NORTEC® 2000D

NORTEC® 2000D+

Nortec® 2000 Dual Eddyscope Operation Manual

Staveley P/N #7720064
Rev. 6
March 2005

STAVELEY
NDT TECHNOLOGIES

Staveley Instruments
421 North Quay Street
Kennewick, Washington 99336
(509) 735-7550
Fax: (509) 735-4672
www.staveleyndt.com

Statement of Inspection and Warranty

This statement covers new instruments, electromechanical 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

Upon receipt of the equipment, it should be examined immediately for any evidence of hidden or external damage. Damage should be promptly reported to the carrier making delivery, as the carrier is normally liable for such damage. All documentation, waybills, and packing materials should be retained in order to establish claims. Please advise SNDT at the nearest service center listed in this manual after notifying the carrier of shipping damage so we may assist in damage claims and supply replacement equipment, if necessary.

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 electromechanical 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 to be free from defects in materials and workmanship for the lifetime of the probe.

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

Batteries, cables 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, corrosion, 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 prepaid shipments to our authorized service centers. Repair at customer facilities will be quoted as requested.

All instrument outputs have protection against short circuits. However, the protection cannot be 100% guaranteed. SNDT is not responsible for damage to the instrument caused by:

•   Shorted Cables
•   High Frequency "tuned" transducers with the pulser set to a wide pulse width and receiver set to a low frequency

SNDT also does not recommend the use of transducers with an impedance of *less than 25Ω.*
SNDT makes no other warranty of any kind whatsoever and there are no implied warranties of merchantability or fitness for a particular purpose.

Any problems identified with system software will be evaluated for criticality based on product specification, as stated in the manual, and the product's ability to accomplish standard non-destructive testing functions. Problems related to non-test features or applications inappropriate with the design of the product may not be covered by this warranty. 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.

Calibration Intervals

Calibration intervals should be established to ensure this equipment remains in tolerance during the entire operational period.

As a manufacturer of this nondestructive test (NDT) equipment, we cannot make general recommendations since we have no detailed knowledge of the end use or of the environmental conditions in which the equipment is being used. This equipment can be operated in sterile lab conditions, or harsh, rugged, outside environments.
MIL-STD-45662A (obsolete) Section 5.4 and ANSI/NCSL Z540-1-1994 Section 18.4 allow the end user to establish calibration intervals based on their application and conditions. Included in the rationale should be the environment in which the equipment is used, historical data, handling and storage considerations, and any other factor that may influence the calibration.

Initial Calibration Certificates issued by Staveley Instruments are for a 12-month period. On follow-on calibrations performed by Staveley Instruments, the intervals are set per customer request as required by their calibration and quality requirements (which are based on their applications). Typical examples range from 3-month intervals up to 12 months.

Staveley Instruments recommends that this test equipment be calibrated and certified to manufacturer's specification at a minimum of 12 months.

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. 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.

IMPORTANT!

Staveley Instruments recommends that a hardcopy or electronic backup of stored programs be maintained by the customer. It is especially crucial to make a backup of stored programs before returning the instrument for any type of service as information stored in memory may be cleared during the servicing process.

This instrument is a microprocessor-based product. In the event of a system lockup or other display problem, turn the instrument off, then back on to reinitialize the current parameters. If the problem persists, initiate a power-on reset to clear the instrument and reset all system parameters back to default.

For **priority service**, the following telephone number will put you in touch with the service center best capable of meeting your requirements: **(513) 671-2428**.

