the **[STOR]** key repeatedly until **FREEZE** is displayed on the LCD.

Press the **[ENTR]** key. The LCD display will display **Storing...**, as it records the display into memory.

**RECALLING A WATERFALL DISPLAY**

Any stored waterfall display may be recalled and manipulated in the same manner as in the SP21 mode with the exception that the **[STOR]** key is inactive during a recalled waterfall display. The RECALL menu is accessed by pressing the **[STOR]** key repeatedly until the LCD displays **RECALL**. Those memory locations containing a waterfall display are indicated by a **W**. A display which required more than one storage location is indicated when the locations following that number are labeled using ellipses (...). As the SmartKnob™ is used to select the desired number, the astrict skips these locations.

To recall a waterfall display press the **[STOR]** key repeatedly until **[RECALL]** is displayed on the LCD. Use the SmartKnob™ to scroll through the numbered storage locations displayed on the screen, or use the key-pad to enter the number of the memory location and press **[ENTR]**.

With the asterick located adjacent to the selected number, press **[ENTR]**. The LCD displays **Reading...** and the recalled waterfall display appears on the screen as shown in *Figure 11*. *Figures 11 through 14* demonstrate how a recalled waterfall may be manipulated and displayed using the various depth and sync selections.

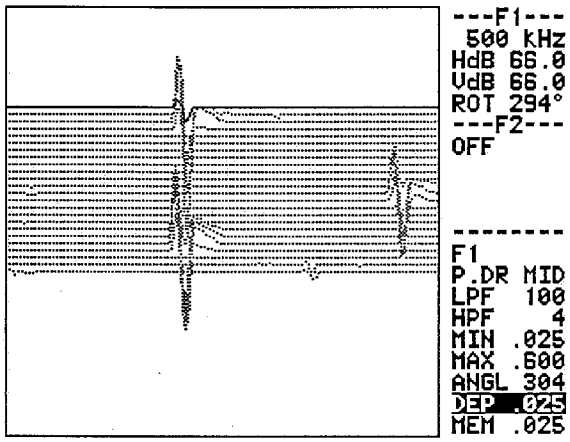



**Figure 4-11** *Recalled Waterfall Display*

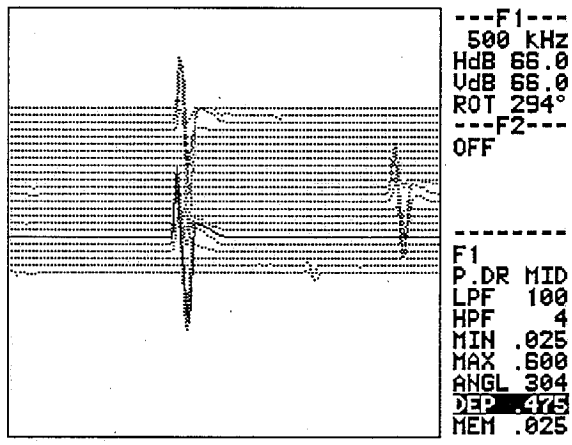



**Figure 4-12** *Depth Adjusted To 0.475*

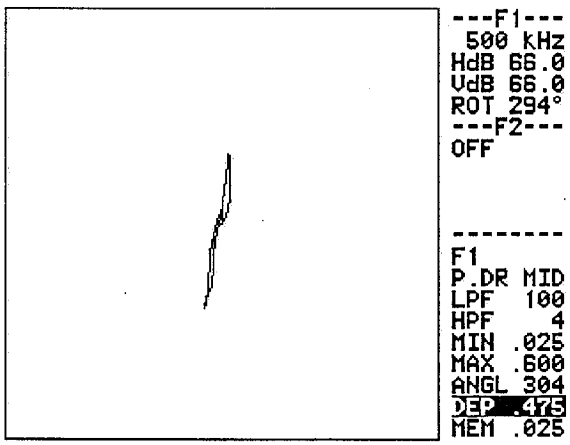



**Figure 4-13** *Impedance Plane Display Of Sweep*

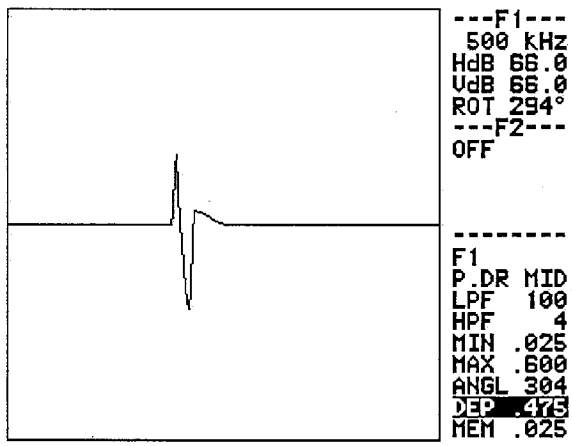



**Figure 4-14** *Single Sweep Line Display*

As shown in *Figure 11*, all 32 waterfall sweeps appear as dotted lines on the recalled display with the exception of the upper-most line which represents a depth of 0.025 inch. The SmartKnob™ may be rotated to change the depth value. *Figure 12* shows the depth value at 0.475 inch following adjustment by the SmartKnob™. Note also that the solid line has descended down through the display to the relative depth indication following adjustment by the SmartKnob™.

By pressing the **[SWP]** key the selected solid sweep line can be displayed as shown in the impedance plane mode as shown in *Figure 13*. By pressing the **[SWP]** key again a single sweep line may be displayed as shown in *Figure 14*. Both the **DEP, ANGL** and **MEM 2** may be changed while these displays are on the screen. Pressing the **[8]** (UP) key and the **[2]** (DOWN) key shifts the highlighted side-bar on the screen to the desired parameter for adjustment.

**MEM 2**

The MEM 2 feature allows marking of a reference sweep line which may be used for purposes of comparison in future tests. It can be recalled when needed and super-imposed on the screen with the display under examination as shown in *Figure 15*.

**Note**

MEM 2 waterfall mode is not compatible with the standard MEM 2. Therefore a waterfall MEM 2 cannot be displayed in non-waterfall sweep modes and vise versa.

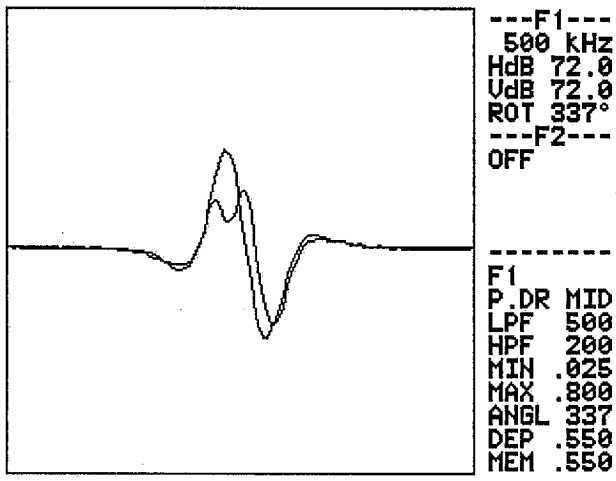



**Figure 4-15** *Sample MEM 2 display*

To create a MEM 2 reference line using the SP21 feature perform the following steps.

Perform the standard waterfall test which is to be used as a reference.

Access the SP21 feature by pressing **[SP]**, **[2]**, **[1]**, **[ENTR]**, **[ENTR]**. Select the MEM side-bar using the [2] down arrow key.

Rotate the SmartKnob™ to select the desired reference depth. The sweep which appears as a solid line is the line which becomes the reference sweep line for the MEM 2 display.

**Note**

The MEM 2 reference line marked via SP21 is lost from all memory when the **[ERASE]** key is pressed. The SP21 **[STOR]** procedure must be used to retain the waterfall and MEM 2 data in the instrument memory.

Exit the SP21 menu by pressing **[ENTR]**.

To create a MEM 2 reference line using a previously stored display perform the following steps.

Turn off or disconnect the scanner.

Access the RECALL menu by pressing **[STORE]** repeatedly until **RECALL** appears on the LCD. Rotate the SmartKnob™ until the desired memory location is selected.

Press **[ENTR]**. The LCD displays **Reading...** and the recalled display appears on the CRT screen.

Select the MEM side-bar using the [2] down arrow key. Rotate the SmartKnob™ to select the desired reference depth. The sweep which appears as a solid line is the line which becomes the reference sweep line for the MEM 2 display.

Exit the STORE menu by pressing **[ENTR]**.

To recall MEM 2 reference data perform the following steps.

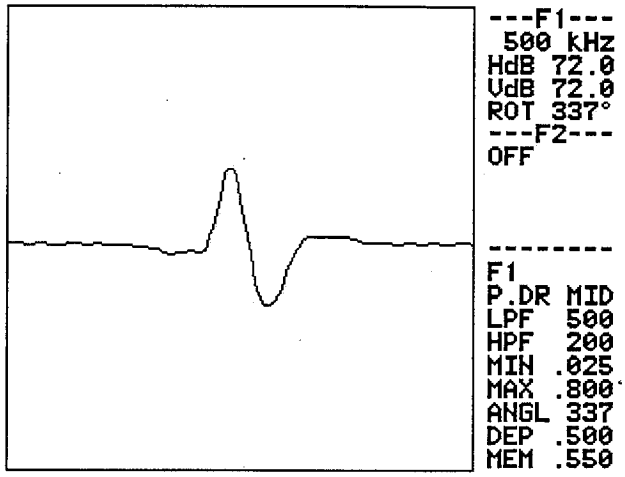



**Figure 4-16** *Sample Reference Sweep Line*

The waterfall currently displayed on the screen may be one which has been recalled from memory or the results of a recent test. If it is from a recent test the SP21 function must be accessed by pressing **[SP]**, **[2]**, **[1]**, **[ENTR]**.

A recalled waterfall display and one displayed via the SP21 function appear the same on the screen. Both consist of dotted sweep lines except for one sweep line which appears solid. The solid sweep line represents either the DEP reference line or the MEM 2 reference line depending on the feature selected in the side-bar.

Press **[MEM2]** to access the MEM 2 reference sweep line. The LCD indicates whether MEM 2 is in the ON or OFF mode.

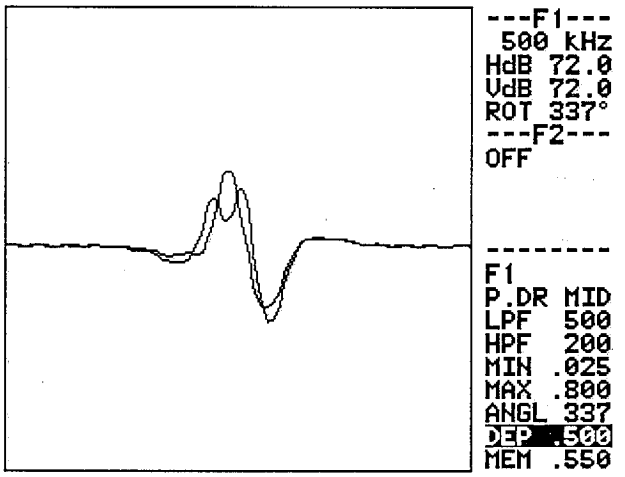



**Figure 4-17** *MEM 2 Super-imposed Over Sweep Line*

If MEM 2 is OFF the LCD screen reads **MEM 2 OFF** along with the currently selected storage location followed by a letter depicting the status of that location **E** = Empty, **F** = Full, **R** = Capture/Reply, **W** = Waterfall). Rotate the SmartKnob™ to select the desired memory location containing the reference waterfall display. Press **[MEM2]** to turn on and recall the MEM 2 reference data. When MEM 2 is ON, the CRT shows the two lines super-imposed similar to that shown in *Figure 26* and the LCD reads **MEM 2 ON**.

**Note**

The MEM 2 line is displayed corresponding to the rotation angle specified when the waterfall display was stored and is not affected by the current rotation angle setting. Also, the points per sweep of the MEM 2 corresponds with that of the stored display and is independent of the current waterfall points per sweep.

As before, the **[8]** up and **[2]** down arrows select and highlight a side-bar feature which may be varied using the SmartKnob™.

Other memory locations may be selected by pressing **[MEM2]** (turning MEM 2 OFF), rotating the SmartKnob™ until the desired location appears on the LCD, and pressing **[MEM2]** again (turning MEM 2 ON).

**MEM 2 OFFSET**

The MEM 2 line displayed during a waterfall recall or SP21 operation can be moved on the screen. As soon as the MEM 2 has been turned on, the LCD will show **MEM 2 ON** on the top line and **OFFSET 40%** on the second line (note that 40% is the default offset). This means that the solid line for the current waterfall and the MEM 2 line are separated by 40% of the screen. Use the SmartKnob™ to adjust the offset. A reading of 0% will show the lines overlapped, while 100% will move the lines to the edge of the screen. As the SmartKnob™ is turned, both lines are moved on the screen. If MEM 2 is turned off the current waterfall line will be repositioned to the center of the screen. In the impedance plane display the MEM 2 line moves on the left side of the screen and in sweep mode the MEM 2 line moves in the top half of the screen.

## 4.15 SPO 3196 - External VCR Option

The 19e$^{II}$ SPO 3196 is available with an external video attachment which makes it possible to connect a video recorder to the instrument. This is a special option and is not standard on all instruments. When a VCR is connected to the instrument it can be used to make a video taped record of entirely every screen display. All that appears on the screen including tests, memory recall, and adjustments to parameters is transferred to the VCR.

The video tape can be used with any VCR connected to any monitor or television. The 19e$^{II}$ SPO 3196 can also be used as the viewing monitor by simply rewinding the tape and pressing the PLAY button on the VCR.

Perform the following steps to record and play-back the screen display a standard VCR:

1. Connect a standard video cable from the **VIDEO-OUT** of the 19e$^{II}$ SPO 3196 to the **VIDEO-IN** of the VCR.

2. Connect a standard video cable from the **VIDEO-IN** of the 19e$^{II}$ SPO 3196 to the **VIDEO-OUT** of the VCR.

3. Apply power to the VCR and insert a blank video tape. Adjust the necessary control functions to begin the **RECORD** mode of operation.

4. Apply power to the 19e$^{II}$ SPO 3196 and begin performing the operation to be recorded.

5. When the operation is complete perform the necessary procedures to stop the VCR recording and rewind the tape.

6. Restart the VCR in the **PLAY** mode of operation and review the recorded session on the screen of the 19e$^{II}$ SPO 3196.

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# 5.0 Application Examples

## 5.1 Introduction

The purpose of this section is to guide the user through a broad range of Eddy Current applications. During the course of these examples a good understanding of the Nortec 19e$^{II}$ SPO 3196's performance will be obtained. In going from one test set-up to the next, it is easier to have the instrument returned to a standard starting point. The factory default setup is a good starting point and is easily recalled. To reset to this default, press the "SP" button, then 99 on the numeric keypad, and then press "ENTR". LOAD DEFAULT-PRESS ENTER will now be displayed on the LCD. Press the "ENTR" button again and the default reset will take place. This is especially helpful after using the Nortec 19/RA or PS-5 scanner. The **default settings** are:

| | |
|---|---|
| Frequency 1 | 100kHz |
| Frequency 2 | OFF |
| Horizontal Gain | 40 dB |
| Vertical Gain | 40 dB |
| Phase ( ROT ) | 0 deg |
| Probe Drive | MID |
| Low Pass Filter | 500 Hz |
| High Pass Filter | 0 Hz |
| Horizontal Position | 50% |
| Vertical Position | 50% |

## 5.2 Impedance Plane Display-Conductivity Curve

This is the same test used to perform the initial check out of the instrument and is a good first exercise for becoming familiar with the 19e$^{II}$ SPO 3196.

1. Equipment Used:

   100 kHz surface probe, Nortec S/100 kHz-500 kHz/.44
   Nortec Conductivity Samples (set of six)

2. Attach the probe to the PROBE connector on the front panel. Apply power to the instrument.

3. Perform an instrument parameter reset using SP99. This will not erase any stored data or programs, only the current test parameters. Press [SP], [9], [9], then [ENTR]. Press [ENTR] one more time to perform the reset.

4. Press [SP], [2], [ENTR]. Rotate the SmartKnob™ counterclockwise until the LCD reads *PROBE DRIVE LOW.*

5. Press [NULL] to move the dot to the middle of the screen.

6. Press [ERASE] to clear the screen.

7. Press [$\phi$ ANGL]. Then, while holding the probe on the ferrite sample from the standard, turn the SmartKnob™ until the dot is directly above the center of the screen.

8. Press [GAIN]. Now, hold the probe on the 7075-0 aluminum sample, and turn the SmartKnob™ until the dot just touches the bottom of the screen.

9. Remove the probe from the sample, then press the [ERASE] key to clear the CRT again. Now, touch the probe to the middle of the samples, each in turn for all 6 samples. The CRT display should be similar to Figure 1. It is called a Conductivity Curve and shows how the instrument is affected by lift-off and conductivity of various materials.

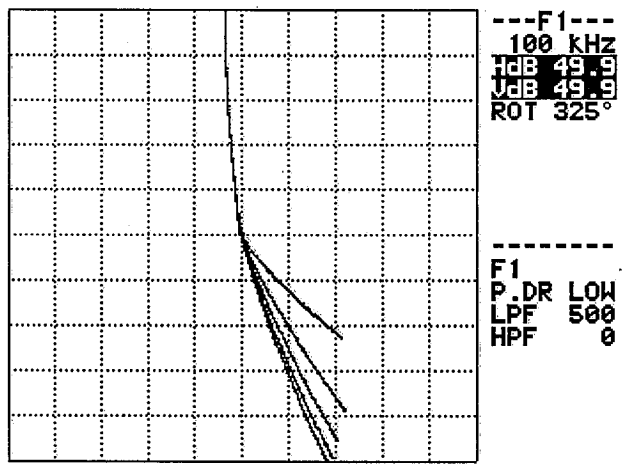



**Figure 5-1** *Conductivity Curve*

## 5.3 Surface Flaw Detection

1. Equipment Used:

   Nortec TB-S1 Crack Standard, with .040", .020", and .008" Deep notches
   S/100kHz-500kHz/.44 Nortec Probe
   C/SC/6 Detachable Cable

2. Push the "SP" button and then 99 on the keypad. Press "ENTR" twice to load the default setup.

3. Frequency: The frequency should be pre-set to 100kHz as a result of the "sp 99" default setting. If the default was not used, press the "FREQ KHZ" button. Adjust to 100kHz by rotating the Smart Knob™ or pressing 100 "ENTR" on the keypad.

4. Gain: Press the "GAIN", then "H" buttons and adjust HdB (horizontal gain), to 67.0. Now press the "V" button and adjust VdB (vertical gain), to 74.0. This can be done by rotating the SmartKnob™ or entered on the keypad.

5. Place the probe on the crack block away from any cracks or writing. Press the "NULL" button and then the "ANGL" button. Slowly tap the probe up and down on the crack block. While doing this turn the SmartKnob™ until the dot goes on and off the left side of the screen, in a horizontal direction.

6. Press the "POSN" then "H" buttons. Adjust the horizontal position to 85% using either the Smart Knob™ or keypad. Now press the "V" button and adjust the vertical position to 15%. This will move the nulled dot to the lower left area on the screen.

7. Place the probe on the crack block away from any cracks or writing. Press the "NULL" button. If the dot is jumpy, press the "FLTR" button once or twice until "FILTER LO" appears on the LCD and "LPF" is highlighted on the screen. Using the SmartKnob™ adjust to 30, (30 Hz). The noise should clear up.

8. Now run the probe smoothly over the cracks. The response should be similar to Figure 2.

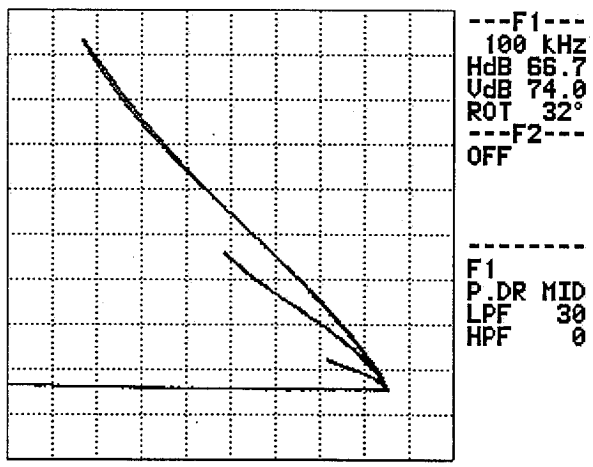



**Figure 5-2** *Surface Flaw Detection*

## 5.4 Bolt Hole Flaw Detection

Bolt hole probes are sized for a particular hole diameter and are split to allow the coil to stay in contact with the inside surface of the hole despite minor variations in diameter. To help maintain pressure against the surface, a small piece of rubber band should be placed in the slot of the probe head. This keeps the test coil against the hole wall thereby reducing lift off. It should make the probe fit feel snug but not tight.

1. Equipment Used:

   Nortec B/100kHz-500kHz/.250 Bolt Hole Probe
   Nortec TB-16 Aluminum Bolt Hole Standard
   C/SC/6 Cable

2. Adjust the frequency to 300 kHz by pressing the "FREQ KHZ" button and using the SmartKnob™ or keypad.

3. Press the "GAIN" then "V" button and adjust the vertical gain to 73 dB using the SmartKnob™ or keypad.

4. Press the "GAIN" then "H" button and adjust the horizontal gain to 59 dB using the SmartKnob™ or keypad.

5. Press "SP 2 PR. DRIVE", "ENTER". Use the SmartKnob™ to adjust the probe drive to HI.

6. Adjust the collar around the probe to allow the coil to be lined up with one of the notches in the standard. A small ruler, stick, or an actual depth gage may be used to help determine this setting.

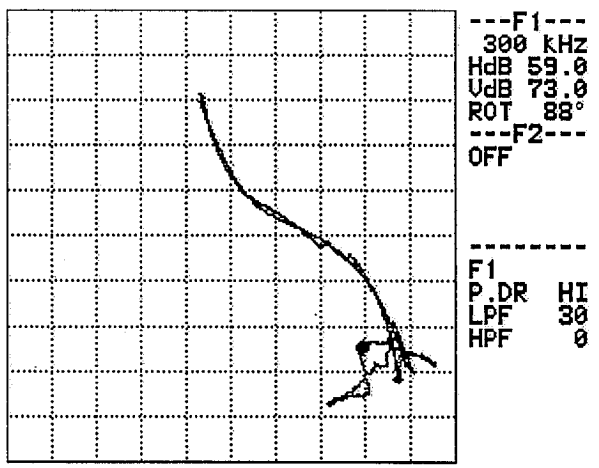



**Figure 5-3** *Bolt Hole Flaw Detection*

7. Move the null point to the lower right hand corner of the screen. To do this, press the "POSN" button and move vertically to 15%. Use the SmartKnob™ or keypad to accomplish this. Now press "H" and move horizontally to 81%.

8. Place the probe in the hole so that the coil is not next to a defect and press the "NULL" button.

9. Perform lift off adjustment as follows:

   a. With the probe in the hole, push the coil side of the probe away from the hole wall.
   b. Note the direction of the lift off line as the probe is moved away from the hole wall.
   c. Use the rotation control "ANGL" to adjust the lift off line as close to horizontal as possible. It will be a slightly curved line.

10. Spread the ends of the probe and place a very small piece of rubber cut from a rubber band in the slot to help maintain contact as described in the introduction.

11. Test the set up by rotating the probe around the I.D. of the hole in the TB-S1 standard. Your screen should look somewhat like Figure 3.

12. Increase/Decrease gain or probe drive to adjust notch signal size. If the probe drive is changed, the instrument must be re-nulled.

## 5.5 Aircraft Fastener Hole Inspection Using The 19/RA Scanner

The Nortec 19/RA is a lightweight, handheld Eddy Current probe scanner (rotator). It operates at 1200 R.P.M. and is powered directly from the Nortec 19e$^{II}$ SPO 3196. The Nortec 19/RA's main use is inspecting for flaws in airframe fastener holes after the fastener has been removed. This inspection method utilizes a display on the CRT, which sweeps from 0 degrees on the left to 360 degrees on the right of the display. The angular position of a flaw indication is determined clockwise with 0 being directly opposite the scanner handle.

1. Equipment Used:

   Nortec RA - .250" Probe
   Nortec TB-16 Test Block (1/4")
   Nortec 19/RA scanner w/cable
   1/4" Teflon Tape

2. Connect one end of the cable to the 19e$^{II}$ SPO 3196 and the other end to the 19/RA scanner.

3. Stick Teflon tape over the coils on the probe. Use only enough to allow for a good fit in the hole size to be inspected. This tape must be replaced as it deteriorates. Install the probe into the scanner and lightly tighten.

4. Turn the instrument on by pressing the "ON" button.

5. Press "SP" then "99" then "ENTR." The LCD will read "LOAD DEFAULT Press ENTR Key." At this time press "ENTR" again to load the factory default setting.

6. Press "SP" then "3" then "ENTR." The LCD will read "SCANNER RESET Press ENTR Key." Press the "ENTR" key again and the LCD will now read "PHASE 1 0 degrees ENTR for sweep." Do not press ENTR yet.

7. The " SP 3 " command will automatically enter the parameters for testing with the 19/RA scanner. They are:

   | | |
   |---|---|
   | Frequency: | 500 kHz. |
   | Gain: | 66dB vertical and horizontal |
   | Angle: | 0 degrees |
   | Position: | 50% vertical and horizontal |
   | Low Pass Filter: | 500 Hz. |
   | High Pass Filter: | 200 Hz |

**These are approximate settings, you may alter these settings to your preference.**

8. Turn the scanner on by pressing the button on the handle of the scanner. You should still be in the Impedance Plane Analysis Display. Now insert the probe into the test block. When you go across the flaw you will see a large signal. Our next step is to rotate that signal so it will be displayed mostly in the vertical plane. To do this, press the "ANGL" button and use the SmartKnob™ to rotate the signal to a vertical axis. The probe must remain in the hole and centered over the flaw while this is being done.

9. Now press "ENTR." This will turn the sweep on. Again, with the scanner rotating, insert the probe into the test block. Your response should look like Figure 4.

10. The signal may not appear on the screen at the same position as Figure 4 because it depends on the relative alignment of the scanner and test standard. Rotating the test standard or scanner will change the indicated position. When you are looking at the back of the scanner as though

you are checking fastener holes, visualize the top of the scanner as being 0 degrees, the right side is 90 degrees, the bottom, 180 degrees, and the left side, 270 degrees.

11. Use care when testing with this method. If the scanner is misaligned with the hole, the results could, and probably will be, bent probes and/or bent shafts in the scanner.

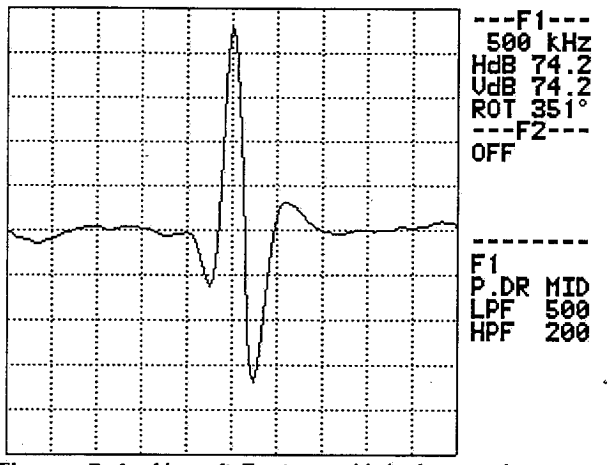



**Figure 5-4** *Aircraft Fastener Hole Inspection*

## 5.6 Thickness Measurement of Non-Conductive Coatings

Determining the thickness of paint or insulation on non-ferrous metal is a test that takes advantage of an Eddy Current device's sensitivity to lift-off.

1. Equipment Used:

   Nortec P/500kHz-1MHz/A Pencil Probe
   C/SC/6 Detachable Cable
   TB-S1 Aluminum Crack Block
   .0005", .001", .0015", .002", and .003" Plastic Shims

2. Clear instrument, if desired, by pressing "SP99" and "ENTR". Now press "ENTR" key again.

3. Set frequency to 500 kHz by pressing the "FREQ KHZ" button and adjusting the SmartKnob™ or keypad to 500.

4. Set the horizontal position to 95% by pressing the "POSN" then the "H" buttons. Adjust the position using the SmartKnob™ or keypad.

5. Set the gain to 66dB on both horizontal and vertical. To do this, press the "GAIN" and adjust to 66 dB using the SmartKnob™ or keypad.

6. Place the probe on the back of the TB-S1 block and press "NULL".

7. Now adjust the rotation by pressing the "ANGL" button and while lightly tapping the probe on the block, turn the SmartKnob™ until the signal goes off the screen from right (null point) to left.

8. Place the probe on the block and press "POSN" then "V". Turn the SmartKnob™ to 60% then down to 40% and back to 50%. This will give you a hash mark representing no coating (bare material).

9. Place the .0005" shim on the block. Bring the probe down on top of the shim. Again turn the SmartKnob™ to 60% then down to 40% and back to 50%. This hash mark represents .0005" coating thickness on aluminum. Repeat these steps for .001", .0015", .002", and .003". Your screen should look like Figure 5.

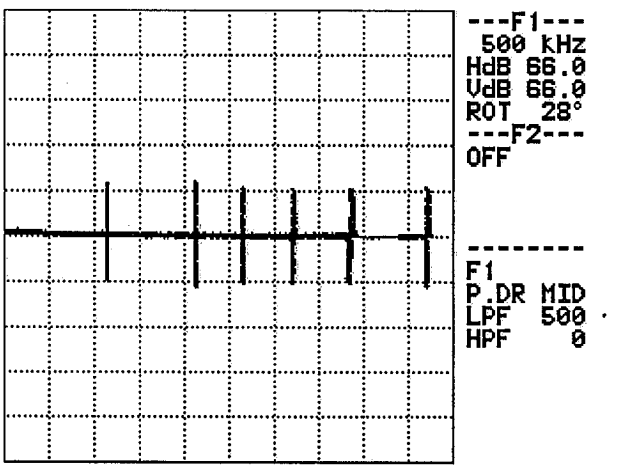



**Figure 5-5** *Thickness Measurement of Non-Conductive Coatings*

## 5.7 Conductivity Measurement

To identify materials by their conductivity, reference standards will be required which have conductivities above and below the conductivity of interest. Most codes will specify a frequency of either 100 kHz or 60 kHz. It is important to use the correct frequency in order to prevent penetrating the test piece and reading thickness instead of conductivity.

Conductivity measurements utilize the % I.A.C.S. (International Annealed Copper Standard).

1. Equipment Used:

   S/100kHz-500kHz/.44 Surface Probe
   C/SC/6 Detachable Cable
   Nortec Set of Three Conductivity Standards 27.4%, 41.7% & 58.8% I.A.C.S.

2. Set the frequency to 100 kHz by pressing the "FREQ KHZ" button and adjusting to 100kHz using the SmartKnob™ or keypad.

3. Press the "GAIN" then "V" buttons and adjust the vertical gain to 67.8 dB by using the SmartKnob™ or keypad.

4. Press the "H" button and adjust the horizontal gain to 50 Db using the SmartKnob™ or keypad.

5. Press the "POSN" button and adjust the horizontal position to 75% using the SmartKnob™ or keypad.

6. Press the "ANGL" button and adjust the rotation to 35 degree's using the SmartKnob™ or keypad.

7. Press the "FLTR" button to obtain the LPF (Low Pass filter). Adjust to 100 Hz using the SmartKnob™.

8. Place the probe on the lowest conductivity standard (27.4%) and press the "NULL" button. Now raise the probe off the standard. The right end of this "Lift-off Line" is the conductivity point. As the line travels to the left it approaches the air point.

9. Repeat the probe placement on the 41.7% and the 58.8% I.A.C.S. standards. Your screen should look like Figure 6.

   Estimations of conductivity of unknown samples may be accomplished by comparison with these conductivity lines.

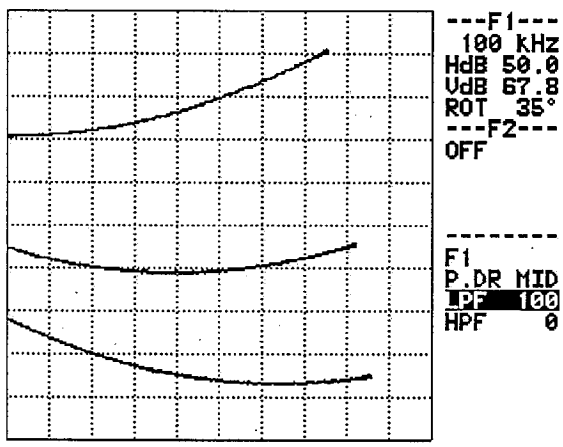



**Figure 5-6** *Conductivity Measurement*

## 5.8 Thickness Measurement

Thickness measurements of non-ferrous metals can be accomplished using Eddy Currents. It is important that a low enough frequency is selected to allow the Eddy Currents to penetrate the complete thickness being measured. The critical thickness for a given material and frequency is known as One Standard Depth of Penetration.

This type of testing is most useful when trying to determine the remaining wall thickness as a result of internal corrosion.

1. Equipment Used:

   Nortec S/300Hz-10kHz/.62 Surface Probe
   C/SC/6 Detachable Cable
   Nortec Thinning Sample tapering from .164" to .039".
   Nortec Eddy Current Slide Rule.

2. Using the Eddy Current Slide Rule, the frequencies for one standard depth of penetration in aluminum alloy for this range of thicknesses is from approximately 0.6 to 10 kHz. 1.0 kHz should yield adequate penetration over the range of the sample.

3. Press the "FREQ KHZ" button and adjust to 1.0 kHz using the SmartKnob™ or keypad.

4. Press the "GAIN" then "V" button. Adjust the vertical gain to 60.6 dB using the SmartKnob™ or keypad.

5. Press the "GAIN" then "H" button. adjust the horizontal gain to 66.7 dB using the SmartKnob™ or keypad.

6. Press the "ANGL" button and adjust the rotation to 26 degrees. To accomplish this, rotate the Smart Knob™ or use the keypad. This angle may be changed to present any desired display orientation.

7. The LPF (Low Pass Filter) should be set at 30Hz. Press "FLTR" until LPF is displayed on screen. Use the SmartKnob™ to adjust to 30Hz.

8. Press "SP" then "2" then "ENTR" and adjust the probe drive to MID Using the SmartKnob™.

9. Place the probe about half way up the tapered standard. Press "NULL" then "ERASE" . Now bring the probe in contact with the tapered block at different thicknesses. Your screen should look something like Figure 7.

10. To increase the distance between lines (thicknesses) increase the vertical gain a little at a time.

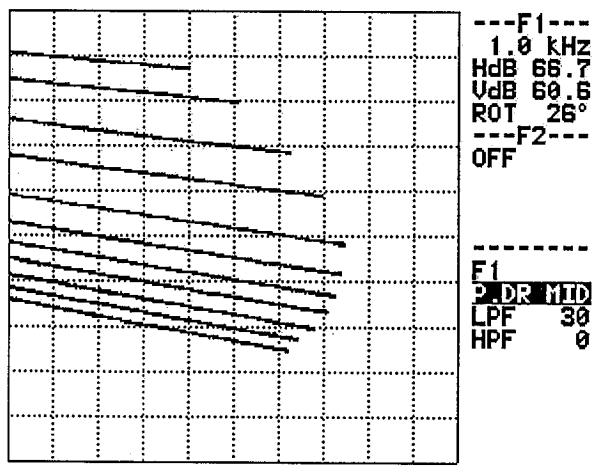



**Figure 5-7** *Thickness Measurement*

## 5.9 Second Layer Crack Detection

Second layer crack inspection is an Eddy Current inspection method used mainly by the aerospace industry. Ultrasonic inspections of any but the top layer are usually impossible because the interface between layers reflects ultrasonic energy preventing any usable penetration. However, these interfaces are practically invisible to eddy current devices applied normal to the surface of the layers. Therefore, when using Eddy Current, the number of layers is insignificant and the total depth of material is the only limiting factor.

1. Equipment Used:
   Nortec SPO-3806 Sliding/Reflection Probe
   CR/SC/6 6' Reflection Cable
   SPO-3932 Second Layer Crack Standard (1/16"AL ON 1/16"AL)

2. Press the "FREQ KHZ" button. Adjust the frequency to 2 kHz by rotating the SmartKnob™ or entering it on the keypad. This is a good frequency for this test allowing penetration through the first layer into the second layer. Usually, deeper tests require lower frequencies and shallower tests require higher frequencies.

3. Press the "GAIN" and "H" buttons and adjust HdB ( horizontal gain), to 52.5. Now press the "V" button and adjust VdB (vertical gain), to 60.3.This can be done by rotating the SmartKnob™ or entering on the keypad.

4. Probe Drive: Press the "SP" "2" and "ENTR" buttons. Now adjust the probe drive to "HI" by rotating the SmartKnob™.

5. Position: Press the "POSN" then "H" buttons. Adjust the horizontal position to 75% using either the SmartKnob™ or keypad. Now press the "V" button and adjust the vertical position to 15% using the same method.

6. Phase Angle: Press the "ANGL" button and adjust to 230 Degrees. This can be done with either the SmartKnob™ or the keypad.

7. Press "SP", "12", then "ENTR". Use the SmartKnob™ to turn the graticule off.

8. Place the crack standard so that the "Nortec SPO-3932" label can be read. This will put unflawed holes at the #1 and #7 positions moving from left to right.

9. Place the SPO 3806 probe between the first two fasteners and in line with the rest of the fasteners. The red arrow should be pointing towards the other end of the standard. Now press the "NULL" button.

10. Place the SPO 3806 probe on the left end of the standard and press "ERASE". Slide the probe towards the opposite end of the standard, being careful to remain in perfect alignment with the center of all of the fasteners. A nonmetallic straightedge may be used to help keep the probe in alignment. Your screen should look similar to the one below. You may change the gain, null position, or angle to obtain the desired separation between the good and bad signals.

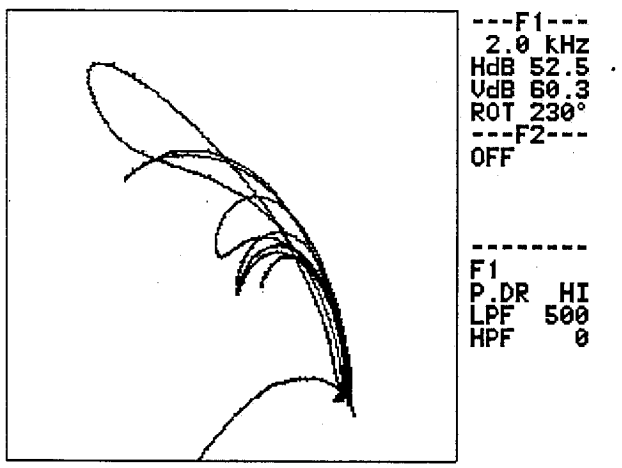



**Figure 5-8** *Second Layer Crack Detection*

## 5.10 I.D. Tube Inspection Using Dual Frequency

The examination of non-ferrous tubes can be accomplished with the use of basic Eddy Current instrumentation and probes. The field test for tubing is normally performed using an I.D. probe. This I.D. probe will test for I.D. defects, O.D. defects, wall thickness (% of wall thinning), and presence of a baffle plate or tube support (normally an unwanted signal).

When testing a tube, a ferrous baffle plate will produce a large signal which may mask out any defects in the tube at that location. It is very common to have wearing or thinning directly underneath the tube support caused by rattling or vibration of the tube against the support. Signals indicating this thinning tend to be hidden by the support signal.

The accepted way of canceling or reducing the unwanted support signal is by using a dual frequency signal subtraction technique. Once this dual frequency is set up, you need only push the F1-F2 display button, and the Nortec 19e$^{II}$ SPO 3196 will do the subtraction for you.

1. Equipment Used:

   Nortec 19e$^{II}$ SPO 3196 Dual Frequency Eddyscope
   Nortec SPO-2629, .586", 100 kHz, Differential I.D. probe
   Stainless Steel I.D. Tube Standard (Figure 9)
   Teflon tape - Tape both full diameter ends of the probe circumferentially to allow for a good fit in the tube

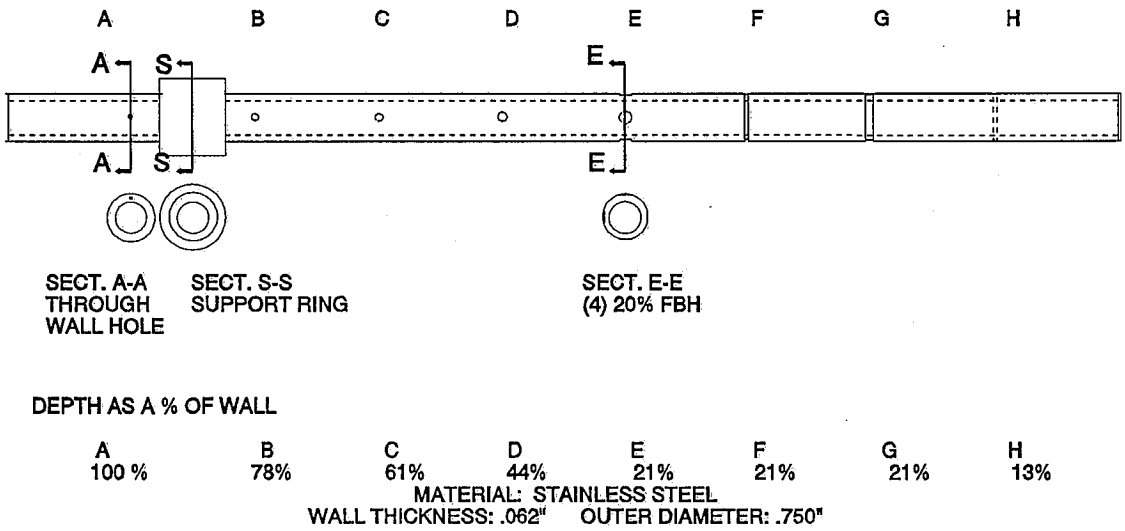



**Figure 5-9** *Stainless Steel I.D. Tube Standard*

2. Turn on the instrument. Press the DSPL, F1/F2, and FREQ KHz buttons as necessary until FREQUENCY 1 is displayed on the LCD and the F1 signal is displayed on the CRT.

3. Set Frequency 1 to 100 kHz using the SmartKnob™ or keypad and ENTR buttons.

4. Set the Horizontal and Vertical gain to 79.5 using the GAIN, H, and V buttons and the SmartKnob™ or keypad and ENTR buttons as necessary.

5. Set the Rotation to 70 degrees using the $\phi$ ANGL button and SmartKnob™ or keypad and ENTR

buttons.

6. Set the Probe Drive at Mid using the SP, 2, and ENTR buttons and rotating the SmartKnob™ as necessary.

7. Set the LPF to 500 Hz and the HPF to 0 using the FLTR button and SmartKnob™. The 19e$^{II}$ SPO 3196 is now set up to test with the single frequency method.

8. Insert the probe into the tube end closest to the I.D. defect. Allow about 3/4" of the probe to hang out at the cable end.

9. Press the Null button.

10. Press the erase button.

11. Run the probe from one end of the tube to the other and observe the I.D., O.D., and through hole defects and the tube support.

12. Press the DSPL, F1/F2, and FREQ KHz buttons as necessary until FREQUENCY 2 is displayed on the LCD and the F2 signal is displayed on the CRT.

13. Set Frequency 2 to 50 kHz using the SmartKnob™ or keypad and ENTR buttons. * Frequency 2 will always be a fraction of Frequency 1, such as: 1/2, 1/4, 1/8, 1/16.

14. Set the Horizontal gain to 70.7 dB and the Vertical gain to 67.9 dB using the GAIN, H, and V buttons and the SmartKnob™ or keypad and ENTR buttons as necessary.

15. Set the Rotation to 318 degrees using the $\phi$ ANGL button and SmartKnob™ or keypad and ENTR buttons.

16. Repeat steps 8 through 11.

17. Press the Display button until DISPLAY F1-F2 is on LCD.

18. Again repeat steps 8 through 11. If everything has been set up properly you should have seen the tube support signal attenuate to almost nothing.

*** Key To Subtraction Of Tube Support**

1. Set up for operation with Frequency 1 as above. Insert the probe into the tube so it is not on a defect. Press the Null then Erase buttons.

2. Hold the probe steady and move the tube support back and forth over the probe. This will produce a pattern of the support as seen by Frequency 1. **It is important to note which direction the dot travels.** (Figure 10)

3. Enter this signal into Memory 2. Now it can be left on screen as a frozen reference signal. (Review section 4.8 if necessary.)

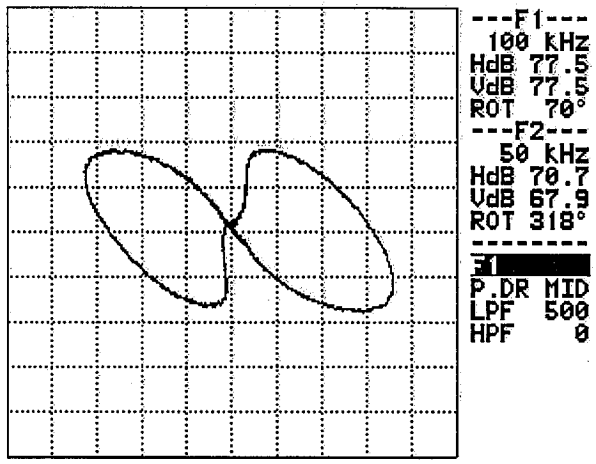



**Figure 5-10** *The tube support as shown by frequency 1*

4. Next, set up for Frequency 2 operation as above. You will now superimpose the support signal from frequency 2 over that of frequency 1. By using the Gain, and Angle buttons, this signal is adjusted to match the frequency 1 signal as closely as possible.

   **CAUTION**
   **The dot must go the same direction as when using frequency 1. (Figure 11)**

5. When the signals are matched as closely as possible, change the display to F1-F2 (DSPL button). (Figure 12)

6. You should now have a test set up to cancel the tube support signal. (Figure 13)

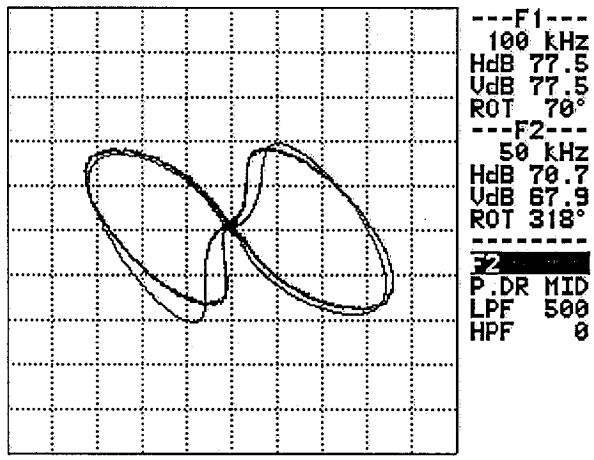



**Figure 5-11** *The tube support as shown by frequency 2 superimposed over the stored signal from frequency 1*

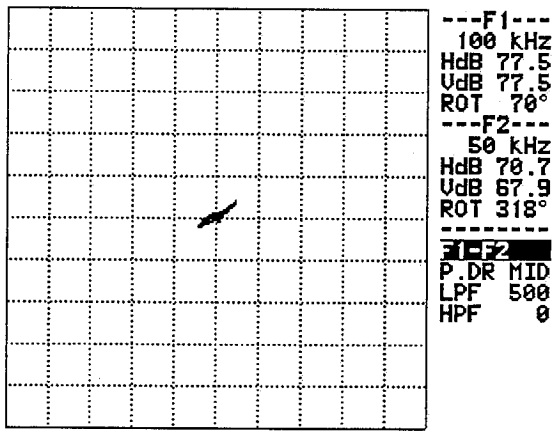



**Figure 5-12** *The canceled out tube support signal displayed by F1-F2*

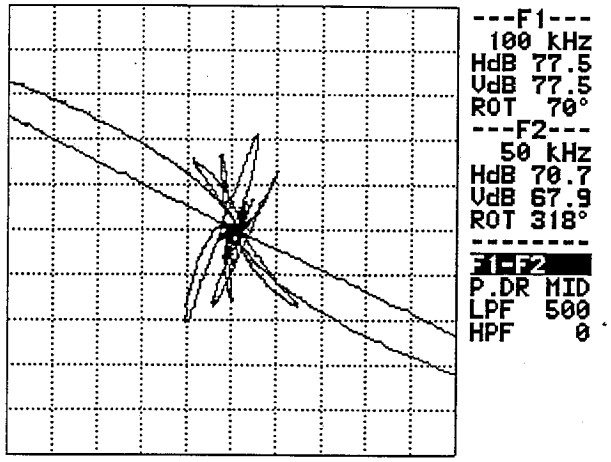



**Figure 5-13** *The tube test showing eight flaws and very little effect from the tube support*

## 5.11 I.D. Tube Testing Analysis Using A Strip Chart Recorder

For a recording use the strip chart recorder cable, Nortec part number 9106434, or a 25 pin D-subminiature connector using pins 14,15, and 13 for vertical, horizontal, and ground.

1. Connect the 25 pin cable to the rear of the Nortec 19e" SPO 3196 and the other end to the respective horizontal and vertical inputs on the strip chart recorder.

2. Set up the Nortec 19e" SPO 3196 for a single frequency test as in steps 1-11 of the Dual Frequency Testing.

3. Adjust the rotation so the probe wobble gives a horizontal deflection of the spot on the CRT.

4. Defects in the tube wall will now give a figure eight pattern, while probe wobble will give only a horizontal line on the CRT. The size and orientation of the pattern is related to size or location, (whether on the I.D. or the O.D. or through the wall) of the defect.