Staveley NDT Technologies, Inc
Authorized Service Centers

Kennewick Technical Center
421 N. Quay Street
Kennewick, WA 99336
(509) 736-2751
(509) 735-4672 (fax)
E-Mail: sndt1@staveleyndt.com

Cincinnati Technical Center
1329 E. Kemper Road
Bldg. 400, Suite 4222
Cincinnati, OH 45246
(513) 671-6951
(513) 671-6950 (fax)

Southwest Technical Center
16903 Buccaneer Lane
Suite 110
Houston, TX 77058
(281) 286-9371
(281) 286-9613 (fax)

European Technical Centre
3A Marston House
Cromwell Park
Chipping Norton
Oxfordshire OX7 5SR
United Kingdom
+44 (0) 1608 642001
+44 (0) 1608 644752   Fax

This instrument and its accessories have been tested in accordance with EN55011, and have met the limits specified in EN50081-1 Class "A" and EN50082-1, as required by the EMC directive 89/336/EEC.

Generic Immunity Standard — EN50082-1

This Nortec® 2000D instrument with a functioning charger has performance characteristic "C" indicated for the Electrostatic Discharge Test (IEC801-2) and the Fast Transients Test (IEC801-4).

WARNING

Any changes or modifications to this instrument, or use of unauthorized accessories not expressly approved by the party responsible for compliance, could void the user's authority to operate this equipment in countries that require compliance with the EMC directive.

CAUTION

Operators must receive adequate training before using this non-destructive testing (NDT) equipment. Operators must be trained in general NDT procedures and in the specific requirements for a particular test. Operators must also consult this manual for proper operation of this equipment prior to use.

Tests utilizing this instrument should be created and supervised by qualified NDT personnel. Setups outside the ranges of those recommended in this manual or other approved NDT text may not yield reliable results.

More specific information regarding operator training, qualification and certification is available from various government agencies, industry groups, and technical societies.

Table of Contents

PowerLink™

Introduction to PowerLink™

The *PowerLink™* feature enables the Nortec® 2000D instrument to recognize Nortec® PowerLink™ probes and scanners, configuring the instrument according to the parameters programmed into the ID chip.

Each *PowerLink™* probe is programmed at the factory to identify itself by model number, pre-selected operating frequency, and serial number.

PowerLink™ Connection

The PowerLink™ connection is automatically made when a PowerLink™ probe is connected into the Nortec® 2000D instrument. When the PowerLink™ probe is connected to the instrument, the following screen will appear:

```
         POWERLINK™
MODEL: 9222165
FREQ : 100 kHz
S/N  : E01527
TYPE :
MODE : IMPEDANCE
SET INST?    CANCEL
PROGRAM  STORE | ERASE | NAME | RECALL
```
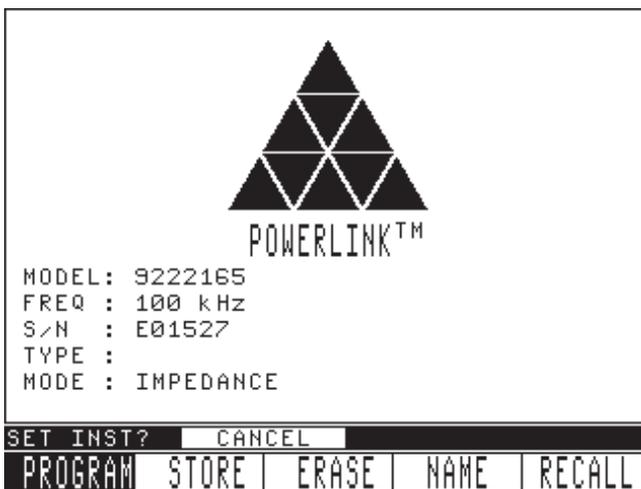
- Part Number of Probe
- Last Operating Frequency
- Serial Number
- Operating Mode
- Cancel / Confirm Prompt

To proceed without using the PowerLink™ feature, press the ENTER key followed by the MAIN key.