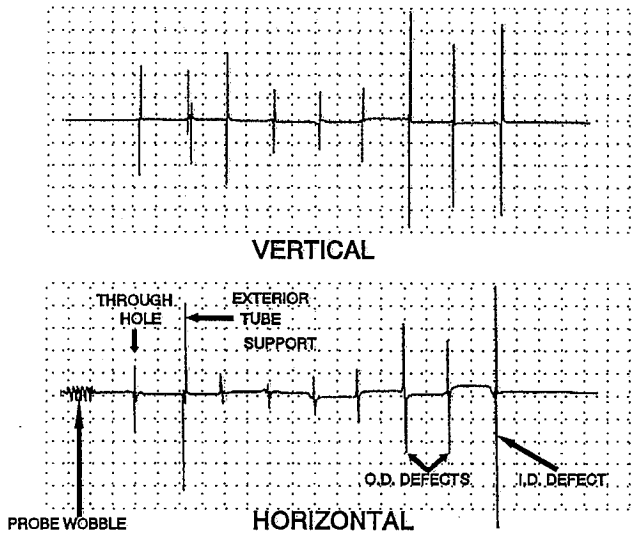



**Figure 5-14** *Chart Recording*

Typical chart recordings of probe wobble and various flaws in tubing are shown in Figure 14. Note that the probe wobble provides a signal in the horizontal recorder channel, but not in the vertical. Results from the recorder chart may be analyzed for each individual vector if the phase angle indication of a hole is known. Factors such as depth of penetration, test frequency, and test material, affect the phase angles. In stainless steel tubing, a phase angle of approximately 135 degrees indicates a hole. Any angle greater than this indicates I.D. defects while any angle smaller than this indicates an O.D. defect.

An indication of defect location can be derived by comparing peak-to-peak chart records. If the vertical signal is larger, the defect is closer to the O.D. If the horizontal signal is larger, the defect is nearer to the I.D.

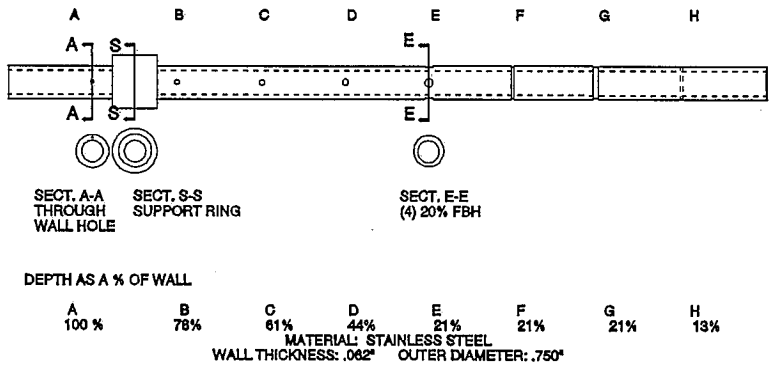



**Figure 5-15** *Stainless Steel I.D. Tube Standard*

## 5.12 Fastener Hole Inspection Using The Waterfall Display

The waterfall display is used in conjunction with a rotating scanner making it possible to more accurately locate a flaw inside fastener holes. It not only helps determine the radial position of the flaw inside the hole but also indicates the relative depth at which the flaw begins and ends. The default waterfall display simultaneously exhibits 32 sweep lines on the CRT screen. Each line represents one rotation of the probe as it moves forward into the hole. The forward movement is determined by the PITCH setting of the instrument and scanner used.

1. Equipment Used:

   Nortec RA-.250" Probe
   Nortec TB-16 Test Block (1/4")
   Nortec 19/RA scanner
   1/4" Teflon Tape

2. Connect the 19-RA scanner to the 19e$^{II}$ SPO 3196 through the connecting cable.

3. Carefully place teflon tape over the face of the coils on the probe tip. Use just enough tape to make a good bond without overlapping the ends as they wrap around the tip.

4. Apply power to the instrument.

5. Load the factory default parameters by pressing **[SP]**, **[9]**, **[9]**, **[ENTR]**. When the LCD displays the message, **LOAD DEFAULT Press ENTR Key**, press **[ENTR]**.

   **Note**

   The waterfall display is best viewed without the graticule lines on the screen. The graticule can be removed by using the SP12 function. Press **[SP]**, **[1]**, **[2]**, **[ENTR]**. Rotate the SmartKnob™ until the graticule no longer appears on the screen.

6. Load the SCANNER default parameters by pressing **[SP]**, **[3]**, **[ENTR]**.

7. Apply power to the scanner by placing the switch in the **ON** position.

8. Place the probe tip near the entrance to the test hole until a deflection begins to appear on the CRT screen.

9. Adjust the SmartKnob™ until the screen deflection becomes as vertically oriented as possible. It should appear similar to that shown in figure 5.

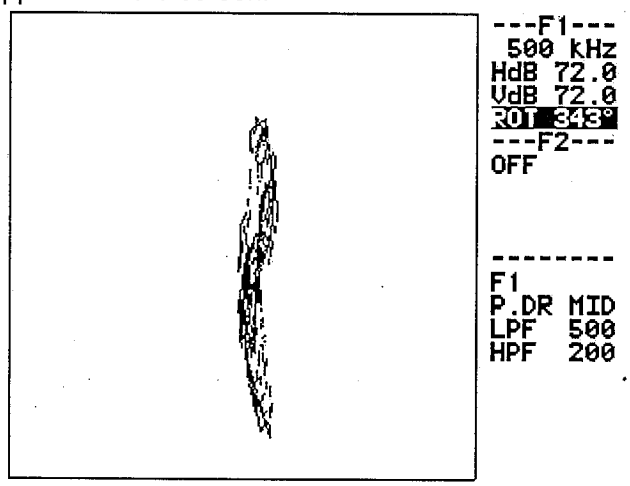



**Figure 5-16** *Waterfall SP3 Setup*

10. Remove the probe from the test hole and press **[ENTR]**.

11. Press **[SWP]** repeatedly until the LCD reads **SWEEP WFALL SYNC.**

The set-up is complete and the instrument is ready to begin the test. Avoid binding the rotating probe against the sides of the test hole as this can cause damage to the scanner and probe.

The CRT screen fills with a waterfall display of all 32 sweep lines as long as the scanner power switch

is in the **ON** position. A new display appears each time the **[ERASE]** key is pressed. For this test care must be taken as one hand is required to press the key while the other is moving the scanner probe into the hole. Prepare a satisfactory work area which promotes a trouble-free procedure.

12. Place the probe tip at the entrance of the test hole.

13. Press **[ERASE]** while moving the probe tip forward into the test hole. The CRT screen should display a patter similar to that shown in Figure 6.

14. Repeat steps 12 and 13 as often as necessary until a desirable waterfall pattern is generated. Rotate the test block 90° or more if the vertical deflection lines are not horizontally centered.

15. Press **[SP]**, **[2]**, **[1]**, **[ENTR]**.

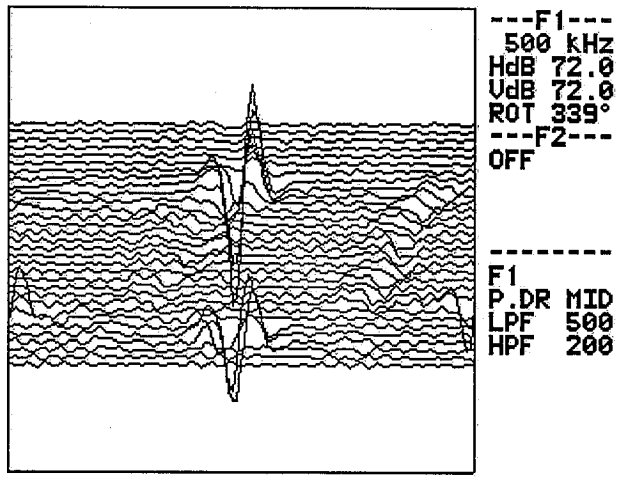



**Figure 5-17** *Flaw Detection in TB-16 Test Block*

16. Rotate the SmartKnob™ until the solid sweep line is located in the area of greatest vertical deflection.

17. Press the **[SWP]** key until a single sweep line appears on the CRT screen. Rotating the SmartKnob™ scrolls through the waterfall display one-line at a time.

18. Press the **[SWP]** key until the impedance plane display appears on the CRT screen.

19. Press the **[8]** (UP) key. The **ANGL** side-bar is highlighted on the CRT screen. Rotating the Smart Knob™ changes the rotation angle of the display causing the image to rotate away from the vertical orientation.

18. Press the **[SWP]** key until the waterfall display returns. The display may not appear the same as when it was first generated following the changes made in step 19. Press the **[2]** or **[8]** key until the **ANGL** side-bar is highlighted. Turning the SmartKnob™ will change the rotation angle. As the rotation angle is changed the display can be brought back to its original appearance.

## 5.13 Fastener or Bolt Hole Inspection Using The PS-5 and a Gulton Probe

This sample set-up procedure is for a PS-5 using a Gulton style two pin probe in conjunction with the waterfall display. This not only helps determine the radial position of the flaw inside the hole but also indicates the relative depth at which the flaw begins and ends. A Gulton style two pin probe contains no reference coil. This coil is necessary to balance the bridge located in the PS-5 scanner and must be selected from one of two choices in the PS-5 for optimum performance. The recommended instrument settings are approximate and may have to be varied due to differences in coils and standards.

1. Equipment Used:

   Nortec 19e$^{II}$ SPO3196 Portable Eddyscope
   Nortec PS-5 Probe Scanner
   Air Force Standard P/N 7947478-10
   200kHz Gulton Scanner Probe

2. Attach the PS-5 cable to the Probe and AUX connectors on the Nortec 19e$^{II}$ front panel and to the PS-5 scanner.

3. Turn the Nortec 19e$^{II}$ instrument power on.

4. Perform an instrument parameter reset using SP99. This will not erase any stored data or programs, only the current test parameters. Press **[SP][9][9]**, then **[ENTR]**. When the LCD displays the message **LOAD DEFAULT Press ENTR Key**, Press **[ENTR]**.

5. Adjust the frequency by pressing **[FREQ KHZ]** and rotate the SmartKnob™ until the LCD reads **FREQUENCY 1 200.**

6. Press the **[GAIN]** button on the instrument and rotate the SmartKnob™ until the LCD reads **GAIN1 VdB & HdB, H60.0 V60.0.**

7. The graticule may be turned off if desired. Press **[SP][1][2]**, then **[ENTR]**. Adjust the SmartKnob™ until the graticule no longer appears on the screen.

8. Optional - Apply teflon tape over the probe coil. This aids in longer probe life as well as reducing surface noise in the hole.

9. Place a spacer (such as a piece of a rubber band) in the slot at the coil end of the probe. This spacer should be adjusted to allow the probe to fit snugly into the selected test standard hole. Do not make it to tight. The probe should be able to stand upright in the hole on its' own.

10. Insert the probe into the PS-5 scanner by aligning the T-slot on the probe with the pin in the PS-5 barrel. Push the probe in and turn to engage the T-slot and pin.

11. Press **[SP][2][2]**, then **[ENTR]**. Adjust to the proper probe RPM with either the SmartKnob™ or the keypad. If the keypad is used, press **[ENTR]** after selecting the RPM. 100 RPM was selected for this example.

12. The cover plate on the back of the scanner contains two slide switches, one for REF COIL (reference coil) and one for PROBE TYPE. Set **PROBE TYPE** to **BRDG** and **REF COIL** to **INT 1** (bottom position).

13. Adjust the instrument gain to 90dB. Press the **[GAIN]** button on the instrument and rotate the SmartKnob™ until the LCD reads **GAIN1 VdB & HdB, H90.0 V90.0.** Press the **[NULL]** button. If the dot does not null to the center of the screen (or it is excessively noisy), set the REF COIL switch to **INT 2** (middle position) and press the **[NULL]** button again. If both positions null on screen, use the one with the least amount of noise (dot movement). Rotate the SmartKnob™ to return the gain to 60 dB and press **NULL.** The screen should resemble *Figure 18.*

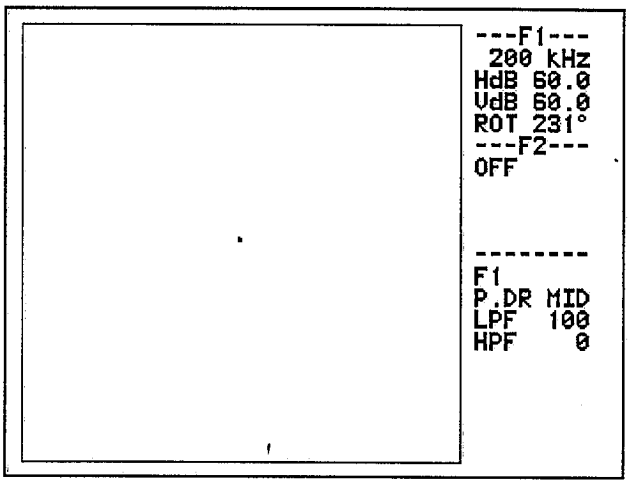



**Figure 5-18** *Nulled Screen*

14. Turn ON the PS-5 scanner and use the shifter to translate the probe until the coil is approximately half way down the long notch in the selected hole on the standard. Disengage the translation so the PS-5 is in rotate only. The coil should be passing over the long notch once per rotation. Turn the scanner OFF. Press the **[NULL]** and **[ERASE]** buttons on the 19e$^{II}$ instrument front panel or the PS-5 scanner. Turn the scanner back ON. The screen should look similar to *Figure 19* (impedance plane display), if not stop the scanner rotation and re-null. Turn the scanner rotation back ON. The gain and rotation may have to be adjusted slightly. Press the **[ANGL]** button to position the noise (lift off signal). Use the SmartKnob™ to rotate this signal until it moves back and forth horizontally, and the flaw signal moves up and to the left on the display.

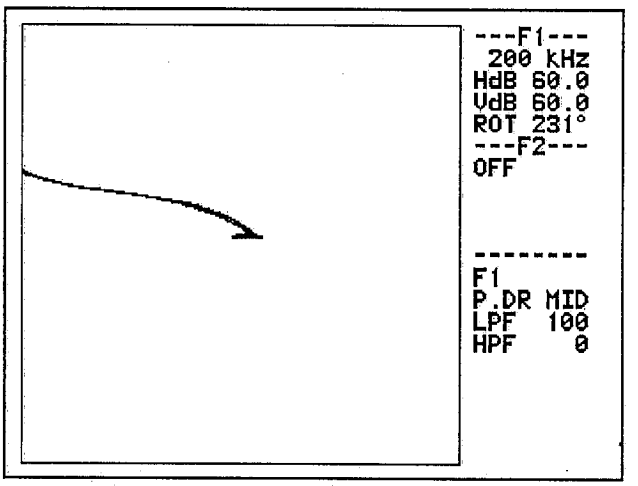



**Figure 5-19** *Lift-off and Flaw Signal*

15. Press the **[FLTR]** button until the HPF is in black text on the screen. Adjust the SmartKnob™ until the LCD reads **FILTER HI 8.** This will produce a sideways looking figure 8. Stop the scanner and press the **[NULL]** button to center this figure 8 on the instruments display. Turn the scanner back ON.

16. Press the **[SWP]** button until the LCD reads **SWEEP EXTERNAL.** The sweep display should look similar to *Figure 20.* Noise on the sweep line can be reduced by adjusting the rotation. Make sure the notch signal remains visible during this operation. The objective is to obtain the greatest signal to noise ratio. Adjust the gain to bring the notch signal to the desired amplitude.

17. Optional - The LPF (low pass filter) cutoff frequency may be reduced to smooth out any saw tooth appearing as high frequency noise on the sweep line.

    **CAUTION:** Do not reduce the LPF cutoff frequency so much as to change the shape or amplitude of the notch signal.

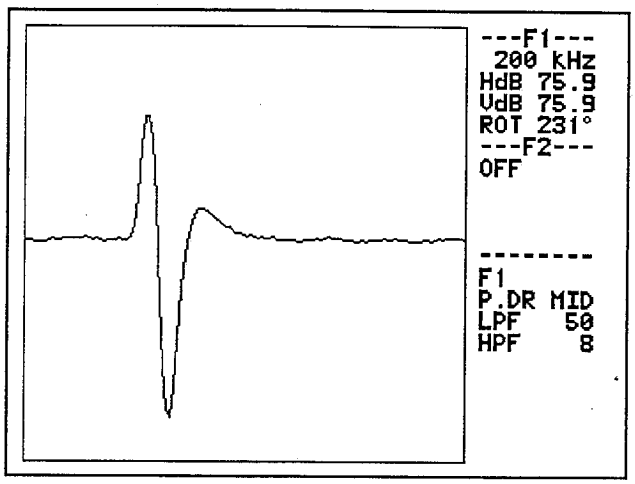



**Figure 5-20** *Typical Notch Signal*

18. Waterfall Display: Adjust the PS-5 extension and retraction limits so the probe translates from surface to surface through the thickness of the test standard (up to 1.5").

    Fully retract the probe. Press the **[SWP]** button once. The LCD should read **SWEEP WFALL SYNC.** Press **[ERASE]** to prepare for the scan. With the translator engaged, turn ON the scanner and scan through the hole. The screen should look similar to *Figure 21,* displaying consecutive revolutions of the probe as it translates through the hole.

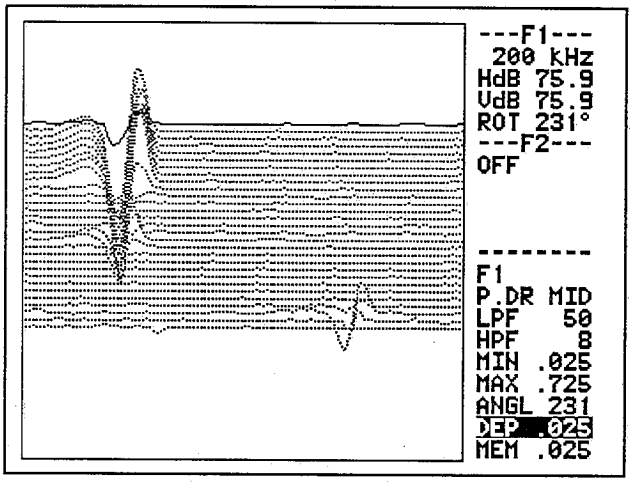



**Figure 5-21** *Waterfall Flaw Detection*

## 5.14 Fastener or Bolt Hole Inspection Using the PS-5 and an Absolute Bridge Probe

This sample set-up procedure is for use with an Absolute Bridge probe. This type of probe contains both the test and reference coils necessary to balance the bridge. These recommended instrument settings are approximate and may have to be varied due to differences in coils and standards.

1. Equipment Used:

   Nortec 19e$^{II}$ SPO3196 Portable Eddyscope
   Nortec PS-5 Probe Scanner
   Air Force Standard P/N 7947478-10
   200kHz Absolute Bridge Probe

2. Attach the PS-5 cable to the Probe and AUX connectors on the Nortec 19e$^{II}$ front panel and to the PS-5 scanner.

3. Turn the Nortec 19e$^{II}$ instrument power on.

4. Perform an instrument parameter reset using SP99. This will not erase any stored data or programs, only the current test parameters. Press **[SP][9][9]**, then **[ENTR]**. When the LCD displays the message, **LOAD DEFAULT Press ENTR Key**, Press **[ENTR]**.

5. Adjust the frequency by pressing **[FREQ KHZ]** and rotate the SmartKnob™ until the LCD reads **FREQUENCY 1 200.**

6. Press the **[GAIN]** button on the instrument and rotate the SmartKnob™ until the LCD reads **GAIN1 VdB & HdB, H60.0 V60.0.**

7. The graticule may be turned off if desired. Press **[SP][1][2]**, then **[ENTR]**. Adjust the SmartKnob™ until the graticule no longer appears on the screen.

8. Optional - Apply teflon tape over the probe coil. This aids in longer probe life as well as reducing surface noise in the hole.

9. Place a spacer (such as a piece of a rubber band) in the slot at the coil end of the probe. This spacer should be adjusted to allow the probe to fit snugly into the selected test standard hole. Do not make it to tight. The probe should be able to stand upright in the hole on its' own.

10. Insert the probe into the PS-5 scanner by aligning the T-slot on the probe with the pin in the PS-5 barrel. Push the probe in and turn to engage the T-slot and pin.

11. Press **[SP][2][2]**, then **[ENTR]**. Adjust to the proper probe RPM with either the Smart Knob™ or the keypad. If the keypad is used, press **[ENTR]** after selecting the RPM. 100 RPM was selected for this example.

12. The cover plate on the back of the scanner contains two slide switches, one for REF COIL (reference coil) and one for PROBE TYPE. Set **PROBE TYPE** to **BRDG** and **REF COIL** to **EXT** (top).

13. Press the **[NULL]** button. The screen should look like *Figure 22.*

14. Turn ON the PS-5 scanner and use the shifter to translate the probe until the coil is about half way down the long notch in the selected hole on the standard. Disengage the translation so the PS-5 is in rotate only. The coil should be passing over the long notch once per rotation. Turn the scanner OFF. Press the **[NULL]** and **[ERASE]** buttons on the 19e$^{II}$ instrument front panel or the PS-5 scanner. Turn the scanner back ON. The screen should look similar to *Figure 23* (impedance plane display), if not stop the scanner rotation and re-null. Turn the scanner rotation back ON. The gain and rotation may have to be adjusted slightly. Press the **[ANGL]** button to position the noise (lift off signal). Use the SmartKnob™ to rotate this signal until it moves back and forth horizontally, and the flaw signal moves up and to the left on the display.

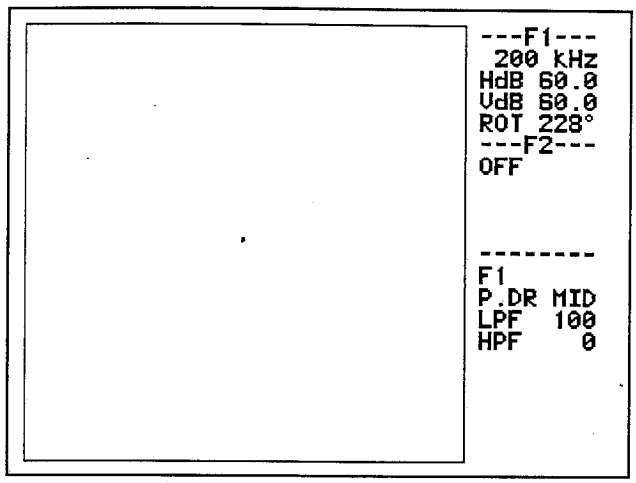



**Figure 5-22** *Nulled Screen*

15. Press the **[FLTR]** button until the HPF is in black text on the screen. Adjust the SmartKnob™ until the LCD reads **FILTER HI 8.** This will produce a sideways looking figure 8. Stop the scanner and press the **[NULL]** button to center this figure 8 on the instruments display. Turn the scanner back ON.

16. Press the **[SWP]** button until the LCD reads **SWEEP EXTERNAL.** The sweep display should look similar to *Figure 24*. Noise on the sweep line can be reduced by adjusting the rotation. Make sure the notch signal remains visible during this operation. The objective is to obtain the greatest signal to noise ratio. Adjust the gain to bring the notch signal to the desired amplitude.

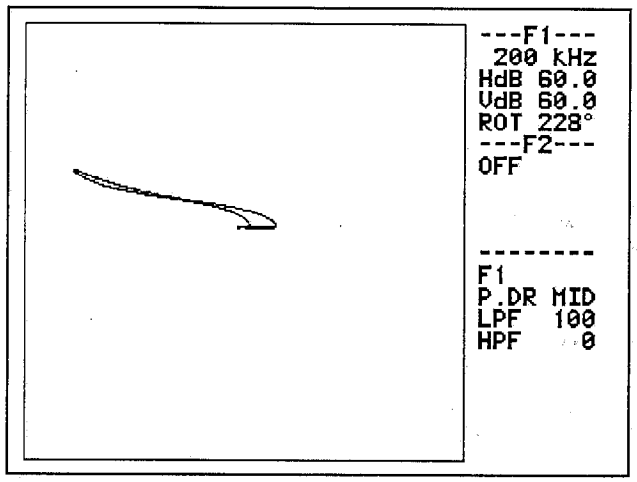



**Figure 5-23** *Lift-off and Flaw Signal*

17. Optional - The LPF (low pass filter) cutoff frequency may be reduced to smooth out any saw tooth appearing as high frequency noise on the sweep line.

    **CAUTION:** Do not reduce the LPF cutoff frequency so much as to change the shape or amplitude of the notch signal.

18. Waterfall Display: Adjust the PS-5 extension and retraction limits so the probe translates from surface to surface through the thickness of the test standard (up to 1.5").

    Fully retract the probe. Press the **[SWP]** button once. The LCD should read **SWEEP WFALL SYNC**. Press **[ERASE]** to prepare for the scan.

    With the translator engaged, turn ON the scanner and scan through the hole. The screen should look similar to *Figure 25*, displaying consecutive revolutions of the probe as it translates through the hole.