To use the PowerLink™ feature, rotate the SmartKnob™ clockwise to change SET INST? from CANCEL to CONFIRM. Pressing the ENTER key will download the information from the ID chip to the instrument and a new screen will appear:

```
         POWERLINK™
MODEL: 9222165
FREQ : 100 kHz
S/N  : E01527
TYPE :
MODE : IMPEDANCE
SET INST?    CONFIRM
PROGRAM  STORE | ERASE | NAME | RECALL
```
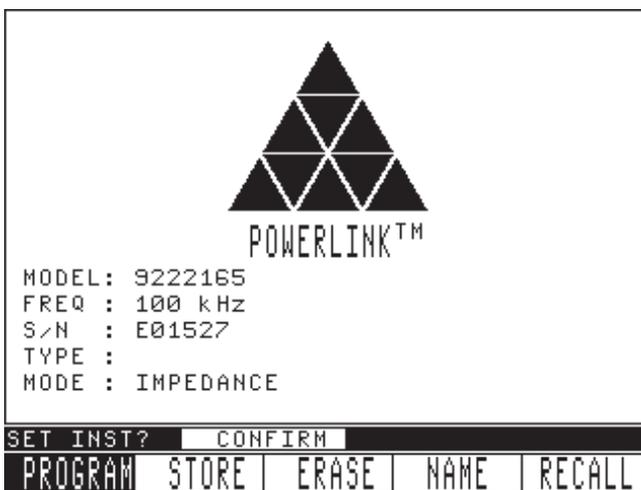
- Probe Description
- Operating Frequency
- Serial Number
- Coil Type
- Operating Mode
- Date
- Pre-Stored Programs

```
                POWERLINK™
MODEL: ML/50KHZ-100KHZ/A/0.0/4
FREQ : 100 kHz
S/N  : E01527
TYPE : BRIDGE/ABSOLUTE
MODE : IMPEDANCE
PL  1.E01527                    05/15/03
PROGRAM  STORE │ ERASE │ NAME │ RECALL
```

After the PowerLink™ screen appears, you can recall any existing program that has been saved in the program storage menu. By rotating the SmartKnob™ clockwise, the list of pre-stored programs and the date stored will appear at the bottom of the display.

See Section 3.11 for complete details on how to store, erase, name, and recall programs.

PowerLink™ probes can also be programmed for Level II commands, and any of the instrument parameter commands can be pre-loaded at the factory to fully set up the desired test. Contact Staveley Instruments for more information on Level II probes.

Level III PowerLink™ programming (user programmable) is supported by using a Nortec® WorkStation or PowerStation. Level III programming allows the user to program the ID chip to meet their specific needs. Large chip data capacity allows for a chip to be re-programmed if the need arises.

For every probe, PowerLink™ can be bypassed to allow the probe to be used for any applicable test.

PowerLink™ is an additional "Value Added" capability when used on Staveley's new line of Eddy Current instruments.

WARNING!

Probe operation may be erratic if a probe is being driven at less than 1/10 its rated frequency in High Probe Drive. To avoid this problem, do NOT drive a probe at less than 1/10 its rated frequency.

This page intentionally left blank

1.0 Nortec® 2000D Preparation for Operation

What's in this section?

1.1   Unpacking the Nortec® 2000D

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 Universal Battery Charger and external accessories, all Nortec® 2000D 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.

1.2   Nortec® 2000D/D+ Optional Accessories

A variety of optional accessories are available for the Nortec® 2000D/D+. A short list of some of these options follows. For specific needs not listed below, contact your Staveley Instruments sales representative for an additional list of optional accessories.

Description	Function
Transducers and Probes (contact your Staveley Instruments sales representative for a complete list of transducers and probes)	Primary sensor for flaw detection, thickness gauging, and conductivity measurement
External Null/Erase Adapter	Provides Null/Erase function near probe on Eddy Current instruments
Hands-Free Chest Harness	Supports the instrument while climbing
SPAN Dual Ni-MH Battery Charger	Charges batteries outside of instrument
Protective Soft Cover	Protection of instrument while in use
Hard Shell Travel Case	Protection of instrument while not in use
Replacement Ni-MH batteries	Primary power source
Portable Printer (includes RS-232 cable)	Printouts and Reports
Parallel to Serial converter	For use with parallel printers
Printer Battery	Power for portable printer
Computer Software	Provides method of up/down load of reports and test setups
'+' Model Accessories	
Dual Li-Ion Charger	Charges the batteries outside of the instrument
Replacement Li-Ion batteries	Primary power source
Color LCD Display	Required for external VGA output, includes VGA adapter cable
Heads-Up Display	For use when you cannot see the instrument display directly / hands free instrument use

The following is a list of probes and accessories that are used in the *Application* Section of this manual.