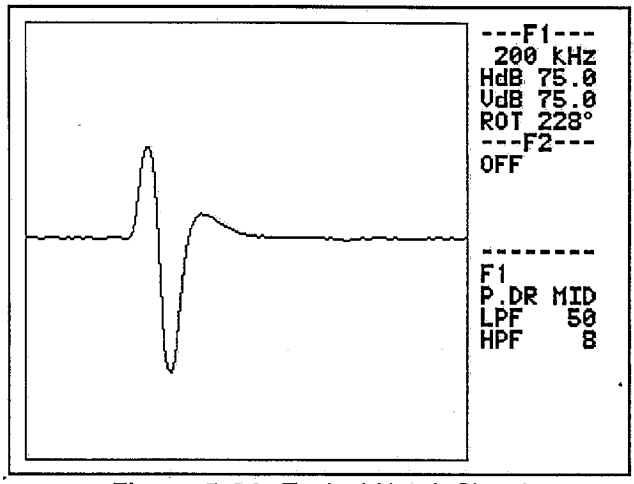



**Figure 5-24** *Typical Notch Signal*

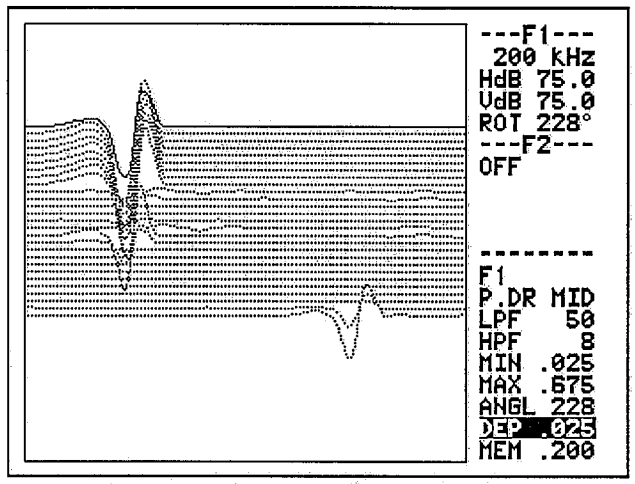



**Figure 5-25** *Waterfall Flaw Detection*

## 5.15 Fastener or Bolt Hole Inspection Using the PS-5 and a Differential Bridge Probe

This sample set-up procedure is for a PS-5 using a Differential Bridge probe. This type of probe contains both the test and reference coils necessary to balance the bridge. These recommended instrument settings are approximate and may have to be varied due to differences in coils and standards.

1. Equipment Used:

   Nortec 19e$^{II}$ SPO3196 Portable Eddyscope
   Nortec PS-5 Probe Scanner
   Air Force Standard P/N 7947478-10
   500kHz Differential Bridge Probe

2. Attach the PS-5 cable to the Probe and AUX connectors on the Nortec 19e$^{II}$ front panel and to the PS-5 scanner.

3. Turn the Nortec 19e$^{II}$ instrument power on.

4. Perform an instrument parameter reset using SP99. This will not erase any stored data or programs, only the current test parameters. Press **[SP][9][9]**, then **[ENTR]**. When the LCD displays the message, **LOAD DEFAULT Press ENTR Key**, Press **[ENTR]**.

5. Adjust the frequency by pressing **[FREQ KHZ]** and rotate the SmartKnob™ until the LCD reads **FREQUENCY 1 500.**

6. Press the **[GAIN]** button on the instrument and rotate the SmartKnob™ until the LCD reads **GAIN1 VdB & HdB, H66.0 V66.0.**

7. The graticule may be turned off if desired. Press **[SP][1][2]**, then **[ENTR]**. Adjust the SmartKnob™ until the graticule no longer appears on the screen.

8. Optional - Apply teflon tape over the probe coil. This aids in longer probe life as well as reducing surface noise in the hole.

9. Place a spacer (such as a piece of a rubber band) in the slot at the coil end of the probe. This spacer should be adjusted to allow the probe to fit snugly into the selected test standard hole. Do not make it to tight. The probe should be able to stand upright in the hole on its' own.

10. Insert the probe into the PS-5 scanner by aligning the T-slot on the probe with the pin in the PS-5 barrel. Push the probe in and turn to engage the T-slot and pin.

11. Press **[SP][2][2]**, then **[ENTR]**. Adjust to the proper probe RPM with either the Smart Knob™ or the keypad. If the keypad is used, press **[ENTR]** after selecting the RPM. 100 RPM was selected for this example.

12. The cover plate on the back of the scanner contains two slide switches, one for REF COIL (reference coil) and one for PROBE TYPE. Set **PROBE TYPE** to **BRDG** and **REF COIL** to **EXT** (top position).

13. Press the **[NULL]** button. The screen should resemble *Figure 26.*

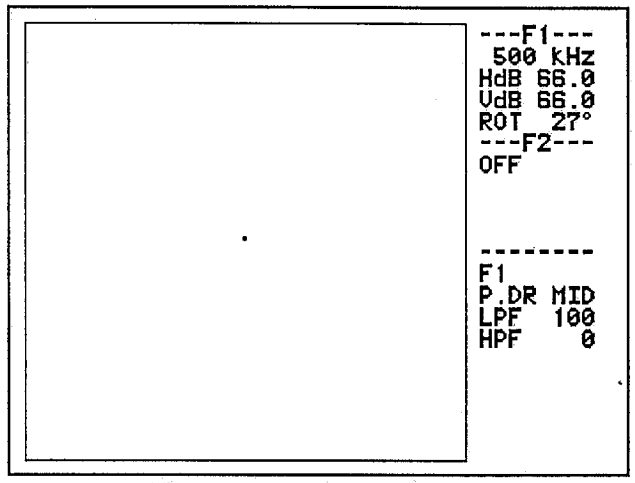



**Figure 5-26** *Nulled Screen*

14. Turn ON the PS-5 scanner and use the shifter to translate the probe until the coil is appromimately half way down the long notch in the selected hole on the standard. Disengage the translation so the PS-5 is in rotate only. The coil should be passing over the long notch once per rotation. Turn the scanner OFF. Press the **[NULL]**and **[ERASE]** buttons on the 19e$^{II}$ instrument front panel or the PS-5 scanner. Turn the scanner back ON. The screen should look similar to *Figure 27* (impedance plane display), if not stop the scanner rotation and re-null. Turn the scanner rotation back ON. The gain and rotation may have to be adjusted slightly. Press the **[ANGL]** button to position the noise (lift off signal). Use the SmartKnob™ to rotate this signal until it moves back and forth horizontally, and the flaw signal moves up and to the left on the display.

15. Press the **[FLTR]** button until the HPF is in black text on the screen. Adjust the SmartKnob™ until the LCD reads **FILTER HI 2.** Stop the scanner and press the **[NULL]** button. Turn the scanner back ON.

16. Press the **[SWP]** button until the LCD reads **SWEEP EXTERNAL.** The sweep display should look similar to *Figure 28.* Noise on the sweep line can be reduced by adjusting the rotation. Make sure the notch signal remains visible during this operation.
The objective is to obtain the greatest signal to noise ratio. Adjust the gain to bring the notch signal to the desired amplitude.

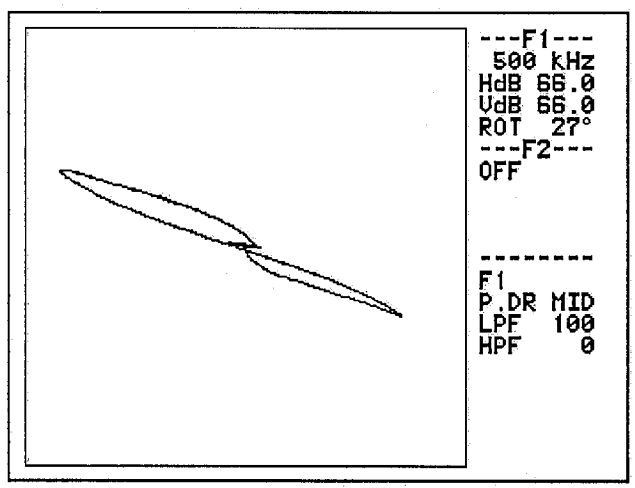



**Figure 5-27** *Lift-off and Flaw Signal*

17. Optional - The LPF (low pass filter) cutoff frequency may be reduced to smooth out any saw tooth appearing as high frequency noise on the sweep line.

    **CAUTION:** Do not reduce the LPF cutoff frequency enough to change the shape or amplitude of the notch signal.

18. Waterfall Display: Adjust the PS-5 extension and retraction limits so the probe translates from surface to surface through the thickness of the test standard (up to 1.5").

    Fully retract the probe. Press the **[SWP]** button once. The LCD should read **SWEEP WFALL SYNC.** Press **[ERASE]** to prepare for the scan.

    With the translator engaged, turn ON the scanner and scan through the hole. The screen should look similar to *Figure 29*, displaying consecutive revolutions of the probe as it translates through the hole.

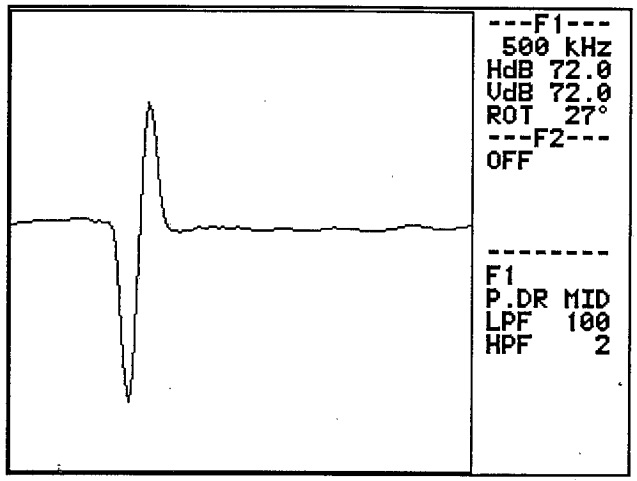



**Figure 5-28** *Typical Notch Signal*

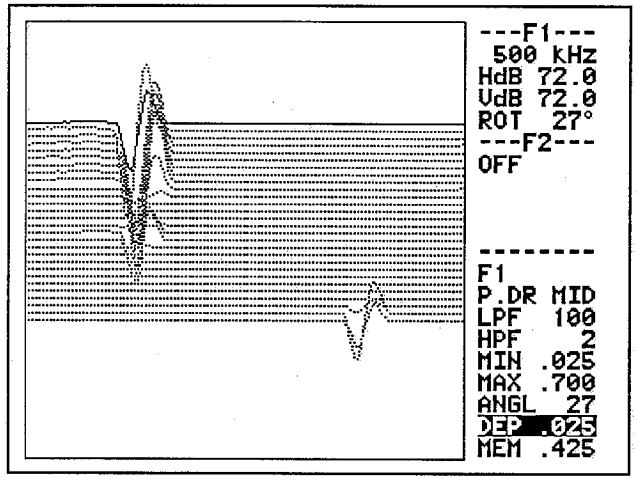



**Figure 5-29** *Waterfall Flaw Detection*

## 5.16 Fastener or Bolt Hole Inspection Using PS-5 and a Differential Reflection Probe

This sample set-up procedure is for a PS-5 using a Differential Reflection probe. This type of probe contains both the driver and pick-up coils necessary to balance the instrument. These recommended instrument settings are approximate and may have to be varied due to differences in coils and standards.

1. Equipment Used:

   Nortec 19e$^{II}$ SPO3196 Portable Eddyscope
   Nortec PS-5 Probe Scanner
   Air Force Standard P/N 7947478-10
   500kHz Differential Reflection Probe

2. Attach the PS-5 cable to the Probe and AUX connectors on the Nortec 19e$^{II}$ front panel and to the PS-5 scanner.

3. Turn the Nortec 19e$^{II}$ instrument power on.

4. Perform an instrument parameter reset using SP99. This will not erase any stored data or programs, only the current test parameters. Press **[SP][9][9]**, then **[ENTR]**. When the LCD displays the message, **LOAD DEFAULT Press ENTR Key**, Press **[ENTR]**.

5. Adjust the frequency by pressing **[FREQ KHZ]** and rotate the SmartKnob™ until the LCD reads **FREQUENCY 1 500.**

6. Press **[GAIN]** button on the instrument and rotate the Smart Knob until the LCD reads **GAIN1 VdB & HdB, H60.0 V60.0.**

7. The graticule may be turned off if desired. Press **[SP][1][2]**, then **[ENTR]**. Adjust the SmartKnob™ until the graticule no longer appears on the screen.

8. Optional - Apply teflon tape over the probe coil. This aids in longer probe life as well as reducing surface noise in the hole.

9. Place a spacer (such as a piece of a rubber band) in the slot at the coil end of the probe. This spacer should be adjusted to allow the probe to fit snugly into the selected test standard hole. Do not make it to tight. The probe should be able to stand upright in the hole on its' own.

10. Insert the probe into the PS-5 scanner by aligning the T-slot on the probe with the pin in the PS-5 barrel. Push the probe in and turn to engage the T-slot and pin.

11. Press **[SP][2][2]**, then **[ENTR]**. Adjust to the proper probe RPM with either the smart knob or the keypad. If the keypad is used, press **[ENTR]** after selecting the RPM. 100 RPM was selected for this example.

12. The cover plate on the back of the scanner contains two slide switches, one for REF COIL (reference coil) and one for PROBE TYPE. Set **PROBE TYPE** to **REFL** and **REF COIL** to **EXT** (bottom position).

13. Press the **[NULL]** button. The screen should resemble *Figure 30*.

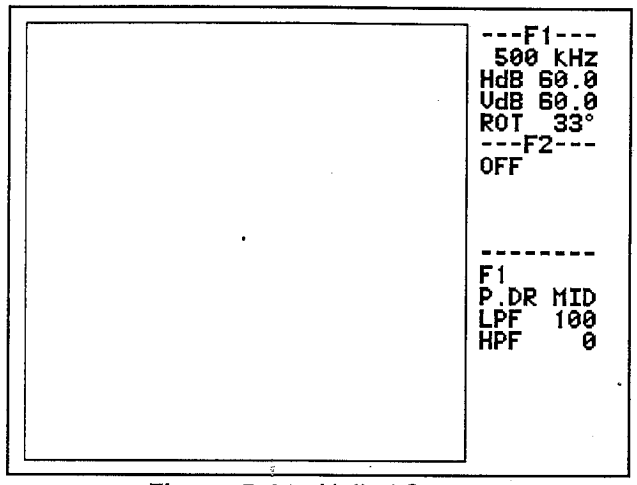



**Figure 5-30** *Nulled Screen*

14. Turn ON the PS-5 scanner and use the shifter to translate the probe until the coil is approximately half way down the long notch in the selected hole on the standard. Disengage the translation so the PS-5 is in rotate only. The coil should be passing over the long notch once per rotation. Turn the scanner OFF. Press the [**NULL**] and [**ERASE**] buttons on the 19e$^{II}$ instrument front panel or the PS-5 scanner. Turn the scanner back ON. The screen should look similar to *Figure 31* (impedance plane display), if not stop the scanner rotation and re-null. Turn the scanner rotation back ON. The gain and rotation may have to be adjusted slightly. Press the **[ANGL]** button to position the noise (lift off signal). Use the SmartKnob™ to rotate this signal until it moves back and forth horizontally, and the flaw signal moves up and to the left on the display.

15. Press the **[FLTR]** button until the HPF is in black text on the screen. Adjust the SmartKnob™ until the LCD reads **FILTER HI 2.** This will produce a sideways looking figure 8. Stop the scanner and press the **[NULL]** button to center this figure 8 on the instruments display. Turn the scanner back ON.

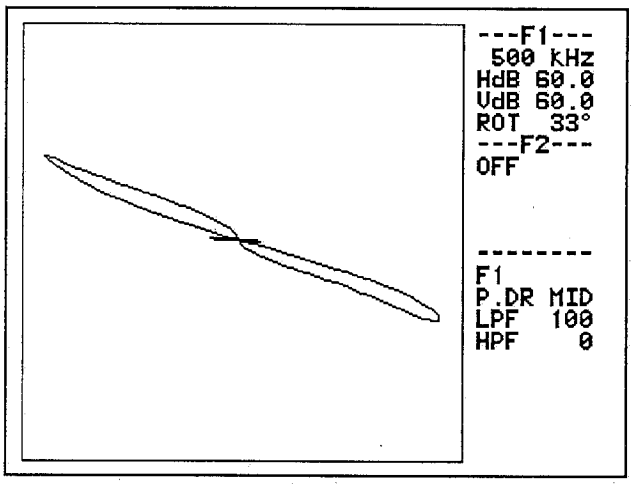



**Figure 5-31** *Lift-off and Flaw Signal*

16. Press the **[SWP]** button until the LCD reads **SWEEP EXTERNAL.** The sweep display should look similar to *Figure 32*. Noise on the sweep line can be reduced by adjusting the rotation. Make sure the notch signal remains visible during this operation. The objective is to obtain the greatest signal to noise ratio. Adjust the gain to bring the notch signal to the desired amplitude.

17. Optional - The LPF (low pass filter) cutoff frequency may be reduced to smooth out any saw tooth appearing as high frequency noise on the sweep line.

    **CAUTION:** Do not reduce the LPF cutoff frequency so much as to change the shape or amplitude of the notch signal.

18. Waterfall Display: Adjust the PS-5 extension and retraction limits so the probe translates from surface to surface through the thickness of the test standard (up to 1.5").

    Fully retract the probe. Press the **[SWP]** button once. The LCD should read **SWEEP WFALL SYNC.**

    Press **[ERASE]** to prepare for the scan. With the translator engaged, turn ON the scanner and scan through the hole. The screen should look similar to *Figure 33,* displaying consecutive revolutions of the probe as it translates through the hole.

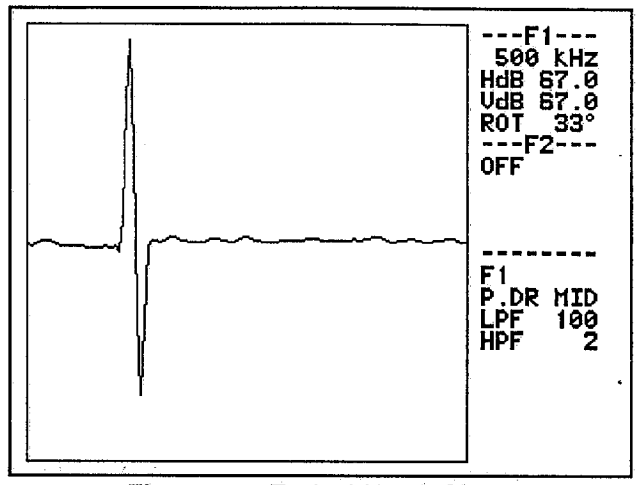



**Figure 32** *Typical Notch Signal*

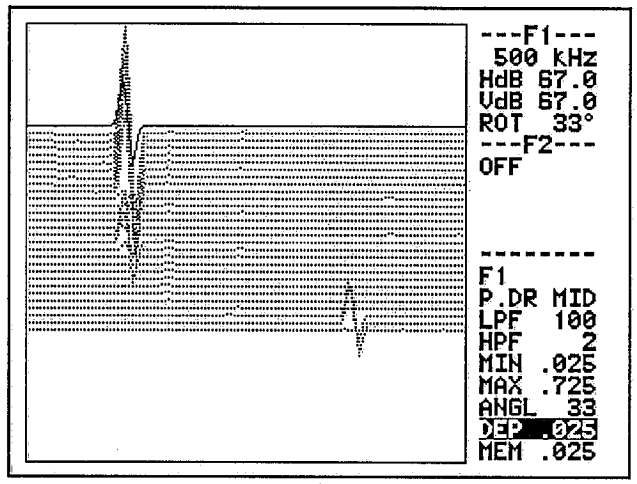



**Figure 33** *Waterfall Flaw Detection*

# 6.0 Rear Panel Connections

## 6.1 Introduction

The rear panel of the Nortec-19e$^{II}$ SPO 3196 contains provisions for connection to various types of equipment, such as power supply and battery chargers, external printers, computers, and process control equipment. This section details each signal available and the methods for interfacing external devices to the instrument.

On the back of the Nortec-19e$^{II}$ SPO 3196 are three connectors:

* Power connector. Used to connect the LA12CE Battery Charger/Eliminator for powering the instrument and charging the battery.
* I/O connector. Contains several miscellaneous input and output signals.
* RS-232C serial interface. Used for connection to an external printer for printout of information, or to host computer for information transfer.

*Figure 1* shows the location of these 3 connectors on the rear panel.

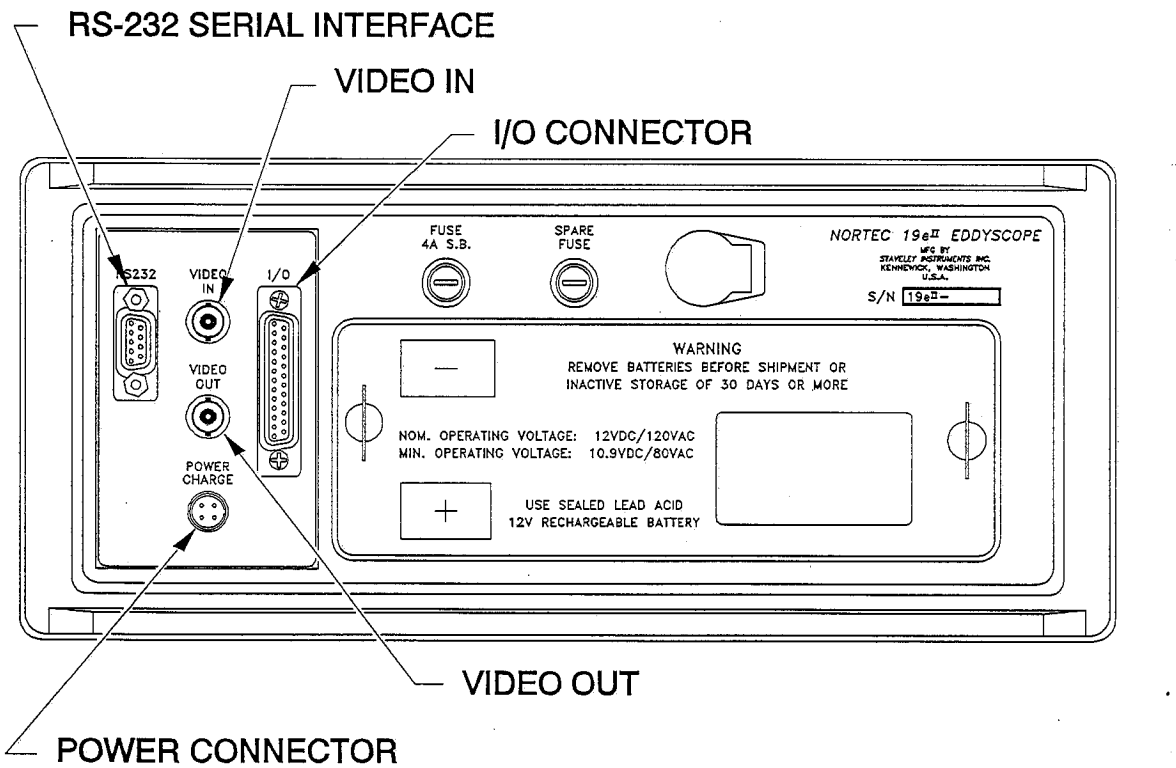



**Figure 6-1** *Nortec-19e$^{II}$* SPO 3196 *Rear Panel Connectors*

The location of pins for the 3 connectors on the rear panel is shown in *Figure* 2. These pins are numbered as they would be viewed looking directly at the rear panel. Details of the connectors are listed in the pages that follow.

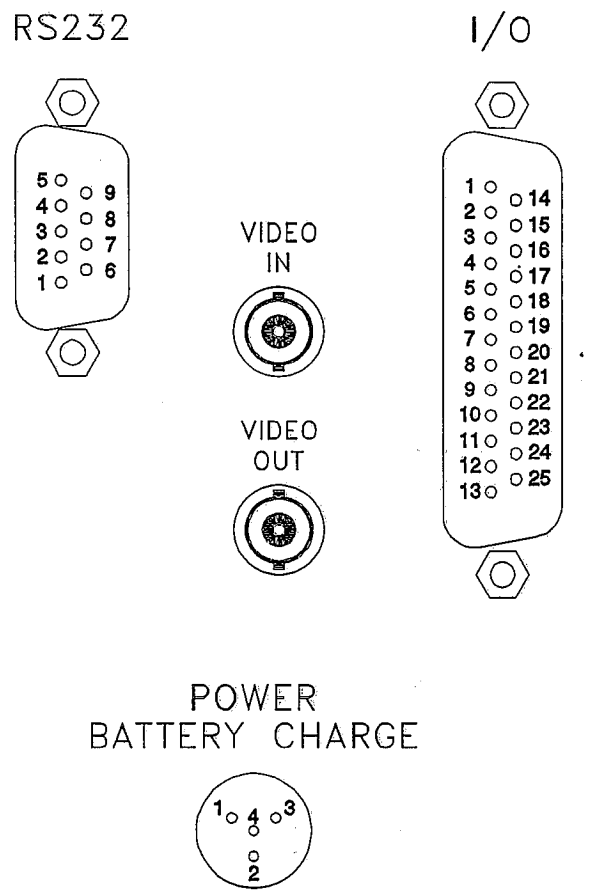



**Figure 6-2** *Rear Panel Connector Pinouts*

## 6.2 Power Connector

The power connector is used to supply power to the instrument and recharge the battery. It is only to be connected to a model LA12CE Battery Charger/Eliminator. Pins listed here are for reference:

| Pin No. | Signal Name |
|---|---|
| 1 | Common |
| 2 | Battery charger |
| 3 | Instrument power |
| 4 | Earth (shield) |

### Power Requirements

As a fully portable inspection instrument, the Nortec 19e$^{II}$ SPO 3196 relies on a battery as its primary source of power. The 12 volt sealed lead acid battery is located at the rear of the unit. The battery is conveniently accessed by removing the rear panel of the instrument.

A battery charger/eliminator unit is provided with the Nortec 19e$^{II}$ SPO 3196, which will recharge up to two batteries, and allows the instrument to be operated from AC line power. For remote sites with available line power, the charger may be installed in the instrument in place of the battery.

### Battery Charger/Eliminator

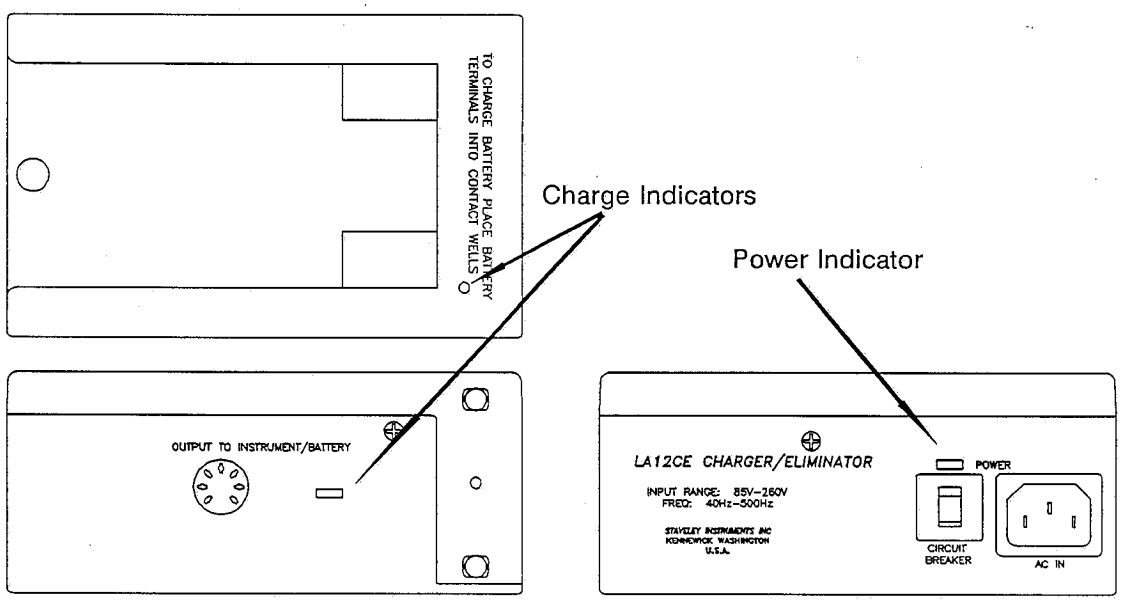



**Figure 6-3** *LA12CE Battery Charger/Eliminator*

**WARNING**

The AC charger and power source, LA12CE, supplied with the Nortec 19e$^{II}$ SPO 3196 (*Figure 6-3*) is specifically designed for use with 12 volt lead acid batteries. Its'charging characteristic is incompatible with NiCad batteries and the manufacturer recommends that this charger not be used with any other battery type. Use of a non-recommended battery type with the LA12CE charger will void the charger warranty.

The condition of the battery is monitored by the charger, while charging a battery either externally or mounted in the instrument. Charge cycles are automatically initiated by the charger. A yellow charge light on the LA12CE will glow for the duration of a charge cycle. The charge lamp on the top surface of the charger will illuminate for a battery placed on the charger case, while the indicator on the side of the charger case will illuminate while charging a battery installed in the instrument. The lamp will extinguish only when the battery is fully charged, however a partially charged battery may provide over 6 hours of operation. A fully discharged battery will require about 9 hours for a complete charging cycle.

The charger will operate properly over a wide range of input line voltage and frequency, no user adjustment is required for changes from 120 to 240 volt operation. When the charger is energized, the yellow power indicator on the chargers' front surface will illuminate.

The LA12CE Charger/Eliminator is supplied with a charging cable.

## 6.3 I/O Connector

The I/O connector is an industry standard 25 pin D-subminiature female connector. Various signals coming from and going to the instrument pass through this connector.

This connector contains several TTL compatible signal outputs for alarms, eddy current signal outputs, video output, synchronization for externally triggered sweep, and provisions for external (remote) null and erase.

A listing of the signals follows:

| Pin No. | Input/Output | Signal Name |
|---|---|---|
| 1 | | Instrument ground |
| 2 | Output | Alarm 3 (TTL)* |
| 3 | Output | Alarm 4 (TTL)* |
| 4 | Output | Alarm 5 (not currently implemented)* |
| 5 | | Instrument ground |
| 6 | Output | On screen (TTL, sorting gate mode only)* |
| 7 | Output | Alarm 2 (TTL)* |
| 8 | | Instrument ground |
| 9 | | Instrument ground |
| 10 | | Instrument ground |
| 11 | | Instrument ground |
| 12 | | Instrument ground |
| 13 | | Instrument ground |
| 14 | Output | Vertical record output** |
| 15 | Output | Horizontal record output** |
| 16 | Input | External sync |
| 17 | | Not connected |
| 18 | | Not connected |
| 19 | Output | Composite video |
| 20 | | Not connected |
| 21 | Output | Alarm 1 (TTL) |
| 22 | | Not connected |
| 23 | Input | Erase key connection 1 |
| 24 | Input | Erase key connection 2 |
| 25 | Input | Null connection |

*These are added signals on the Nortec-19e$^{II}$ SPO 3196 that are not on the original Nortec-19. All these signals were ground on the original Nortec-19. Connectors wired for a Nortec-19 should be checked to avoid signal conflicts. It is recommended that pin 13 be used for grounding external accessories.

**Vertical and horizontal recorder interfaces are implemented as outputs only. The TAPE IN feature of the original Nortec-19 has been deleted from the Nortec-19e$^{II}$ SPO 3196. The capture/replay feature on the Nortec-19e$^{II}$ SPO 3196 replaces the tape out/in feature of the Nortec-19.

Details for using the various inputs and outputs on the I/O connector follow:

**ALARM OUTPUTS** The alarm outputs are TTL compatible outputs that provide signals to indicate the state of the alarms that the instrument is set for.

**CAUTION**

**Each alarm is capable of sourcing or sinking up to 10 mA (milliamps) of current, with a minimum high voltage of 3.0 volts and a maximum low voltage of 0.5 volts. The higher signal level indicates an alarm state, while the lower level indicates no alarm. External circuits must be used if it is necessary to process signals different from these.**

For the polar, pie, polygon, and sweep alarms, ALARM 1 indicates the status of the alarm, with a high state indicating an alarm condition.

In the box alarm mode, ALARM 1 indicates the status of the first alarm, ALARM 2 the second, and ALARM 3 the third. These are all independent of one another, and are also high when an alarm is active.

The sorting gate uses an alarm encoding scheme. The ALARM 1 through ALARM 4 outputs comprise a bit pattern describing the currently latched zone for the sorting gate. These zones are described in detail in Section 4, *Instrument Operation,* under the Alarm Operation heading. The ON SCREEN signal will be high when the eddy current signal is on screen, low when off screen.

The conditions of the alarm outputs for each zone in the sorting gate are noted below:

| Zone (Position of dot) | ALARM 4 Output | ALARM 3 Output | ALARM 2 Output | ALARM 1 Output | ON SCREEN Output |
|---|---|---|---|---|---|
| Off Screen | Low | Low | Low | Low | Low |
| 1 | Low | Low | Low | High | High |
| 2 | Low | Low | High | Low | High |
| 3 | Low | Low | High | High | High |
| 4 | Low | High | Low | Low | High |
| 5 | Low | High | Low | High | High |
| 6 | Low | High | High | Low | High |
| 7 | Low | High | High | High | High |
| 8 | High | Low | Low | Low | High |
| 9 | High | Low | Low | High | High |

Except for the ON SCREEN signal, the alarm outputs will remain latched to the highest priority zone setting until the signal goes off screen, then back on screen. At this time, the latching is reset, and as the signal moves through the zones then alarm outputs will change, remaining at the highest priority zone entered while on screen. Priority of the zones may be set using serial port commands from an external terminal or computer (see Section 7, *Computer Interface).* The default priority is:

Zone 1 (lowest)
Zone 2
Zone 4
Zone 3
Zone 5
Zone 7
Zone 6
Zone 8
Zone 9 (highest)

For example, suppose the dot enters the screen, then moves to zone 1, then 4, then 5, then passes back through zone 4 and 1. On the next test, the signal enters the screen again into zone 1, then 5, then 8, before retracing itself back off screen. The alarm outputs would respond as follows:

| Dot Position | Alarm Outputs | On Screen Signal |
|---|---|---|
| Off screen | [Last latched state] | Low |
| Zone 1 | Zone 1 | High |
| Zone 4 | Zone 4 | High |
| Zone 5 | Zone 5 | High |
| Zone 4 | Zone 5 (latched) | High |
| Zone 1 | Zone 5 (latched) | High |
| Off screen | Zone 5 (latched) | Low |
| Zone 1 | Zone 1 | High |
| Zone 5 | Zone 5 | High |
| Zone 8 | Zone 8 | High |
| Zone 5 | Zone 8 (latched) | High |
| Zone 1 | Zone 8 (latched) | High |
| Off screen | Zone 8 (latched) | Low |

Another consideration in some tests is the rate at which the alarm information is updated in the Nortec-19e$^{II}$ SPO 3196, or the data rate. Two data rates are used by the instrument, 1.5 KHz when complex operations are performed, and 3 KHz for higher speed, basic testing. For the various operating modes, data rates are tabulated below:

| OPERATING MODE | DATA RATE |
|---|---|
| All sweep modes | 3 kHz |
| Impedance plane, single box alarm (alarm 1), no variable persistence, signal capture not active | 3 kHz |
| Impedance plane, sorting gate, no variable persistence, signal capture not active | 3 kHz |
| Impedance plane, with variable persistence and/or signal capture active | 1.5 kHz |
| Impedance plane, using pie, polar, or polygon alarm | 1.5 kHz |
| Impedance plane, using multiple box alarms | 1.5 kHz |

**VERTICAL AND HORIZONTAL OUTPUTS**

The vertical and horizontal outputs (pins 14 and 15 on the I/O connector) reflect the current value of the eddy current signal, relative to the null position. In other words, if the instrument is nulled, the values of these outputs will be at 0 volts (±0.05V). The sensitivity of these outputs is 0.5V ±0.05V) per division of eddy current signal movement.

The circuits internal to the Nortec-19e$^{II}$ SPO 3196 are specified when driving a 1K ohm load, but will function with loads as low as 500 ohms. Excessive loading may produce erroneous results and could possibly damage circuits.

Note that the screen position adjustment does not affect these outputs, only the changes from the selected null position. Thus, when the [NULL] button is pressed, the outputs will return to 0 volts.

The vertical and horizonal outputs may be used to drive strip chart recorders, FM signal recorders, and so on.

**EXTERNAL SYNC INPUT**

The external sync input is used to synchronize the instrument to a rotating scanner when operating in the EXTERNAL SWEEP mode. This input is also routed to the *PROBE* connector on the front panel, where it is used by the 19/RA scanner.

When interfacing to rotating equipment other than the 19/RA scanner, it may be necessary to utilize this input. The instrument is designed to handle sync rates from 600 to 2000 RPM (10 to 33.3 Hz).

This input requires that it be shorted to ground (0.5mA short circuit current), then released to provide a synchronization signal. Duty cycle is unimportant, provided the input remains grounded for 10 microseconds or longer. It can also be driven by a logic signal capable of sinking 0.5 milliamps, provided that the low logic level is from 0.0 to 0.2 volts and the high level is greater than 3.0 volts and less than 5.1 volts. All voltages are referenced to the INSTRUMENT GROUND pins on the I/O connector. It is recommended that pin 13 of the I/O connector be used for ground purposes.

**COMPOSITE VIDEO OUTPUT**

The composite video output on pin 19 of the I/O connector is an RS-170 compatible (NTSC compatible) signal that allows viewing and recording the CRT display signal on external devices such as monitors and video recorders.

The video output is capable of driving a 75 ohm load to the following signal levels, with a ±0.4V tolerance:

* White level, 2.4 volts
* Black level, 1.2 volts
* Horizontal synchronization signal, 0.6 volts
* Vertical synchronization signal, 0.0 volts

There is one minor deviation in the composite video from the RS-170 standard as implemented in the Nortec-19e$^{II}$ SPO 3196. The screen is set up for a 262 line, 60 Hz, non-interlaced scan to improve screen stability, while the RS-170 standard calls for a 525 line, 30 Hz, interlaced scan. The impact of this is that an external device will see this as a 524 line, 30 Hz system. Most video systems are built to handle deviations such as this without error, but a digital line count based system may be incompatible.

Another difference that might be noticed on external video systems is that the Nortec-19e$^{II}$ SPO 3196 is designed to work without overscanning. Overscanning is used in

many video systems to reduce the effects of system nonlinearities by making the picture scan beyond the edges of the screen. Thus, a Nortec-19e$^{II}$ SPO 3196 screen may have the edges clipped off when its video signal is used on such system.

To use the composite video output, attach the video connector signal to pin 19 of the I/O connector and use one of the INSTRUMENT GROUND pins (pins 6-13, with pin 13 recommended) for the ground reference.

**EXTERNAL ERASE**

The external erase (*Figure 6-2*) connection allows the operator to erase the screen without using the front panel of the instrument. This is done by shorting pins 23 and 24 of the I/O connector together.

**WARNING**

**The signals on these pins are special signals used to read the front panel erase key. Thus, no other voltage levels, including INSTRUMENT GROUND, should be attached to these pins. Damage to the instrument could otherwise result. In addition, the cable carrying these signals should be no longer than 12 feet.**

The external erase function is normally done using a momentary switch that the operator may press whenever they want to erase the screen, with the contacts of the switch connected to pins 23 and 24 on the I/O connector. Staveley sells an accessory Remote Null and Erase box, part number 9506320, that utilizes this feature. Another way to set up the erase function is through an isolated set of relay contacts.

**EXTERNAL NULL**

The external null (*Figure 6-2*) connection provides a means to null the Nortec-19e$^{II}$ SPO 3196 instrument from a location remote from the front panel. It is implemented by momentarily shorting pin 25, NULL CONNECTION to one of the INSTRUMENT GROUND pins. It is recommended that pin 13 be used for the ground connection. The external null cable length should be no greater than 12 feet.

A momentary switch, open collector or open drain transistor, or relay contacts may be used for performing the external null function. The output is normally 5 volts ($\pm$0.5 volt) when not activated. Current through the external circuit with null active is 15 milliamps, $\pm$5 milliamps.

Staveley sells an accessory Remote Null and Erase box, part number 9506320, that utilizes this feature.

## 6.4 RS-232C Serial Interface

The RS-232C serial interface will communicate with either a serial interface printer or an externally connected computer at a fixed rate of 9600 baud. It is a 9-pin D-subminiature male connector and is designed to connect directly to an IBM-AT compatible serial port. Pinouts are listed below:

| Pin No. | Input/Output | Signal Name |
|---|---|---|
| 1 | | Not connected |
| 2 | Output | TXD (transmitted data) |
| 3 | Input | RXD (received data) |
| 4 | Input | CTS (clear to send) |
| 5 | | Signal ground |
| 6 | | Not connected |
| 7 | | Not connected |
| 8 | Output | RTS (request to send) |
| 9 | | Not connected |

This serial connector is designed to plug directly into an industry standard IBM-AT compatible serial connector. Using a readily 9 pin to 25 serial adapter cable, it will also connect directly to standard IBM-PC serial connectors by using a 25 pin to 25 pin cable with female connectors on both ends. Finally, the same 9 to 25 adapter cable may be used to connect the instrument directly to the optional Kodak Diconix printer. Interface cables are also available from Staveley.

Proper connection of the serial port to various devices is tabulated below:

| Nortec-19e$^{II}$ SPO 3196 Serial Connector (9 pin male) | Diconix Printer (25 pin female) | IBM-PC Serial Connector (25 pin male) | IBM-AT Serial Connector (9 pin male) |
|---|---|---|---|
| pin 2 (TXD) | pin 3 (RXD) | pin 3 (RXD) | pin 2 (RXD) |
| pin 3 (RXD) | pin 2 (TXD) | pin 2 (TXD) | pin 3 (TXD) |
| pin 4 (CTS) | pin 20 (DTR) | pin 20 (DTR) | pin 4 (DTR) |
| pin 5 (GND) | pin 7 (GND) | pin 7 (GND) | pin 5 (GND) |
| pin 8 (RTS) | pin 5 (CTS) | pin 5 (CTS) | pin 8 (CTS) |

## 6.5 I/O Strip Chart Recorder / Video Cable Accessory

The I/O Strip Chart Recorder and Video cable is a multi-purpose cable. It interfaces the 19e$^{II}$ SPO 3196 to an external single or dual channel recorder and/or an external video monitor. It has both horizontal and vertical channel outputs as well as composite video.

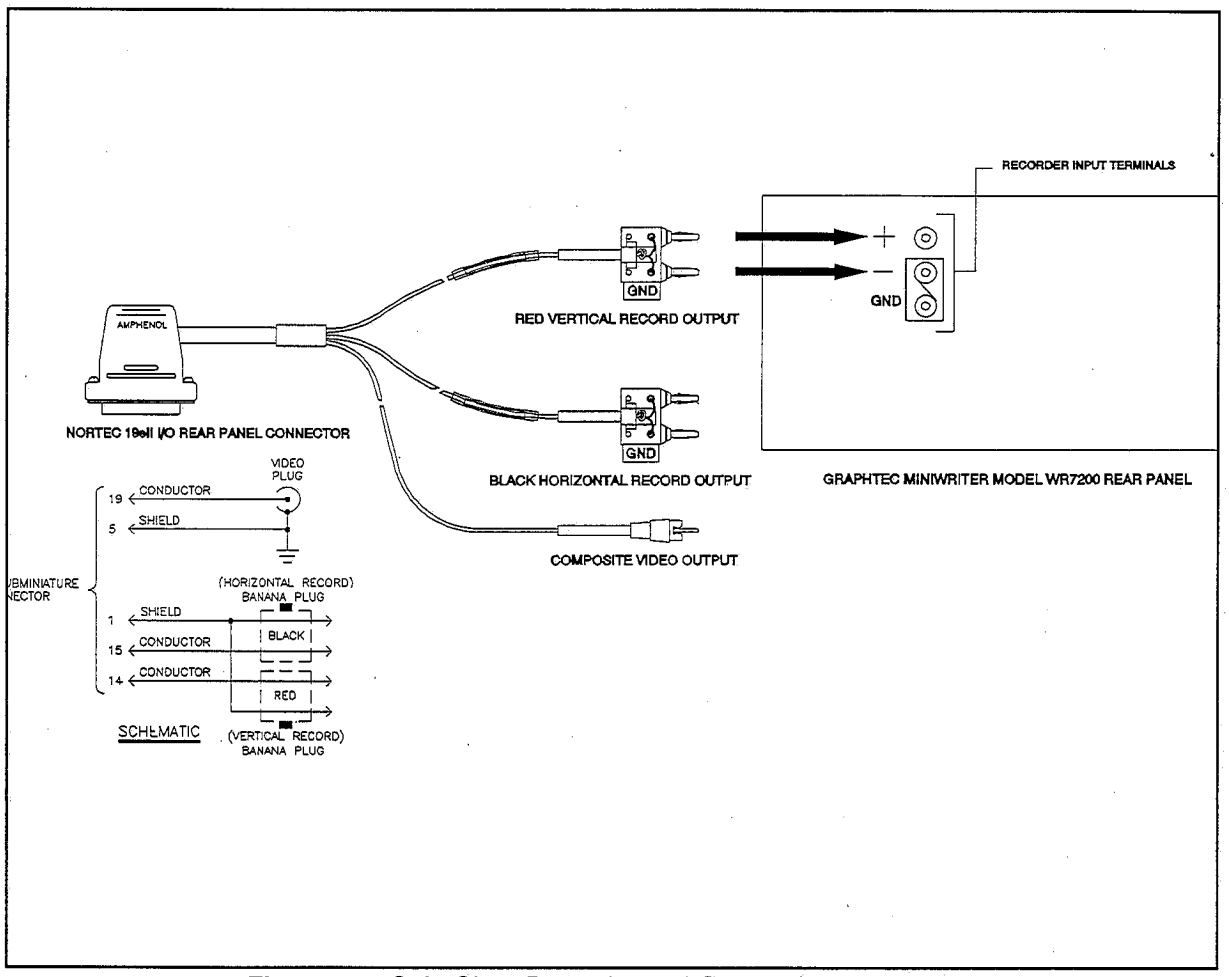



**Figure 6-4** *Strip Chart Recorder and Composite Video cable*

**Note**

Align GND (Ground) tab on banana plug with (- or GND) input terminal on recorder.

Depending on the specific test application and recorder, either channel or both channels may be used. A scanner application test using a single channel strip chart recorder such as the Graphtec WR7200 may use only the vertical channel (RED PLUG).

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# 7.0 Computer Interface

## 7.1 Description

The Nortec 19e$^{II}$ SPO 3196 has the capability of being controlled and monitored by an external computer or terminal. The RS-232C communication port allows an external device to send commands to or obtain information from the Nortec 19e$^{II}$ SPO 3196. With the exception of a few controls, all operations available from the front panel are also available from the RS-232 interface.

**Note**

Use of single quotes (') and double quotes (") throughout this description are for purpose of discussion only. These two symbols are used to delineate specific characters and character strings used in the RS-232 interface, and are NOT to be used in actual RS-232 communications.

## 7.2 RS-232C Communication

The Nortec 19e$^{II}$ SPO 3196 serial interface is configured as Data Terminal Equipment (DTE). This allows a direct connection between the instrument and Data Communication Equipment (DCE) without the need for crossover connections. The communication protocol is shown in the following table:

| RS-232 Parameter | Nortec 19e$^{II}$ SPO 3196 Configuration |
|---|---|
| Baud Rate | 9600 bps* |
| Word Size | 8 |
| Parity | NONE |
| Stop Bits | 1 |

*default setting; the Nortec 19e$^{II}$ SPO 3196 baud rate may be set from 1200 to 38400 bps.

The RS-232C serial interface will communicate with either a serial interface printer or an external connected computer. It is a 9-pin D-subminiature male connector and is designed to connect directly to an IBM-AT compatible serial port. Pinouts are listed below

| Pin No. | Input/Output | Signal Name |
|---|---|---|
| 1 | | Not connected |
| 2 | Output | TXD (transmitted data) |
| 3 | Input | RXD (received data) |
| 4 | Input | CTS (clear to send) |
| 5 | | Signal ground |
| 6 | | Not connected |
| 7 | | Not connected |
| 8 | Output | RTS (request to send) |
| 9 | | Not connected |

This serial connector is designed to plug directly into an industry standard IBM-AT compatible serial connector. Using a readily available 9-pin to 25-pin serial adapter cable, it will also connect to standard

IBM-PC serial connectors by using a 25-pin to 25-pin cable with female connectors on both ends. Finally, the same 9 to 25 adapter cable may be used to connect the instrument to the optional Kodak Diconix printer. Interface cables are also available from Staveley.

Proper connection of the serial port to various devices is tabulated below:

| Nortec 19 Serial Connector (9 pin male) | Diconix Printer (25 pin female) | IBM-PC Serial Connector (25 pin male) | IBM-AT Serial Connector (9 pin male) |
|---|---|---|---|
| pin 2 (TXD) | pin 3 (RXD) | pin 3 (RXD) | pin 2 (RXD) |
| pin 3 (RXD) | pin 2 (TXD) | pin 2 (TXD) | pin 3 (TXD) |
| pin 4 (CTS) | pin 20 (DTR) | pin 20 (DTR) | pin 4 (DTR) |
| pin 5 (GND) | pin 7 (GND) | pin 7 (GND) | pin 5 (GND) |
| pin 8 (RTS) | pin 5 (CTS) | pin 5 (CTS) | pin 8 (CTS) |

## 7.3 Modes of Operation

The Nortec 19e$^{II}$ SPO 3196 has two communication modes, **HOST** mode that permits computer communication with the instrument, and **TERMINAL** mode that is designed for use with a terminal. Each time the Nortec 19e$^{II}$ SPO 3196 is powered on, the operating mode is set to **HOST** mode. The RS-232 command set is identical for both modes, but the way in which the Nortec19e$^{II}$ SPO 3196 responds to serial input differs.