•	Nortec SL/1kHz-50 kHz/.31 PowerLink™ Surface Probe	P/N # 9222161
•	Nortec PL/500kHz-1MHz/A PowerLink™ Surface Probe	P/N # 9222162
•	Nortec SPO-3806L Sliding/Reflection Probe	P/N # 9222242
•	Nortec SL/100Hz-20kHz/.62 Surface Probe	P/N # 9222193
•	Staveley/Nortec Eddy Current Slide Rule	P/N # 3306888
•	Nortec Conductivity Samples (set of six)	P/N # 1902474
•	Nortec TB-S1 Crack Standard, with .040", .020" and .008" deep notches	P/N # 1902510
•	Nortec SPO-3932 Second Layer Crack Sample (1/16" Al on 1/16" Al)	P/N # 1916915
•	Nortec SPO-4304 Tapered Aluminum Standard	P/N # 1916914
•	CL/SC/6 Cable	P/N # 9122083

NOTE:

Hands-free Chest Harness/Battery Belt - This accessory is designed to hold the weight of the Sonic®/Nortec®/BondMaster™ 1000 series of nondestructive test (NDT) equipment and it's accessories. Specifically, the pouch on the chest harness is designed to hold the DR-35 battery sled (Staveley P/N #9522017), which adds two batteries to the system to extend field operation time.

THE CHEST HARNESS IS NOT DESIGNED TO SAFELY SUPPORT THE WEIGHT OF THE USER IN ANY SITUATION!

1.3   Initial Inspection Checklist

After the Nortec® 2000D has been unpacked and the contents of the carton have been checked against the packing list, a visual inspection and a basic operation test should be performed.

- *Cosmetic or structural damage?* .... ☐
- *Instrument Power "On"* .... ☐
- *Power On Self Test* .... ☐
- *EL/LCD Sign On Message displays?* .... ☐

1.4   Power Requirements

As a fully portable inspection instrument, the Nortec® 2000D relies on two nickel-metal hydride (Ni-MH) battery packs (one Li-Ion battery in 2000D+ models) as the primary source of power. The battery compartment is located at the rear of the unit and is conveniently accessed by loosening the two quick release screws and removing the battery cover.

The Ni-MH/Li-Ion battery packs provided with the Nortec® 2000D instrument are small, lightweight, portable, and capable of delivering long service life between recharges or battery replacement. Replacement batteries are available through the factory, please contact your Staveley Instruments sales representative.

The Universal Battery Charger (UBC) unit is provided with the Nortec® 2000D for recharging the Ni-MH/Li-Ion battery packs while in the instrument or external battery pack and allowing the Nortec® 2000D to be operated from AC line power. The charger unit auto senses 100 to 240 volts AC line power at 47 to 63 Hz.

The condition of the batteries used in the Nortec® 2000D is monitored by the charger. Fully discharged Ni-MH batteries will require approximately 8 hours for a complete charging cycle (4 hours for each battery), while Li-Ion batteries will require approximately 6 hours. The charger will not charge batteries which are too hot, too cold or too deeply discharged.