### TERMINAL MODE

In terminal mode, the Nortec 19e$^{II}$ SPO 3196 echoes back each character as it is received. Carriage returns are echoed back as carriage return and line feed. All responses are terminated by carriage return and line feed. Prompts, terminated by carriage return and line feed, are returned in all cases.

| Prompt | | Description |
|---|---|---|
| **">"** | .... | Command Accepted |
| **"C?"** | .... | Invalid Command |
| **"V?"** | .... | Invalid Value |

### HOST MODE

In host mode, the Nortec 19e$^{II}$ SPO 3196 does NOT echo back characters. All responses are terminated by a carriage return only. Prompts are only returned in the event of error conditions:

| Prompt | | Description |
|---|---|---|
| **"C?"** | .... | Invalid Command |
| **"V?"** | .... | Invalid Value |

The Nortec 19e$^{II}$ SPO 3196 ignores space **(20 Hex)** and line feed **(0A Hex)** characters in most cases. To prevent the loss of data, it is important that the HOST/TERMINAL not attempt another serial transaction until the Nortec 19e$^{II}$ SPO 3196 responds (carriage return for HOST mode; prompt, carriage return, and line feed for TERMINAL mode). All commands to the Nortec 19e$^{II}$ SPO 3196 must be terminated by a carriage return **(0D Hex)**. All information sent by the Nortec 19e$^{II}$ SPO 3196 is terminated according to the serial mode (carriage return for HOST mode; carriage return and line feed for TERMINAL mode).

## 7.4 Command Strings

All communication from an external device to the Nortec 19e$^{II}$ SPO 3196 is performed using ASCII characters. A command string is comprised of three or more ASCII characters and a carriage return (terminator). The command string has three parts, not all of which are used in every case.

| | | |
|---|---|---|
| 1. | **Parameter Specification** | A three character code that identifies the instrument item or function (See RS-232 Command Set). |
| 2. | **Command Specification** | A one character code that identifies the operations as READ **'?'**, WRITE '=', or EXECUTE **(carriage return).** |
| 3. | **Parameter Value** | The type and number of ASCII characters in this part of the command string is variable and depends on the parameter specification. |

The Nortec 19e$^{II}$ SPO 3196 recognizes three types of commands, **READ, WRITE, and EXECUTE.** The type of command is indicated by the command specification. To perform a read operation the **'?'** symbol is used. To perform a write operation, the '=' symbol is used. To perform an execute operation, a **carriage return** is used.

**The Nortec 19e$^{II}$ SPO 3196 does NOT process a command string until a carriage return is received.**

## 7.5 Status Reporting

After receiving a command, the Nortec 19e$^{II}$ SPO 3196 checks the string for errors. If no errors are detected, the desired operation is executed. Upon completion of error checking or command execution, the Nortec 19e$^{II}$ SPO 3196 reports back to the host/terminal with a prompt. The prompts vary with the RS-232 mode and the results of the error detection.

Prompts indicating successful completion of a command are to be used by the host/terminal as a signal indicating that the Nortec 19e$^{II}$ SPO 3196 is ready for another command. In host mode, the prompt is simply a carriage return (0D Hex). In terminal mode, an angle bracket '>' is sent followed by carriage return (0D Hex) and line feed (0A Hex).

If an error is encountered, error prompts are returned to the host/terminal. Two types of error prompts are used to indicate **BAD COMMANDS** and **BAD VALUES.** If a bad command is received (command specification), the Nortec 19e$^{II}$ SPO 3196 will return **"C?"** terminated with a carriage return (and line feed for terminal mode). If a bad value is received (parameter value), the Nortec 19e$^{II}$ SPO 3196 will return **"V?"** terminated with a carriage return (and line feed for terminal mode).

## 7.6 RS-232 Command Set

The Nortec 19e$^{II}$ SPO 3196 is controlled using **ASCII** command strings. All commands are terminated by a carriage return (0D Hex), as mentioned previously. For commands that require ASCII letters **A-Z or a-z**, upper or lower case may be used. Space (20 Hex) and line feed (0A Hex) characters are usually ignored by the Nortec 19e$^{II}$ SPO 3196, but may be included in the command strings (spaces may be included in program or data names and print format strings). When specifying a real number value, the decimal point is only required when resolution beyond integers is desired.

Each instrument parameter permits a specific subset of the three available command types to be performed. The command types permitted by each parameter are listed below. References to frequency 2 parameters only apply to dual frequency units.

**INSTRUMENT PARAMETER COMMANDS**

**DISPLAY**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "DSP?" | "F1"<br>"F2"<br>"F1+F2"<br>"F1-F2" | "DSP=F1"<br>"DSP=F2"<br>"DSP=F1+F2"<br>"DSP=F1-F2" | Prompt | Not Applicable |

**MEM2 ENABLE**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "M2E?" | "OFF"<br>"ON" | "M2E=OFF"<br>"M2E=ON" | Prompt | Not Applicable |

**MEM2 NUMBER**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "M2N?" | "##" | "M2N=##" | Prompt | n/a |
| ## is a number in the range of 1 through 20 | | | | |

**SWEEP ENABLE**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "SWP?" | "OFF"<br>"AUTO"<br>"EXTERNAL"<br>"WFALL" | "SWP=OFF"<br>"SWP=AUTO"<br>"SWP=EXTERNAL"<br>"SWP=WFALL" | Prompt | Not Applicable |

**AUTO-SWEEP TIME**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "AST?" | "#.###" | "AST=#.###" | Prompt | n/a |
| #.### is a number in the range of 0.005 through 4.000 seconds | | | | |

**FREQUENCY 1**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "FR1?" | #### | "FR1=####" | Prompt | n/a |
| ### is a number in the range of 0.10 through 6000 **kHz**<br><br>The instrument only implements "Frequency 1" to 2 significant digits. Note that as frequency 1 is varied, frequency 2 is varied according to the proportion set for frequency 2. | | | | |

**FREQUENCY 2**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "FR2?" | "OFF"<br>"1/2"<br>"1/4"<br>"1/8"<br>"1/16" | "FR2=OFF"<br>"FR2=1/2"<br>"FR2=1/4"<br>"FR2=1/8"<br>"FR2=1/16" | Prompt | n/a |
| Frequency 2 is actually Frequency 1 multiplied by the selected fraction | | | | |

**ANGLE 1**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "AN1?" | ### | "AN1=###" | Prompt | n/a |
| ### is a number in the range of 0 through 359 | | | | |

**ANGLE 2**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "AN2?" | ### | "AN2=###" | Prompt | n/a |
| ### is a number in the range of 0 through 359 | | | | |

### LOW FILTER

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "FLO?" | "###"<br>"WB" | FLO="###"<br>FLO="WB" | Prompt | n/a |
| ### is a number in the range of 10 through 500<br>WB is for wideband | | | | |

### HIGH FILTER

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "FHI?" | "###" | "FHI=###" | Prompt | n/a |
| ### is a number in the range of 0 through 500 | | | | |

### COMBINED GAIN 1

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "GN1=##.#" | Prompt | n/a |
| ##.# is a number in the range of 0.0 to 90.0 **dB**, but is further limited by the separation of Frequency 1 horizontal and vertical gain values.<br><br>This command sets frequency 1 horizontal gain value to ##.# **dB** while maintaining original gain separation (between horizontal and vertical). | | | | |

### HORIZONTAL GAIN 1

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "HG1?" | "##.#" | "HG1=##.#" | Prompt | n/a |
| ##.# is a number in the range of 0.0 through 90.0 **dB** | | | | |

### VERTICAL GAIN 1

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "VG1?" | "##.#" | "VG1=##.#" | Prompt | n/a |
| ##.# is a number in the range of 0.0 through 90.0 **dB** | | | | |

### COMBINED GAIN 2

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "GN2=##.#" | Prompt | n/a |
| ##.# is a number in the range of 0.0 to 90.0 **dB**, but is further limited by the separation of Frequency 2 horizontal and vertical gain values.<br><br>This command sets frequency 2 horizontal gain value to ##.# **dB** while maintaining original gain separation (between horizontal and vertical). | | | | |

### HORIZONTAL GAIN 2

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "HG2?" | "##.#" | "HG2=##.#" | Prompt | n/a |
| ##.# is a number in the range of 0.0 through 90.0 **dB** | | | | |

### VERTICAL GAIN 2

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "VG2?" | "##.#" | "VG2=##.#" | Prompt | n/a |
| ##.# is a number in the range of 0.0 through 90.0 **dB** | | | | |

### HORIZONTAL POSITION

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "HPO?" | "###.#" | "HPO=###.#" | Prompt | n/a |
| ###.# is a number in the range of 0.0 through 100.0 % | | | | |

### VERTICAL POSITION

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "VPO?" | "###.#" | "VPO=###.#" | Prompt | n/a |
| ###.# is a number in the range of 0.0 through 100.0 % | | | | |

## SPECIAL FEATURES

### CRT CAPTURE TIME

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "CCT?" | "##.#" | "CCT=##.#" | Prompt | n/a |
| ##.# is a number in the range of 2.5 through 60.0 seconds | | | | |

### PROBE DRIVE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "PDR?" | "LOW"<br>"MID"<br>"HI" | "PDR=LOW"<br>"PDR=MID"<br>"PDR=HI" | Prompt | n/a |

### VARIABLE PERSISTENCE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "VAP?" | "##" | "VAP=##" | Prompt | n/a |
| ## is a number in the range of 0 (OFF) through 20 seconds | | | | |

### AUTO-SWEEP ERASE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "ASE?" | "OFF"<br>"ON" | "ASE=OFF"<br>"ASE=ON" | Prompt | n/a |

### LCD BACKLIGHT

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "LIT?" | "OFF"<br>"ON" | "LIT=OFF"<br>"LIT=ON" | Prompt | n/a |

### TIMED CRT ERASE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "CTE?" | "##" | "CTE=##" | Prompt | n/a |
| ## is a number in the range of 0 (OFF) through 60 seconds | | | | |

### ALARM TYPE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "ALT?" | "BOX"<br>"POLAR"<br>"PIE"<br>"POLY"<br>"SORT" | "ALT=BOX"<br>"ALT=POLAR"<br>"ALT=PIE"<br>"ALT=POLY"<br>"ALT=SORT" | Prompt | n/a |

### ALARM DWELL

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "ADW?" | "##.#" | "ADW=##.#" | Prompt | n/a |
| ##.# is a number in the range of 0.0 through 10.0 seconds | | | | |

### ALARM HORN

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "HRN?" | "OFF"<br>"ON" | "HRN=OFF"<br>"HRN=ON" | Prompt | n/a |

### ALARM LATCH

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "LCH?" | "OFF"<br>"ON" | "LCH=OFF"<br>"LCH=ON" | Prompt | n/a |

### CRT GRATICULE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "GRT?" | "OFF"<br>"ON" | "GRT=OFF"<br>"GRT=ON" | Prompt | n/a |

## CLOCK TIME

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "TIM?" | "hh:mm:ss" | n/a | n/a | n/a |
| Instrument time is expressed as hh:mm:ss, where:<br>**hh** is the hours (0-23)<br>**mm** is the minutes (0-59)<br>**ss** is the seconds (0-59) | | | | |

## HOURS

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "HR.?" | "##" | "HR.=##" | Prompt | n/a |
| ## is an number in the range of 0 through 23 hours | | | | |

## MINUTES

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "MIN?" | "##" | "MIN=##" | Prompt | n/a |
| ## is an number in the range of 0 through 59 minutes | | | | |

## SECONDS

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "SEC?" | "##" | "SEC=##" | Prompt | n/a |
| ## is an number in the range of 0 through 59 seconds | | | | |

## CLOCK DATE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "DAT?" | "ddmmmyyy" | n/a | n/a | n/a |
| Instrument date is expressed as ddmmmyy, where:<br>**dd** is the day (1-31)<br>**mmm** is the month (JAN,...)<br>**yy** is the year (0-99) | | | | |

**DAY**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "DAY?" | "##" | "DAY=##" | Prompt | n/a |
| ## is an number in the range of 0 through 31 days | | | | |

**MONTH**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "MON?" | "MMM" | "MON=MMM" | Prompt | n/a |

MMM is 1 of 12 month abbreviations:

| | | | |
|---|---|---|---|
| **"JAN"** .... | January | **"JUL"** .... | July |
| **"FEB"** .... | February | **"AUG"** .... | August |
| **"MAR"** .... | March | **"SEP"** .... | September |
| **"APR"** .... | April | **"OCT"** .... | October |
| **"MAY"** .... | May | **"NOV"** .... | November |
| **"JUN"** .... | June | **"DEC"** .... | December |

**YEAR**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "YR.?" | "##" | "YR.=##" | Prompt | n/a |
| ## is an number in the range of 0 through 99 year | | | | |

## READ REPORT HEADER

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "RHD=1" | "AAAAA" | n/a |
| "AAAAA" is an ASCII string of 26 characters in length. | | | | |

## SET REPORT HEADER

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "SHD=1"<br>"AAAAA" | Prompt | n/a |

"AAAAA" is an ASCII string of no more than 26 characters in length. Note that the Nortec 19e$^{II}$ SPO 3196 utilizes only a subset of the printable ASCII characters **(A-Z, 0-9, ., -, /, #, %, and SPACE)**. All other characters should be avoided.

To ensure proper transfer, the following steps are used to set a program name:

1. Host sends "Report Header" command **(SHD=1)**
2. Host waits for the Nortec 19e$^{II}$ SPO 3196 to respond with a carriage return (0D Hex) or an error prompt.
3. If no error was encountered, the host sends the 40 character string and waits for a prompt

## READ REPORT LABEL

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "RLB=#" | "AAAAA" | n/a |

# is a number in the range of 1 through 7

"AAAAA" is an ASCII string 26 characters in length.

## SET REPORT LABEL

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "SLB=#"<br>"AAAAA" | Prompt | n/a |

# is a number in the range of 1 through 7

"AAAAA" is an ASCII string of no more than 26 characters in length. Note that the Nortec 19e$^{II}$ SPO 3196 utilizes only a subset of the printable ASCII characters **(A-Z, 0-9, ., -, /, #, %, and SPACE)**. All other characters should be avoided.

To ensure proper transfer, the following steps are used to set a report label name:

1. Host sends "Set Label Name" command **(SLB=1)**
2. Host waits for the Nortec 19e$^{II}$ SPO 3196 to respond with a carriage return (0D Hex) or an error prompt.
3. If no error was encountered, the host sends the 26 character string and waits for a prompt

## READ REPORT FIELD

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "RFL=#" | "AAAAA" | n/a |

# is a number in the range of 1 through 7

"AAAAA" is an ASCII string 40 characters in length.

## SET REPORT FIELD

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "SFL=#" "AAAAA" | Prompt | n/a |

# is a number in the range of 1 through 7

"AAAAA" is an ASCII string of no more than 40 characters in length. Note that the Nortec 19e$^{II}$ SPO 3196 utilizes only a subset of the printable ASCII characters **(A-Z, 0-9, ., -, /, #, %, and SPACE).** All other characters should be avoided.

To ensure proper transfer, the following steps are used to set a field name:

1. Host sends "Set Field Name" command **(SFL=1)**
2. Host waits for the Nortec 19e$^{II}$ SPO 3196 to respond with a carriage return (0D Hex) or an error prompt.
3. If no error was encountered, the host sends the 40 character string and waits for a prompt

### CLEAR PROGRAMS

| Execute Command | Returned Value |
|---|---|
| "CLP" | Prompt |

### CLEAR DATA

| Execute Command | Returned Value |
|---|---|
| "CLD" | Prompt |

### CLEAR INSTRUMENT

| Execute Command | Returned Value |
|---|---|
| "CLI" | Prompt |
| The host should expect a 5 to 10 second delay before receiving a response from this command.<br><br>After this command, the RS232 interface reverts to **HOST** mode. | |

### LOAD DEFAULT

| Execute Command | Returned Value |
|---|---|
| "LOD" | Prompt |
| The host should expect a 5 to 10 second delay before receiving a response from this command.<br><br>After this command, the RS232 interface reverts to **HOST** mode. | |

### CONTINUOUS NULL

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "CNL?" | "OFF"<br>"ON" | "CNL=OFF"<br>"CNL=ON" | Prompt | n/a |

## BOX ALARM COMMANDS

### BOX 1/2/3 TOP

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "B1T?"<br>"B2T?"<br>"B3T?" | "###.#" | "B1T=###.#"<br>"B2T=###.#"<br>"B3T=###.#" | Prompt | n/a |

###.# is a number in the range of 0.0 through 100.0 %

The alarm box top setting must obey the following inequality:

alarm box bottom < ###.# <= 100.0

### BOX 1/2/3 LEFT

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "B1L?"<br>"B2L?"<br>"B3L?" | "###.#" | "B1L=###.#"<br>"B2L=###.#"<br>"B3L=###.#" | Prompt | n/a |

###.# is a number in the range of 0.0 through 100.0 %

The alarm box left setting must obey the following inequality:

0.0 <= ###.# <= alarm box right

### BOX 1/2/3 BOTTOM

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "B1B?"<br>"B2B?"<br>"B3B?" | "###.#" | "B1B=###.#"<br>"B2B=###.#"<br>"B3B=###.#" | Prompt | n/a |

###.# is a number in the range of 0.0 through 100.0 %

The alarm box bottom setting must obey the following inequality:

0.0 < ###.# <= alarm box top

**BOX 1/2/3 RIGHT**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "B1R?"<br>"B2R?"<br>"B3R?" | "###.#" | "B1R=###.#"<br>"B2R=###.#"<br>"B3R=###.#" | Prompt | n/a |
| ###.# is a number in the range of 0.0 through 100.0 %<br><br>The alarm box right setting must obey the following inequality:<br><br>alarm box left < ###.# <= 100.0 | | | | |

**BOX 1/2/3 ENABLE**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "B1E?"<br>"B2E?"<br>"B3E?" | "AAA" | "B1E=AAA"<br>"B2E=AAA"<br>"B3E=AAA" | Prompt | n/a |
| AAA is the OFF/POLARITY state of the selected alarm box. AAA must be one of the 3 following strings: **"OFF"**, **"POSITIVE"**, **"NEGATIVE"** | | | | |

## SWEEP ALARM COMMANDS

### SWEEP ALARM TOP

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "SWT?" | "###.#" | "SWT=###.#" | Prompt | n/a |
| ###.# is a number in the range of 0.0 through 100.0 %<br>The sweep alarm top setting must obey the following inequality:<br>sweep alarm bottom < ###.# <= 100.0 | | | | |

### SWEEP ALARM BOTTOM

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "SWB?" | "###.#" | "SWB=###.#" | Prompt | n/a |
| ###.# is a number in the range of 0.0 through 100.0 %<br>The sweep alarm bottom setting must obey the following inequality:<br>0.0 <= ###.# <= sweep alarm top | | | | |

### SWEEP ALARM ENABLE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "SWE?" | "AAA" | "SWE=AAA" | Prompt | n/a |
| AAA is the OFF/POLARITY state of the sweep alarm. AAA must be one of the 3 following strings: **"OFF", "POSITIVE", "NEGATIVE"** | | | | |

## POLAR ALARM COMMANDS

### X COORDINATE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "POX?" | "###.#" | "POX=###.#" | Prompt | n/a |
| ###.# is a number in the range of 0.0 through 100.0 %<br>The polar alarm X coordinate must obey the following inequality:<br>polar alarm radius <= ###.# <= 100.0 - polar alarm radius | | | | |

### Y COORDINATE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "POY?" | "###.#" | "POY=###.#" | Prompt | n/a |
| ###.# is a number in the range of 0.0 through 100.0 %<br>The polar alarm Y coordinate must obey the following inequality:<br>polar alarm radius <= ###.# <= 100.0 - polar alarm radius | | | | |

### RADIUS

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "POR?" | "###.#" | "POR=###.#" | Prompt | n/a |
| ###.# is a number in the range of 0.0 through 100.0 %<br>The polar alarm radius must obey the following inequalities:<br>###.# <= polar X position,<br>###.# <= 100.0 - polar X position<br>###.# <= polar Y position<br>###.# <= 100.0 - polar Y position | | | | |

### POLAR ALARM ENABLE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "POE?" | "AAA" | "POE=AAA" | Prompt | n/a |
| AAA is the OFF/POLARITY state of the polar alarm. AAA must be one of the 3 following strings: **"OFF", "POSITIVE", "NEGATIVE"** | | | | |

## PIE ALARM COMMANDS

### X COORDINATE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "PIX?" | "###.#" | "PIX=###.#" | Prompt | n/a |
| ###.# is a number in the range of 0.0 through 100.0 %<br>The pie alarm X coordinate must obey the following inequality:<br>pie alarm radius <= ###.# <= 100.0 - pie alarm radius | | | | |

### Y COORDINATE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "PIY?" | "###.#" | "PIY=###.#" | Prompt | n/a |
| ###.# is a number in the range of 0.0 through 100.0 %<br>The pie alarm Y coordinate must obey the following inequality:<br>pie alarm radius <= ###.# <= 100.0 - pie alarm radius | | | | |

**RADIUS**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "PIR?" | "###.#" | "PIR=###.#" | Prompt | n/a |

###.# is a number in the range of 0.0 through 100.0 %

The pie alarm radius must obey the following inequalities:

###.# <= pie X position,
###.# <= 100.0 - pie X position
###.# <= pie Y position
###.# <= 100.0 - pie Y position

**START ANGLE**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "PI1?" | "###" | "PI1=###" | Prompt | n/a |

### is a number in the range of 0 through 359 degrees

The pie alarm start angle must differ from the pie alarm stop angle by at least 30 degrees (on both sides).

**STOP ANGLE**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "PI2?" | "###" | "PI2=###" | Prompt | n/a |

### is a number in the range of 0 through 359 degrees

The pie alarm stop angle must differ from the pie alarm start angle by at least 30 degrees (on both sides).

**PIE ALARM ENABLE**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "PIE?" | "AAA" | "PIE=AAA" | Prompt | n/a |

AAA is the OFF/POLARITY state of the pie alarm. AAA must be one of the 3 following strings: **"OFF"**, **"POSITIVE"**, **"NEGATIVE"**

## POLYGON ALARM COMMANDS

### X COORDINATES (1-8)

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "PX1?"- "PX8?" | "###.#" | "PX1=###.#"- "PX8=###.#" | Prompt | n/a |
| ###.# is a number in the range of 0.0 through 100.0 %<br><br>**(Note: restrictions of polygon alarm vertex adjustment in "Control Descriptions")** | | | | |

### Y COORDINATES (1-8)

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "PY1?"- "PY8?" | "###.#" | "PY1=###.#"- "PY8=###.#" | Prompt | n/a |
| ###.# is a number in the range of 0.0 through 100.0 %<br><br>**(Note: restrictions of polygon alarm vertex adjustment in "Control Descriptions")** | | | | |

### POLYGON ALARM ENABLE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "PEN?" | "AAA" | "PEN=AAA" | Prompt | n/a |
| AAA is the OFF/POLARITY state of the polygon alarm. AAA must be one of the 3 following strings: **"OFF"**, **"POSITIVE"**, **"NEGATIVE"** | | | | |

## SORTING GATE COMMANDS

### SORTING GATE TOP

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "SRT?" | "###.#" | "SRT=###.#" | Prompt | n/a |

###.# is a number in the range of 0.0 through 100.0 %

The sorting gate top setting must obey the following inequality:

sorting gate bottom < ###.# <= 100.0

### SORTING GATE LEFT

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "SRL?" | "###.#" | "SRL=###.#" | Prompt | n/a |

###.# is a number in the range of 0.0 through 100.0 %

The sorting gate left setting must obey the following inequality:

0.0 <= ###.# <= sorting gate right

### SORTING GATE BOTTOM

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "SRB?" | "###.#" | "SRB=###.#" | Prompt | n/a |

###.# is a number in the range of 0.0 through 100.0 %

The sorting gate bottom setting must obey the following inequality:

0.0 < ###.# <= sorting gate top

## SORTING GATE RIGHT

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "SRR?" | "###.#" | "SRR=###.#" | Prompt | n/a |
| ###.# is a number in the range of 0.0 through 100.0 %<br><br>The sorting gate right setting must obey the following inequality:<br><br>sorting gate left < ###.# <= 100.0 | | | | |

## SORTING GATE ALARM ENABLE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "SEN?" | "AAA" | "SEN=AAA" | Prompt | n/a |
| AAA is the OFF/POLARITY state of the pie alarm. AAA must be one of the 2 following strings: **"OFF"** or **"ON"** | | | | |

## SORTING GATE PRIORITY

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "PRI?" | "#########" | "PRI=#########" | Prompt | n/a |
| "NNNNNNNNN" is a 9 number string indicating the priority level for each of the 9 sorting gate zones. Each number **(#)** in the returned string will be in the range of 1 through 9. Priority levels may be duplicated in multiple zones. | | | | |

## GOOD ZONE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "GDZ?" | "#" | "GDZ=#" | Prompt | n/a |
| # is a number in the range of 1 through 9 indicating the zone that is tied to the "GOOD ZONE" alarm output | | | | |

## PROGRAM STORAGE COMMANDS

### PROGRAM NUMBER

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "PGM?" | "###" | "PGM=###" | Prompt | n/a |
| ### is a number in the range of 1 through 120 | | | | |

### PROGRAM STATUS

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "PEF=###" | "E", "F", "W", or "R" | n/a |

### in the range of 1 through 120

The returned values are defined as follows:

| | |
|---|---|
| "E" | Program is EMPTY |
| "F" | Program is FULL (or tied to frozen data (101-120) |
| "R" | Program is tied to replay data (101-120) |
| "W" | Program is tied to waterfall (101-120) |

### STORE PROGRAM

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "PST=###" | Prompt | n/a |
| ### is a number in the range of 1 through 100 | | | | |

### RECALL PROGRAM

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "PRC=###" | Prompt | n/a |
| ### is a number in the range of 1 through 120 | | | | |

### ERASE PROGRAM

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "PER=###" | Prompt | n/a |
| ### is a number in the range of 1 through 100 | | | | |

### READ PROGRAM NAME

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "PRN=###" | "AAAAA" | n/a |
| ### is a number in the range of 1 through 100<br><br>"AAAAA" is an ASCII string 26 characters in length. | | | | |

### SET PROGRAM NAME

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "PSN=###"<br>"AAAAA" | Prompt | n/a |

### is a number in the range of 1 through 100

"AAAAA" is an ASCII string of no more than 26 characters in length. Note that the Nortec 19e$^{II}$ SPO 3196 utilizes only a subset of the printable ASCII characters **(A-Z, 0-9, ., -, /, #, %, and SPACE)**. All other characters should be avoided.