Quick Release Screws

Top of Instrument

Li-Ion

Ni-MH
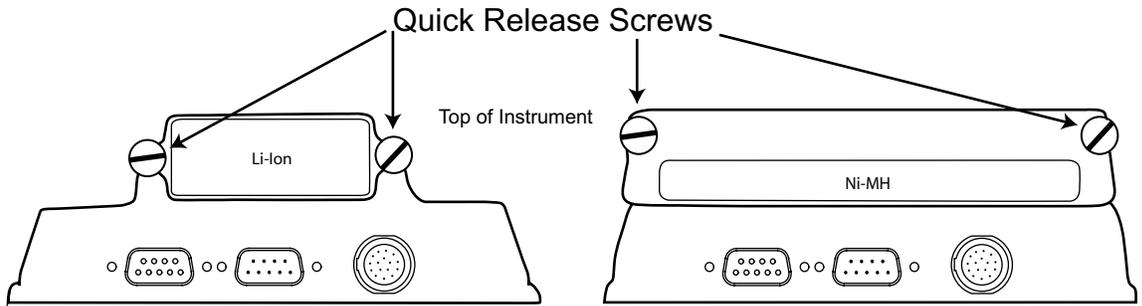
NOTE:

Fully charge battery before first use. Instrument run time is affected by variables such as: quality of charge, age of battery, and display type. The battery charge indicator on the display is an estimation of expected run time. Instruments are equipped with a circuit that shuts off power prior to full discharge. Battery life is affected by: number of charge/discharge cycles, storage conditions, temperature, and use. Batteries stored for extended periods of time (months/years) without use may no longer recharge. Under normal use Nickel-Metal Hydride (NiMH) batteries last approximately 500 charge/discharge cycles, while a Lithium-Ion battery will last approximately 300 cycles. Expect to change the batteries after 1 year of heavy use or 3 years of light use under normal conditions. Batteries must be disposed of in accordance to local law or returned to Staveley Instruments. Staveley Instruments does not warranty batteries due to operating conditions beyond Staveley's control affecting battery life.

PLEASE READ THESE INSTRUCTIONS CAREFULLY BEFORE USING THIS BATTERY

For Optimum Performance

- Refer to the manual that came with your instrument or charger for charging instructions.

- When you charge your battery for the first time, your charger may indicate that charging is complete after just 10 to 15 minutes. This is normal and can happen with all rechargeable batteries when first charged. Simply remove the battery and then repeat the charging procedure.

- Upon first use, or after prolonged periods of storage, you may need to charge and discharge your battery two or three times before obtaining optimum performance.

- It is best to charge the battery at room temperature ranging between 59°F (15°C) and 86°F (30°C).

- It is normal for the battery to become warm during charging or after use.

- It is not necessary to fully discharge your battery before charging. You can top-off the charge at any time.

- A charged battery will gradually lose its charge if left in storage. We therefore suggest that you top-off the charge before use.

- Remove your battery from the equipment, charger or AC adapter when not in use. Store at room temperature in a dry place.

SAFETY PRECAUTIONS

- Do not disassemble or attempt to open the battery under any circumstances.

- The battery can explode, leak, or catch on fire if heated or exposed to fire or high temperatures.

- Do not short circuit the battery by directly connecting the metal terminals (+, -). Be certain that no metal objects such as coins, paper clips, etc., touch the terminals.

- Only use the charger recommended by the device manufacturer.

TO AVOID DAMAGE TO THE BATTERY

- Do not drop the battery or subject it to mechanical shock.

- Use the battery only with equipment that specifies its use.

MEMORY BATTERIES

- Internal memory batteries should be changed as a preventative maintenance feature every 2 years.

IMPORTANT!

It is recommended that you refrain from operating the instrument while recharging fully discharged batteries. The charge may be incomplete and thus activate the temperature fault indicator — as a result, battery life and instrument "run time" may be shortened significantly. If the indicator is activated, shut off the instrument and disconnect the instrument from the charger. Allow the batteries to cool, then reconnect the charger to the instrument to start a new charge cycle.