To ensure proper transfer, the following steps are used to set a program name:

1. Host sends "Set Program Name" command **(PEN=1)**
2. Host waits for the Nortec 19e$^{II}$ SPO 3196 to respond with a carriage return (0D Hex) or an error prompt.
3. If no error was encountered, the host sends the 26 character string and waits for a prompt

## PRINT PROGRAM

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "PPR=###" | "PPPPP" | n/a |
| ### is a number in the range of 1 through 120<br><br>PPPPP represents printer formatted data that will consist of a stream of text and EPSON compatible escape codes. | | | | |

## DUMP PROGRAM (ASCII)

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "PDP=###" | Program parameter strings | n/a |
| ### is a number in the range of 1 through 120<br><br>The following table lists the parameters (in order) that are returned by the Nortec 19e$^{II}$ SPO 3196. Each parameter string is terminated by a carriage return. | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 1 | Program name | 29 | Box alarm 3 top | 57 | Poly alarm Y3 |
| 2 | Instrument type | 30 | Box alarm 3 left | 58 | Poly alarm Y4 |
| 3 | Display mixing | 31 | Box alarm 3 bottom | 59 | Poly alarm Y5 |
| 4 | Sweep mode | 32 | Box alarm 3 right | 60 | Poly alarm Y6 |
| 5 | Auto-sweep time | 33 | Box alarm 3 enable | 61 | Poly alarm Y7 |
| 6 | Frequency 1 | 34 | Sweep alarm top | 62 | Poly alarm Y8 |
| 7 | Frequency 2 | 35 | Sweep alarm bottom | 63 | Poly alarm enable |
| 8 | Angle 1 | 36 | Sweep alarm enable | 64 | Sort gate top |
| 9 | Angle 2 | 37 | Polar alarm X | 65 | Sort gate left |
| 10 | Low filter | 38 | Polar alarm Y | 66 | Sort gate bottom |
| 11 | High filter | 39 | Polar alarm radius | 67 | Sort gate right |
| 12 | Horizontal gain 1 | 40 | Polar alarm enable | 68 | Sort gate enable |
| 13 | Vertical gain 1 | 41 | Pie alarm X | 69 | Sort gate priorities |
| 14 | Horizontal gain 2 | 42 | Pie alarm Y | 70 | Good zone |
| 15 | Vertical gain 2 | 43 | Pie alarm radius | 71 | Capture time |
| 16 | Horizontal position | 44 | Pie alarm angle 1 | 72 | Probe Drive |
| 17 | Vertical position | 45 | Pie alarm angle 2 | 73 | Variable Persistence |
| 18 | Continuous null | 46 | Pie alarm enable | 74 | Sweep auto-erase |
| 19 | Box alarm 1 top | 47 | Poly alarm X1 | 75 | CRT timed erase |
| 20 | Box alarm 1 left | 48 | Poly alarm X2 | 76 | Alarm type |
| 21 | Box alarm 1 bottom | 49 | Poly alarm X3 | 77 | Alarm dwell |
| 22 | Box alarm 1 right | 50 | Poly alarm X4 | 78 | Alarm horn |
| 23 | Box alarm 1 enable | 51 | Poly alarm X5 | 79 | Alarm latch |
| 24 | Box alarm 2 top | 52 | Poly alarm X6 | 80 | CRT Graticule |
| 25 | Box alarm 2 left | 53 | Poly alarm X7 | 81 | Waterfall Trigger |
| 26 | Box alarm 2 bottom | 54 | Poly alarm X8 | 82 | HPF Pole Selection |
| 27 | Box alarm 2 right | 55 | Poly alarm Y1 | 83 | Flying Dot |
| 28 | Box alarm 2 enable | 56 | Poly alarm Y2 | 84 | Scanner RPM |

| | | | | | |
|---|---|---|---|---|---|
| 85 | Scanner Pitch | 88 | Waterfall MEM2 | 91 | Scanner Zero |
| 86 | Waterfall Min Sweep | 89 | Points/Sweep | 92 | Time |
| 87 | Waterfall Max Sweep | 90 | Waterfall Angle | 93 | Date |

## UPLOAD PROGRAM (BINARY)

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "PUP=###" | SSB..BC | n/a |

### is a number in the range of 0 through 120. Program 0 represents the current program settings.

The transfer consists of a 2-byte size count (SS) followed by the binary data information (B..B) and a 1-byte checksum (C). The size count is sent in low byte then high byte order.

To ensure data integrity, the host should calculate its own checksum and compare it to that sent by the Nortec 19e$^{II}$ SPO 3196. The checksum is generated by summing all byte values, excluding the size count and checksum, modulus 256.

(Byte1 + Byte2 + ... + ByteN) % 256

Program information stored in this form may be downloaded if the data (including size count and checksum) are returned unaltered.

## DOWNLOAD PROGRAM (BINARY)

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "PDN=###" SSB..BC | Prompt | n/a |

### is a number in the range of 0 through 100. Program 0 represents the current front panel settings

The transfer consists of a 2-byte size count (SS) followed by the binary data information (B..B) and a 1-byte checksum (C).

This command is used to send program data, acquired using the program upload command, back to the Nortec 19e$^{II}$ SPO 3196. The Nortec 19e$^{II}$ SPO 3196 assumes that the program data has not been altered. Altered data will yield unpredictable results.

To ensure proper transfer, the following steps are used to download a program:

1. Host sends "Download Program" command **(PDN=1)**
2. Host waits for the Nortec 19e$^{II}$ SPO 3196 to respond with a carriage return (0D Hex) or an error prompt.
3. If no error was encountered, the host sends the binary program information and waits for a prompt

# DATA STORAGE COMMANDS

## DATA LOCATION

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "DAL?" | "##" | "DAL=##" | Prompt | n/a |
| ## is a number in the range of 1 through 20 | | | | |

## DATA STATUS

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "DEF=###" | "E", "F", "W", or "R" | n/a |

### is a number in the range of 1 through 20

The returned values are defined as follows:

| | |
|---|---|
| "E" | Data is EMPTY |
| "F" | Data is FROZEN |
| "R" | Data is REPLAY |
| "W" | Data is WATERFALL |

## FREEZE DATA

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "DAF=##" | Prompt | n/a |
| ## is a number in the range of 1 through 20 | | | | |

## DATA CAPTURE (ONCE)

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "DC1=##" | Prompt | n/a |
| ## is a number in the range of 1 through 20 | | | | |

## BEGIN DATA CAPTURE (CONTINUOUS)

| Execute Command | Returned Value |
|---|---|
| "DCB" | Prompt |

## END DATA CAPTURE (CONTINUOUS)

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "DCE=##" | Prompt | n/a |
| ## is a number in the range of 1 through 20 | | | | |

## RECALL DATA

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "DRC=##" | Prompt | n/a |
| ## is a number in the range of 1 through 20<br><br>Upon completion of data recall, the instrument will expect the enter key to be pressed either from the front panel or using the remote ENTER key command **"KEN".** | | | | |

## ERASE DATA

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "DER=##" | Prompt | n/a |
| ## is a number in the range of 1 through 20 | | | | |

## READ DATA NAME

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "DRN=##" | "AAAAA" | n/a |

## is a number in the range of 1 through 20

AAAAA is an ASCII string 26 characters in length.

## SET DATA NAME

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "DSN=##" "AAAAA" | Prompt | n/a |

## is a number in the range of 1 through 20

AAAAA is an ASCII string of no more than 26 characters in length. Note that the Nortec 19e$^{II}$ SPO 3196 utilizes only a subset of the printable ASCII characters **(A-Z, 0-9, ., -, /, #, %, and SPACE)**. All other characters should be avoided.

To ensure proper transfer, the following steps are used to set a stored data name:

1. Host sends "Set Program Name" command **(DAN=1)**
2. Host waits for the Nortec 19e$^{II}$ SPO 3196 to respond with a carriage return (0D Hex) or an error prompt.
3. If no error was encountered, the host sends the 26 character string and waits for a prompt

## PRINT DATA

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "DAP=##" | "PPPPP" | n/a |

## is a number in the range of 1 through 20

PPPPP represents printer formatted data that will consist of a stream of graphics, text and EPSON compatible escape codes.

## UPLOAD DATA (BINARY)

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "DUP=##" | "SSB..BC" | n/a |

## is a number in the range of 1 through 20

The transfer consists of a 2-byte size count (SS) followed by the binary data information (B..B) and a 1-byte checksum (C). The size count is sent in low byte then high byte order.

To ensure data integrity, the host should calculate its own checksum and compare it to that sent by the Nortec 19e$^{II}$ SPO 3196. The checksum is generated by summing all byte values, excluding the size count and checksum, modulus 256.

(Byte1 + Byte2 + ... + ByteN) % 256

Data information stored in this form may be downloaded to the instrument if the data (including size count and checksum) are returned unaltered.

## DOWNLOAD DATA (BINARY)

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "DDN=##"<br>"SSB..BC" | Prompt | n/a |

## is a number in the range of 1 through 20

The transfer consists of a 2-byte size count (SS) followed by the binary data information (B..B) and a 1-byte checksum (C).

This command is used to send stored data, acquired using the data upload command, back to the Nortec 19e$^{II}$ SPO 3196. The Nortec 19e$^{II}$ SPO 3196 assumes that the data has not been altered. Altered data will yield unpredictable results.

To ensure proper transfer, the following steps are used to download stored data:

1. Host sends "Download Program" command **(DDN=1)**
2. Host waits for the Nortec 19e$^{II}$ SPO 3196 to respond with a carriage return (0D Hex) or an error prompt.
3. If no error was encountered, the host sends the binary data information and waits for a prompt

## UPLOAD DATA (BIT MAP)

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "DBM=##" | "SSB..B" | n/a |

## is a number in the range of 1 through 20

The transfer consists of a 2-byte size count (SS) followed by the binary data information (B..B). The size count is sent in low byte then high byte order.

The data upload provides a bit mapped image of the stored data display. The image data is sent as 241 rows of 320 dots (40 bytes, where 1 byte = 8 dots).

The 40 bytes of dot information are presented in left to right order. Within each byte, bit 0 represents the left most dot and bit 7 represents the right most dot.

## SCREEN DUMP (BIT MAP)

| Execute Command | Returned Value |
|---|---|
| "SCR" | SSB..B |

The transfer consists of a 2-byte size count (SS) followed by the binary data information (B..B). The size count is sent in low byte then high byte order.

The CRT screen dump provides a bit mapped image of the current display. The image data is sent as 241 rows of 320 dots (40 bytes, where 1 byte = 8 dots).

The 40 bytes of dot information are presented in left to right order. Within each byte, bit 0 represents the left most dot and bit 7 represents the right most dot.

## KEY COMMANDS

| Key | Execute Command | Returned Value | Key | Execute Command | Returned Value |
|---|---|---|---|---|---|
| LOCK KEY | "KLK" | Prompt | NULL KEY | "KNL" | Prompt |
| PRNT KEY | "KPR" | Prompt | F1/F2 KEY | "K12" | Prompt |
| DSPL KEY | "KDS" | Prompt | ALM KEY | "KAL" | Prompt |
| MEM 2 KEY | "KM2" | Prompt | LACH KEY | "KLA" | Prompt |
| SWP KEY | "KSW" | Prompt | ENTR KEY | "KEN" | Prompt |
| PROG KEY | "KPG" | Prompt | . KEY | "KDP" | Prompt |
| FREQ KHZ KEY | "KFR" | Prompt | 0 KEY | "KN0" | Prompt |
| GAIN KEY | "KGN" | Prompt | 1 KEY | "KN1" | Prompt |
| H KEY | "KHO" | Prompt | 2 KEY | "KN2" | Prompt |
| STOR KEY | "KST" | Prompt | 3 KEY | "KN3" | Prompt |
| ANGL KEY | "KAN" | Prompt | 4 KEY | "KN4" | Prompt |
| POSN KEY | "KPS" | Prompt | 5 KEY | "KN5" | Prompt |
| V KEY | "KVE" | Prompt | 6 KEY | "KN6" | Prompt |
| FLTR KEY | "KFL" | Prompt | 7 KEY | "KN7" | Prompt |
| SP KEY | "KSP" | Prompt | 8 KEY | "KN8" | Prompt |
| CONT NULL KEY | "KCN" | Prompt | 9 KEY | "KN9" | Prompt |
| ERASE KEY | "KER" | Prompt | | | |

**NOTE:** If the remote lockout feature is ON, all remote key commands will be invalid

## MISCELLANEOUS COMMANDS

### ALARM CONDITION

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "ALC?" | "#" | n/a | n/a | n/a |

## is a number in the range of 0 through 9 based on the alarm type:

| | | | |
|---|---|---|---|
| BOX alarm | 0-7 | POLYGON alarm | 0 or 1 |
| POLAR alarm | 0 or 1 | SORTING GATE | 0 - 9 |
| PIE alarm | 0 or 1 | | |

### INSTRUMENT VERSION

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "VER?" | "R##A" | n/a | n/a | n/a |

The instrument firmware version is R##A, where:

| | | |
|---|---|---|
| **R** | .... | Indicates Revision |
| **##** | .... | Indicates major revision level (00-99) |
| **A** | .... | Indicates minor revision level (A-Z) |

### INSTRUMENT TYPE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "TYP?" | "SINGLE"<br>"DUAL" | n/a | n/a | n/a |

### BATTERY STATUS

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "BAT?" | "LOW"<br>"OK" | n/a | n/a | n/a |

### HOST MODE

| Execute Command | Returned Value |
|---|---|
| "HST" | Prompt |

### TERMINAL MODE

| Execute Command | Returned Value |
|---|---|
| "TRM" | Prompt |

## REMOTE LOCKOUT

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "RLK?" | "OFF"<br>"ON" | "RLK=OFF"<br>"RLK=ON" | Prompt | n/a |
| **NOTE:** If the remote lockout feature is ON, all remote key commands will be invalid | | | | |

## INSTRUMENT NAME

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "NAM?" | "Nortec 19eII" | n/a | n/a | n/a |

## INSTRUMENT OPTIONS

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "OPT?" | "WATERFALL" | n/a | n/a | n/a |

## REMOTE NULL

| Execute Command | Returned Value |
|---|---|
| "NUL" | Prompt |

## REMOTE ERASE

| Execute Command | Returned Value |
|---|---|
| "ERS" | Prompt |

## INSTRUMENT RESET

| Execute Command | Returned Value |
|---|---|
| "RST" | Prompt |
| The host should expect a 5 to 10 second delay before receiving a response from this command.<br><br>After this command, the RS232 interface reverts to **HOST** mode. | |

### HPF POLE SELECTION

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "HPS?" | "2-POLE"<br>"4-POLE" | "HPS=2-POLE"<br>"HPS=4-POLE" | Prompt | n/a |

### FLYING DOT TYPE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "FDT?" | "DOT"<br>"BOX | "FDT=DOT"<br>"FDT=BOX" | Prompt | n/a |

### WATERFALL TRIGGER

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "WTR?" | "##" | "WTR=##" | Prompt | n/a |
| ## is a number in the range 0 through 100 | | | | |

### SCANNER RPM

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "RPM?" | "##" | "RPM=##" | Prompt | n/a |
| ## is a number in the range 6 through 3000 | | | | |

### WATERFALL DISPLAY ANGLE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "WAN?" | "###" | "WAN=###" | Prompt | n/a |
| ### is an angle in the range 0 through 359 | | | | |

## WATERFALL DISPLAY HIGHLIGHT

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "WHI?" | "##" | "WHI=##" | Prompt | n/a |

## is a number in the range waterfall MIN through waterfall MAX

This number is the number of the sweep multiplied by the scanner pitch. The first sweep line with a scanner pitch of 0.025 would have a value of 0.025 and the fifth sweep line would have a value of 0.125.

## X-Y AVERAGE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "AVG?" | "2"<br>"4"<br>"8"<br>"16"<br>"32" | "AVG=2"<br>"AVG=4"<br>"AVG=8"<br>"AVG=16"<br>"AVG=32" | Prompt | n/a |

This is the number of points to be averaged together to produce the X-Y average.

## X-Y AVERAGE (ASCII)

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "AVA?" | "XXXX YYYY" | n/a | n/a | n/a |

XXXX and YYYY are ASCII numbers in the range -2048 through 2047, where XXXX is the x and YYYY is the y value of the average dot position on the instrument screen. The number specified in the command is the number of positions averaged to obtain XXXX and YYYY. The center of the screen is represented by 0 0 and the bottom right corner by 1000 1000.

## X-Y AVERAGE (BINARY)

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "AVB?" | "XXXX YYYY" | n/a | n/a | n/a |

XXXX and YYYY are binary numbers in the range -2048 through 2047, where XXXX is the x and YYYY is the y value of the average dot position on the instrument screen. The number specified in the command is the number of positions averaged to obtain XXXX and YYYY. The center of the screen is represented by 0 0 and the bottom right corner by 1000 1000.

**BAUD RATE**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "BPS=1200"<br>"BPS=2400"<br>"BPS=4800"<br>"BPS=9600"<br>"BPS=19200"<br>"BPS=38400" | Prompt | n/a |

**SCANNER PITCH**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "PIT?" | "#.###" | "PIT=#.###" | Prompt | n/a |
| #.### is a number with a range of 0.000 through 0.050 in 0.005 steps or in the range 0.100 through 1.500 in 0.100 steps. | | | | |

**WATERFALL MIN SWEEP**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "WMN?" | "##.###" | "WMN=##.###" | Prompt | n/a |
| ##.### is a number which is the product of the sweep number and the scanner pitch. For example, if the scanner pitch is 0.025 and the third sweep is selected then ##.### would be 0.075. The sweep number may be from 1 to (MAX WATERFALL SWEEP - 5). | | | | |

**WATERFALL MAX SWEEP**

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "WMX?" | "##.###" | "WMX=##.###" | Prompt | n/a |
| ##.### is a number which is the product of the sweep number and the scanner pitch. For example, if the scanner pitch is 0.025 and the third sweep is selected then ##.### would be 0.075. The sweep number may be from (MIN WATERFALL SWEEP + 5) to 64. | | | | |

### WATERFALL MEM2 SWEEP

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "WM2?" | "##.###" | "WM2=##.###" | Prompt | n/a |
| ##.### is a number which is the product of the sweep number and the scanner pitch. For example, if the scanner pitch is 0.025 and the third sweep is selected then ##.### would be 0.075. The sweep number may be from MIN WATERFALL SWEEP to MAX WATERFALL SWEEP. | | | | |

### POINTS/SWEEP

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "PPS?" | "60"<br>"120"<br>"240"<br>"480" | "PPS=60"<br>"PPS=120"<br>"PPS=240"<br>"PPS=480" | Prompt | n/a |

### WATERFALL DISPLAY STATUS

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "WDM?" | "MAP"<br>"IMP"<br>"SWP" | n/a | n/a | n/a |

### WATERFALL MEM2 STATUS

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "WMS?" | "OFF"<br>"ON" | n/a | n/a | n/a |

### WATERFALL DATA SIZE

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "WSZ=##" | "S" | n/a |
| ## designates the waterfall data location and is in the range 1 through 20. S is the number of data locations occupied by a stored waterfall display and is in the range 1 through 8. | | | | |

## WATERFALL UPLOAD DATA (BINARY)

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "WUP=##" | "T"<br>"SS1B1..B1C1"<br>...<br>"SSTBT..BTCT" | n/a |

## is a number in the range of 1 through 20

T is the total number of data blocks to be transfered and is in the range of 1 through 8. When the computer is ready to receive each block it must send a carriage return (0D Hex) to begin the transfer. The size count, binary data, and checksum are sent for each data block i in the range 1 to T.

The data block transfer consists of a 2-byte size count (SSi) followed by the binary data information (Bi..Bi) and a 1-byte checksum (Ci). The size count is sent in low byte then high byte order.

To ensure data integrity, the host should calculate its own checksum and compare it to that sent by the Nortec 19e$^{II}$ SPO 3196. The checksum is generated by summing all byte values, excluding the size count and checksum, modulus 256.

(Byte1 + Byte2 + ... + ByteN) % 256

Data information stored in this form may be downloaded to the instrument if the data (including size counts and checksums) is returned unaltered.

A complete transfer consists of the following steps:

1. Host sends "Upload Data" command (WUP=1).
2. Host waits for the Nortec 19e$^{II}$ SPO 3196 to respond with a block count (T) or an error prompt.
3. Host sends a carriage return (0D Hex).
4. Host reads the size count, binary data, and checksum.
5. Host repeats steps 3 and 4 for each block of data.
6. Host waits for the final prompt.

## WATERFALL DOWNLOAD DATA (BINARY)

| Read Command | Returned Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| n/a | n/a | "WDN=##"<br>"T"<br>"SS1B1..B1C1"<br>...<br>"SSTBT..BTCT" | Prompt | n/a |

## is a number in the range of 1 through 20

T is the total number of data blocks to be transfered. Each block number i has a size count, binary data, and a checksum, where i goes from 1 to T.

The transfer consists of a 2-byte size count (SSi) followed by the binary data information (Bi..Bi) and a 1-byte checksum (Ci).

This command is used to send stored data (acquired using the data upload command) back to the Nortec 19e$^{II}$ SPO 3196. The Nortec 19e$^{II}$ SPO 3196 assumes that the data has not been altered. Altered data will yield unpredictable results.

To ensure proper transfer, the following steps are carried out to download stored data:

1. Host sends "Download Program" command **(WDN=1)**
2. Host waits for the Nortec 19e$^{II}$ SPO 3196 to respond with a carriage return (0D Hex) or an error prompt.
3. Host sends the block count T.
4. Host waits for a carraige return (0D Hex) or an error prompt.
5. If no error was encountered, the host sends the size count, binary data, and check sum information.
6. Host repeat steps 4 and 5 for each data block.
7. Host waits for the final prompt.

## SCANNER ZERO ADJUSTMENT

| Read Command | Return Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "SCZ?" | "###" | "SCZ=###" | Prompt | n/a |
| ### is the angle in the range 0 through 358 with 2 degree steps. | | | | |

## EXTERNAL SWEEP AVERAGE

| Read Command | Return Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "ESA?" | "OFF"<br>"ON" | "ESA=OFF"<br>"ESA=ON" | Prompt | n/a |

## PRINTER SELECTION

| Read Command | Return Value | Write Command | Returned Value | Execute Command |
|---|---|---|---|---|
| "PRT?" | "DICONIX"<br>"EPSON"<br>"HP-PCL"<br>"24-PIN" | "PRT=DICONIX"<br>"PRT=EPSON"<br>"PRT=HP-PCL"<br>"PRT=24-PIN" | Prompt | n/a |

## 7.7 Quick Reference

| Parameter | Command | RWX | Parameter | Command | RWX |
|---|---|---|---|---|---|
| Display | DSP | RW | Alarm Horn | HRN | RW |
| MEM2 Enable | M2E | RW | Alarm Latch | LCH | RW |
| MEM2 Number | M2N | RW | CRT Graticule | GRT | RW |
| Sweep Enable | SWP | RW | Instrument Time | TIM | R |
| Auto-Sweep Time | AST | RW | Hours | HR. | RW |
| Frequency 1 | FR1 | RW | Minutes | MIN | RW |
| Frequency 2 | FR2 | RW | Seconds | SEC | RW |
| Angle 1 | AN1 | RW | Instrument Date | DAT | R |
| Angle 2 | AN2 | RW | Day | DAY | RW |
| Lowpass Filter | FLO | RW | Month | MON | RW |
| Highpass Filter | FHI | RW | Year | YR. | RW |
| Combined Gain 1 | GN1 | W | Read Print Header | RHD | WO |
| Horizontal Gain 1 | HG1 | RW | Set Print Header | SHD | WO |
| Vertical Gain 1 | VG1 | RW | Read Print Label | RLB | WO |
| Combined Gain 2 | GN2 | W | Set Print Label | SLB | WO |
| Horizontal Gain 2 | HG2 | RW | Read Print Field | RFL | WO |
| Vertical Gain 2 | VG2 | RW | Set Print Field | SFL | WO |
| Horizontal Position | HPO | RW | Clear Programs | CLP | X |
| Vertical Position | VPO | RW | Clear Data | CLD | X |
| Capture Time | CCT | RW | Clear Instrument | CLI | X |
| Probe Drive | PDR | RW | Load Default | LOD | X |
| Variable Persistence | VAP | RW | Continuous Null | CNL | RW |
| Auto-Sweep Erase | ASE | RW | Alarm Box 1 Top | B1T | RW |
| LCD Backlight | LIT | RW | Alarm Box 2 Top | B2T | RW |
| CRT Timed Erase | CTE | RW | Alarm Box 3 Top | B3T | RW |
| Alarm Type | ALT | RW | Alarm Box 1 Left | B1L | RW |
| Alarm Dwell | ADW | RW | Alarm Box 2 Left | B2L | RW |
| Alarm Box 3 Left | B3L | RW | Polygon Alarm X 6 | PX6 | RW |
| Alarm Box 1 Bottom | B1B | RW | Polygon Alarm X 7 | PX7 | RW |
| Alarm Box 2 Bottom | B2B | RW | Polygon Alarm X 8 | PX8 | RW |

| Parameter | Command | RWX | Parameter | Command | RWX |
|---|---|---|---|---|---|
| Alarm Box 3 Bottom | B3B | RW | Polygon Alarm Y 1 | PY1 | RW |
| Alarm Box 1 Right | B1R | RW | Polygon Alarm Y 2 | PY2 | RW |
| Alarm Box 2 Right | B2R | RW | Polygon Alarm Y 3 | PY3 | RW |
| Alarm Box 3 Right | B3R | RW | Polygon Alarm Y 4 | PY4 | RW |
| Alarm Box 1 Enable | B1E | RW | Polygon Alarm Y 5 | PY5 | RW |
| Alarm Box 2 Enable | B2E | RW | Polygon Alarm Y 6 | PY6 | RW |
| Alarm Box 3 Enable | B3E | RW | Polygon Alarm Y 7 | PY7 | RW |
| Sweep Alarm Top | SWT | RW | Polygon Alarm Y 8 | PY8 | RW |
| Sweep Alarm Bottom | SWB | RW | Polygon Alarm Enable | PEN | RW |
| Sweep Alarm Enable | SWE | RW | Sorting Gate Top | SRT | RW |
| Polar Alarm X | POX | RW | Sorting Gate Left | SRL | RW |
| Polar Alarm Y | POY | RW | Sorting Gate Bottom | SRB | RW |
| Polar Alarm Radius | POR | RW | Sorting Gate Right | SRR | RW |
| Polar Alarm Enable | POE | RW | Sorting Gate Enable | SEN | RW |
| Pie Alarm X | PIX | RW | Zone Priority | PRI | RW |
| Pie Alarm Y | PIY | RW | Good Zone | GDZ | RW |
| Pie Alarm Radius | PIR | RW | Program Number | PGM | RW |
| Pie Alarm Angle 1 | PI1 | RW | Program Status | PEF | W |
| Pie Alarm Angle 2 | PI2 | RW | Store Program | PST | W |
| Pie Alarm Enable | PIE | RW | Recall Program | PRC | W |
| Polygon Alarm X 1 | PX1 | RW | Erase Program | PER | W |
| Polygon Alarm X 2 | PX2 | RW | Read Program Name | PRN | W |
| Polygon Alarm X 3 | PX3 | RW | Set Program Name | PSN | W |
| Polygon Alarm X 4 | PX4 | RW | Print Program | PPR | W |
| Polygon Alarm X 5 | PX5 | RW | Dump Program (ASC) | PDP | W |
| Upload Program (BIN) | PUP | W | Vertical Key | KVE | X |
| Download Program (BIN) | PDN | W | Filter Key | KFL | X |
| Data Storage Location | DAL | RW | Special Key | KSP | X |
| Data Status | DEF | W | Continuous Null Key | KCN | X |
| Freeze Data | DAF | W | Erase Key | KER | X |
| Data Capture Begin | DCB | X | Null Key | KNL | X |
| Data Capture End | DCE | W | F1/F2 Key | K12 | X |

| Parameter | Command | RWX | Parameter | Command | RWX |
|---|---|---|---|---|---|
| Recall Data | DRC | W | Alarm Key | KAL | X |
| Erase Data | DER | W | Latch Key | KLA | X |
| Read Data Name | DRN | W | Enter Key | KEN | X |
| Set Data Name | DSN | W | Decimal Point Key | KDP | X |
| Print Data | DAP | W | 0 Key | KN0 | X |
| Upload Data (BIN) | DUP | W | 1 Key | KN1 | X |
| Download Data (BIN) | DDN | W | 2 Key | KN2 | X |
| Upload Data (BIT MAP) | DBM | W | 3 Key | KN3 | X |
| Screen Dump | SCR | X | 4 Key | KN4 | X |
| Lock Key | KLK | X | 5 Key | KN5 | X |
| Print Key | KPR | X | 6 Key | KN6 | X |
| Display Key | KDS | X | 7 Key | KN7 | X |
| Memory 2 Key | KM2 | X | 8 Key | KN8 | X |
| Sweep Key | KSW | X | 9 Key | KN9 | X |
| Program Key | KPG | X | Alarm Condition | ALC | R |
| Frequency Key | KFR | X | Instrument Version | VER | R |
| Gain Key | KGN | X | Instrument Type | TYP | R |
| Horizontal Key | KHO | X | Battery Status | BAT | R |
| Store Key | KST | X | Host Mode | HST | X |
| Angle Key | KAN | X | Terminal Mode | TRM | X |
| Position Key | KPO | X | Remote Lockout | RLK | RW |
| Instrument Name | NAM | R | X-Y Average Binary | AVB | R |
| Instrument Options | OPT | R | Baud Rate | BPS | W |
| Remote Null | NUL | X | Scanner Pitch | PIT | RW |
| Remote Erase | ERS | X | Waterfall Min Sweep | WMN | RW |
| Reset Instrument | RST | X | Waterfall Max Sweep | WMX | RW |
| HPF Pole Selection | HPS | RW | Waterfall MEM2 Sweep | WM2 | RW |
| Flying Dot Type | FDT | RW | Points/Sweep | PPS | RW |
| Waterfall Trigger | WTR | RW | Waterfall Display Status | WDM | R |
| Scanner RPM | RPM | RW | Waterfall MEM2 Status | WMS | R |
| Waterfall Display Angle | WAN | RW | Waterfall Data Size | WSZ | R |
| Waterfall Display Highlight | WHI | RW | Waterfall Upload Data | WUP | W |

| Parameter | Command | RWX | Parameter | Command | RWX |
|---|---|---|---|---|---|
| X-Y Average | AVG | RW | Waterfall Download Data | WDN | W |
| X-Y Average ASCII | AVA | R | Scanner Zero Adjustment | SCZ | RW |
| External Sweep Average | ESA | RW | | | |

# 8.0 PS-5

## 8.1 General Description

The PS-5 is a compact hand-held eddy current scanner powered by the Nortec-19e$^{II}$ Eddyscope. The PS-5 can be used for bolt hole as well as first layer fastener inspection. It features low noise axial rotary slip rings that provide an optimum signal to noise ratio.

The PS-5 is designed to meet virtually all low to medium speed rotary scanner application requirements. A wide selection of probes may be used with the PS-5, including single and dual coil absolute, differential, and reflection probes. Control features include null, erase, forward, reverse, translate/rotate, and rotate only. The range of travel may be adjusted from 0 to 1.5 in. Using a visible gage, travel depth and zero location can be set to handle any scanning task. The motor speed is adjustable from 40 to 200 RPM using the SmartKnob™ on the Nortec-19e$^{II}$.

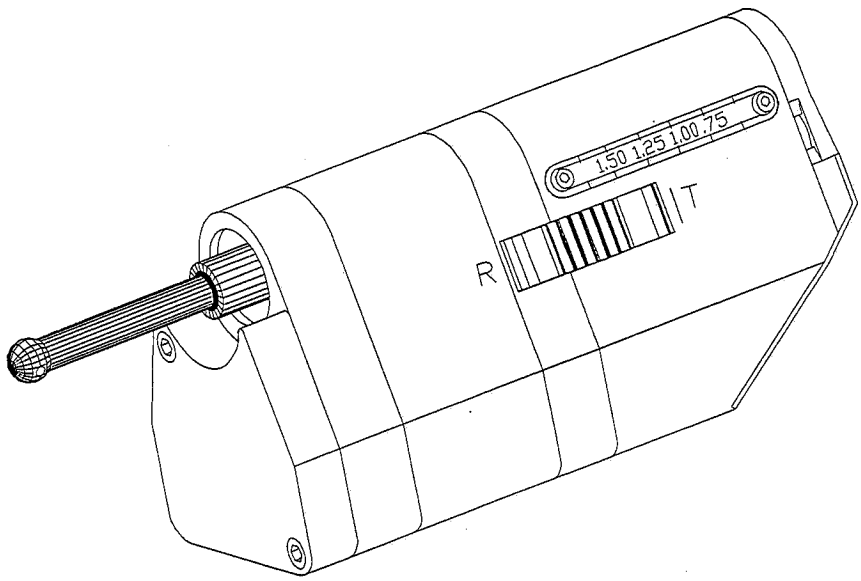



**Figure 8-1** *PS-5 Hand Scanner*

The PS-5 features a rugged construction and is completely portable. It is powered by the Nortec-19e$^{II}$ instrument, which uses an onboard battery supply or external 85 to 260V AC source.

The PS-5 is attached to the Nortec-19e$^{II}$ using the connector cable included in the packing carton.

## 8.2 Unpacking

All cartons should be opened and inspected upon receipt. The cartons and contents should be inspected for any signs of damage that may have occurred during shipment. If damage is noted, contact the carrier and retain the damaged shipping materials until an inspection can be performed by a representative of the carrier. Check the contents of the carton or cartons against the packing list to ensure that all accessories ordered have been received.

If the instrument is shipped frequently from site to site, the packing carton and cushioning can be retained. If not, discard the materials after the unit is determined to be operational.

## 8.3 Operating Environment

The PS-5 hand scanner is designed as a portable accessory, and as such requires no special site preparation before operation. Avoid dropping or suddenly jarring the scanner. The unit should be protected as much as possible from water or chemical splashes, rapid temperature changes, and should be operated away from large electrical equipment that may interfere with the operation of internal circuitry.

## 8.4 Comparison of the PS-5 with the Gulton FD-100 and the 19/RA Scanner

| Features | Gulton FD-100 | 19/RA Scanner | Staveley 19e$^{II}$/PS-5 |
|---|---|---|---|
| Scanner speed | 50-100 RPM | 1000-1500 RPM | 40-200 RPM |
| Speed control | Front panel, no servo | Front panel, servo | Front panel, servo |
| Torque | 40 oz/in max | | 100 oz/in max |
| Battery power | No | Yes; approximately 6 hrs when using scanner | Yes; approximately 6 hrs when using scanner |
| Probe type | Absolute only | Differential reflection | Absolute, differential, and reflection types |
| Gulton compatible | Yes | No | Yes |
| Balance coil location | Instrument | N/A | Scanner head or in probe |
| Index range | 0-1.5" | N/A | 0-1.5" |
| Retraction limit | Fixed | N/A | Adjustable |
| Rotate/translate modes | Translate only | Rotate only | Rotate and translate capable |
| Scanner head weight | 1lb, 10 oz | 11 oz | 2 lb |
| Signal presentation | Meter strip chart | Impedance plane, sweep, mapping mode, computer manipulation, strip chart option | Impedance plane, sweep, mapping mode, computer manipulation, strip chart option |
| Lift-off compensation | Coupled to frequency | Independent of frequency | Independent of frequency |
| Signal coupling | Mercotac, orientation sensitive | Rotary transformer, not orientation sensitive | Slip rings, not orientation sensitive |

## 8.5 Specifications

| | |
|---|---|
| *Probe Types* | Absolute, differential, and reflection (single and multiple coil) |
| *Signal Coupling* | Axial rotary slip rings |
| *Noise* | 12:1 minimum peak to peak signal to maximum peak to peak noise |
| *Modes* | Translate/rotate only |
| *Travel* | Adjustable, 0 to 1-1/2 inches |
| *Extension Limit* | Variable from 0 to 1-3/8 inches, visible adjustment window, automatic stop |
| *Retraction Limit* | Zero adjust -1/8 to +3/8 inches, automatic stop |
| *Null* | Three-stage digital null |
| *Erase* | Screen erase |
| *Translation* | +/- 0.025 inches per revolution (0.0625 inches per second @ 150 RPM) |
| *Direction Control* | Forward/Stop/Reverse |
| *Speed* | 40 to 200 RPM, set from instrument front panel<br>Accurate to +/- 5%, repeatable to +/- 5% |
| *Power Requirements* | Powered by the Nortec-19e$^{II}$ instrument using a special circuit board<br>Motor: 2 to 26 volts DC, 15 Watts max<br>Electronics: 12 volts |
| *Hazardous Area Operation* | Operation in explosive atmospheres when in DC (battery) mode, tested using MIL-STD-810E, Method 511.3, Procedure I |
| *Operating Temperature* | 0° F (-18° C) to 130° F (54° C) |
| *Storage Temperature* | 0° F (-17° C) to 150° F (66° C) |
| *Humidity* | 0% to 95% Relative Humidity) |
| *Altitude (Max Operating)* | 7,280 feet above sea level |
| *Altitude (Max Non-operating)* | 40,000 feet above sea level |
| *Size* | 5 inches deep, 2-1/2 inches high, 1-7/8 inches wide |
| *Weight* | 2 pounds |
| *Chassis* | Stainless steel construction |

## 8.6 Control Descriptions

### Introduction

The PS-5 has many features designed to ease the task of eddy current testing. This section describes the basic function of each scanner control.

### Motor Control

The motor control switch turns the motor on/off and controls its direction. The switch is located in a protective boot on the side of the scanner. Depressing the switch on the side toward the front of the scanner causes the probe to rotate in the clockwise direction. If the scanner is in translate mode the probe will begin to extend. Moving the switch to the center (level) position turns the motor off. Depressing the switch on the side toward the rear of the scanner causes the probe to rotate in the counter-clockwise direction. If the scanner is in translate mode the probe will begin to retract.

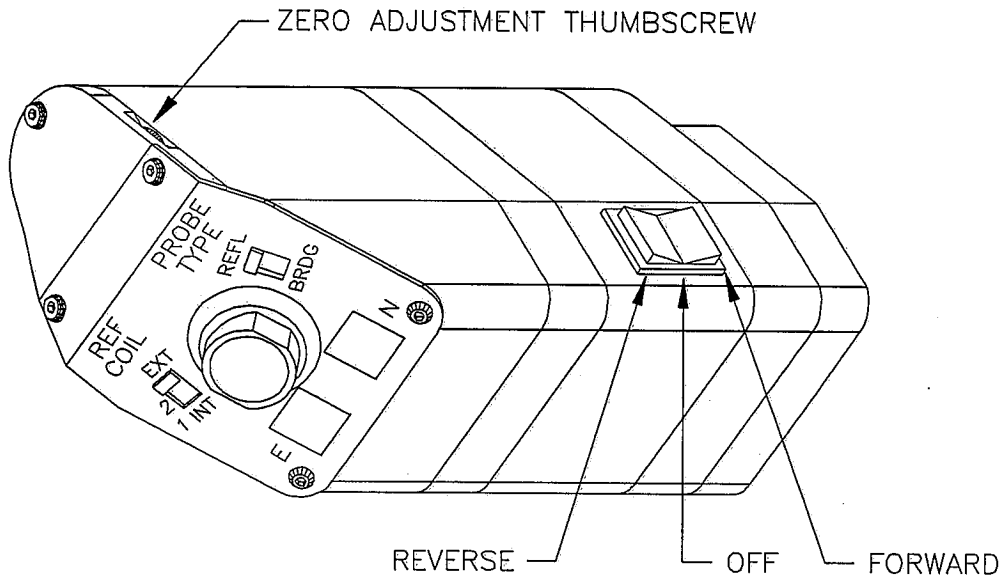



**Figure 8-2** *Motor Control Switch*

The motor speed of the PS-5 is controlled by the (SP22) Scanner RPM function on the Nortec 19e$^{II}$. The PS-5 is designed to operate between 40-200 RPM.

### Translation Control

The shifter is used to control the scanner in translate/rotate mode or rotate only mode. Moving the shifter toward the front of the scanner places the scanner in rotate only mode, while moving the shifter toward the rear of the scanner places the scanner in translate/rotate mode. In the translate/rotate mode, the scanner will advance or retract the probe depending on the motor direction while rotating.

The direction of the translation is determined by the motor direction. Depressing the motor control switch (see *Figure 8-2*) toward the front of the scanner causes the probe to extend; while depressing the motor control switch toward the rear of the scanner causes the probe to retract.

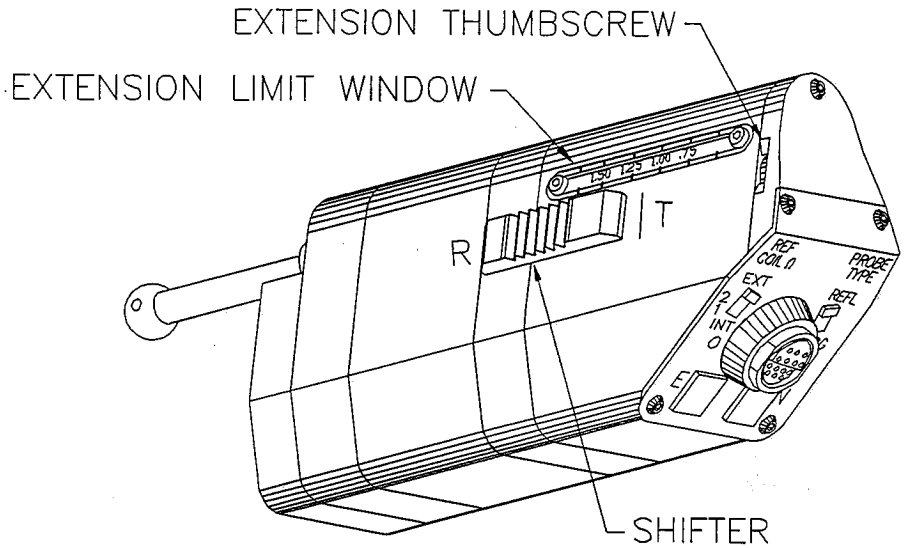



**Figure 8-3** *Shifter and Extension Thumbscrew*

The PS-5 has a maximum translation range of 1-1/2 inches and a variable scan depth limit. The limit window indicates the depth that the scanner will travel. The probe will automatically stop when it reaches the depth indicated in the window. To choose a new depth, rotate the thumbscrew until the desired depth is indicated in the limit window. The extension limit will not adjust to a depth less than the current depth of the probe. In order to adjust to a depth less than the current depth of the probe, the probe must first be retracted at least to that depth.

To compensate for different probe lengths the PS-5 has a variable probe retraction limit. For a probe that is too long, gradually adjust the retraction limit thumbscrew with the scanner in retract mode until the probe is retracted to the zero position. For a probe that is too short, extend the probe past the desired position and then adjust the thumbscrew until the clutch on the thumbscrew releases. Then with the scanner in retract mode adjust the thumbscrew until the probe is at the desired position.

**Probe Connection**

The PS-5 can accommodate absolute, differential, and reflection type eddy current probes. No special adapter is needed for any of the above probes. Align the T-slot with the pin in the scanner and insert the probe until the probe is firmly captured by the scanner. Then rotate the probe slightly to insure that the probe is secured in place.

Once the probe is inserted, the scanner must be set to the probe type using the [PROBE TYPE] and [REF COIL] switches located on the connector plate at the rear of the scanner.

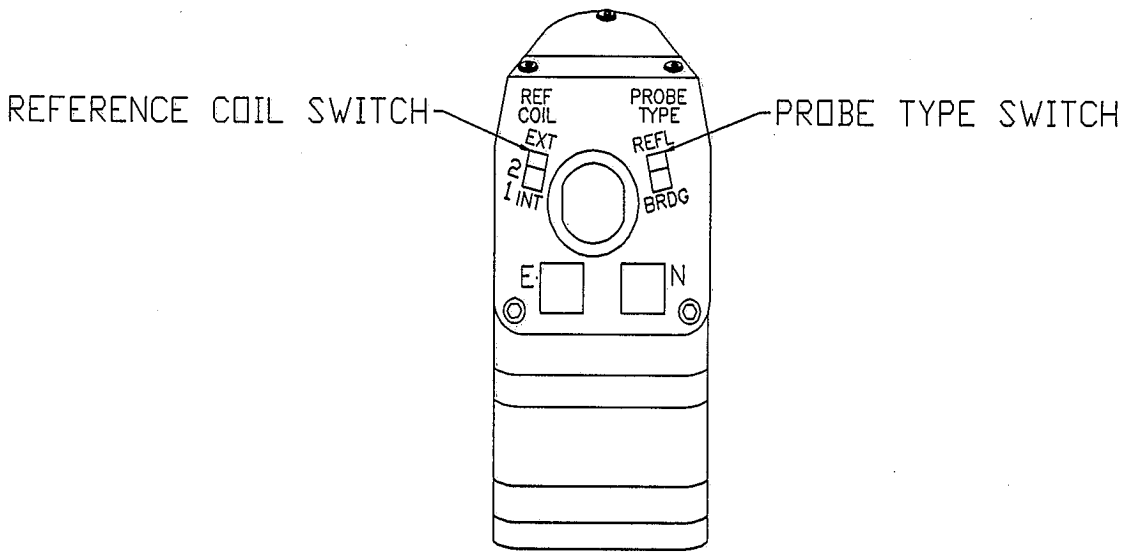



**Figure 8-4** *Coil and Probe Type Selection*

Position the switches as follows:

| PROBE | REFERENCE COIL SWITCH | PROBE TYPE SWITCH |
|---|---|---|
| Reflection | External | Reflection |
| Differential | External | Bridge |
| 3-Pin Absolute* | External | Bridge |
| 2-Pin Gulton | Internal 1 or 2 | Bridge |

*** Dual coil using reference coil in probe body.**

### Immediate Execution Keys

The PS-5 has two immediate execution keys [N] Null and [E] Erase. Immediate execution keys perform a specific function on the instrument as soon as the key is pressed. They are located at the rear of the scanner on the connector plate.

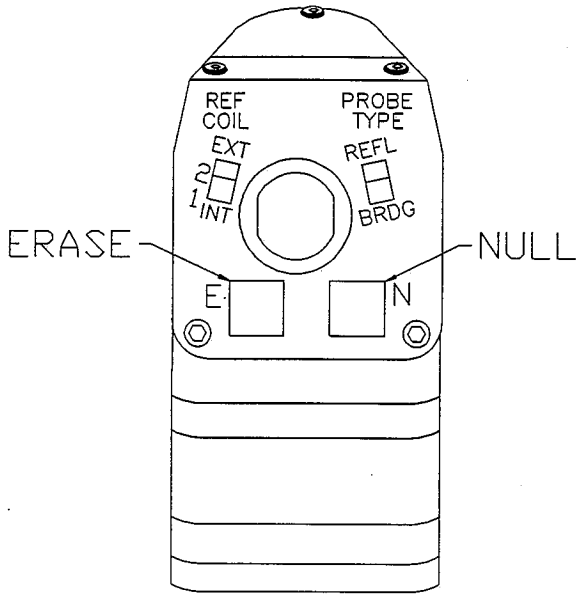



**Figure 8-5** *Null and Erase*

**NULL** The Null function moves the dot (impedance plane display) or sweep display to the selected null position, usually in the middle of the screen. This function is activated by pressing the [N] button. Null should be performed prior to and at periodic intervals when performing eddy current tests.

The test procedure for a specific test determines whether to null the signal with the probe held in air or on the test part.

**ERASE** The [E] key will perform a screen erase whenever the key is pressed during normal operation. This operation clears all data from the screen and is useful to eliminate screen clutter. For example, if the Nortec 19e$^{II}$ is in the waterfall display mode, Erase will clear the screen and restart the waterfall.

To erase the screen at any time the eddy current signal is displayed, press the [E] key.

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