1.5 Ni-MH Battery Characteristics

- *Higher capacity* — up to 40% longer run time than ordinary nickel-cadmium batteries of equivalent size
- *Fast Charge* — approximately 4 - 6 hours
- *Long cycle life* — up to 500 charge/discharge cycles
- *Temperature Range (charging)* — 32°F to 104°F (0°C to 40°C)
- *Temperature Range (operating)* — 32°F to 122°F (0°C to 50°C)
- *Temperature Range (storage)* — -4°F to 122°F (-20°C to 50°C)
- *Environmental friendliness* — 0% cadmium, no disposal problems
- *Size L x W x H* — 8.5 x 2.1 x 0.7 in. (215 x 53 x 19 mm)
- *Weight* — 18.4 oz. (515 g)
- *Nominal Voltage* — 10.8V
- *Rated capacity* — 3.8 Ah nominal
- *Hours of Operation* — 8+ hours with EL display at 30% intensity , 7+ hours with a Monochrome LCD display using 2 Ni-MH battery packs

Narrow Keyway

2" Wide
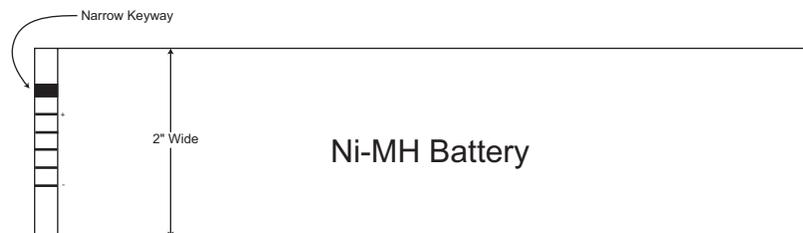
Ni-MH Battery

1.6 Li-Ion Battery Pack Characteristics

- *Higher capacity* — up to 60% longer run time than ordinary Ni-MH batteries of equivalent size
- *Fast Charge* — approximately 6 hours
- *Long cycle life* — up to 300 charge/discharge cycles
- *Temperature Range (charging)* — 32°F to 104°F (0°C to 40°C)
- *Temperature Range (operating)* — -4°F to 140°F (-20°C to 60°C)
- *Temperature Range (storage)* — -4°F to 122°F (-20°C to 50°C)
- *Environmental friendliness* — 0% cadmium, no disposal problems
- *Size L x W x H* — 8.5 x 2.3 x 0.9 in. (215 x 59 x 23 mm)
- *Weight* — 17.6 oz. (493 g)
- *Nominal Voltage* — 10.8V
- *Rated capacity* — 6.6 Ah nominal
- *Hours of Operation* — 7+ hours with EL display at 30% intensity , 6+ hours with Monochrome or Color LCD display

Wide Keyway

2¼" Wide
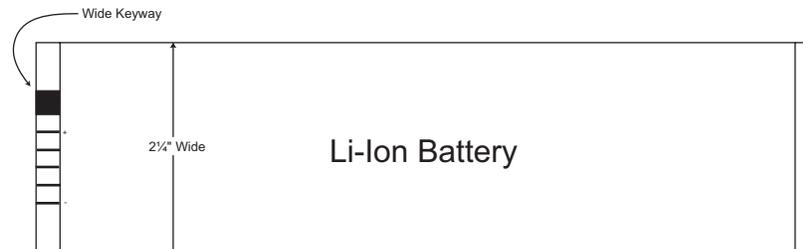
Li-Ion Battery

1.7   Charging the Ni-MH/Li-Ion Battery Pack

Proper charging of the Ni-MH/Li-Ion battery packs is critical for overall life and performance. The **Universal Battery Charger** *(UBC)* will charge either the Li-Ion battery used in the single battery instruments or both Ni-MH batteries in the dual battery instruments. The selection of charging system is made by the detachable cable to instrument connection. The two instrument categories have very different, non-interchangeable connectors to prevent an incorrect connection. Note that the UBC to instrument cables are detachable and replaceable as catalog items.

The charger also functions as a battery eliminator to operate the instrument from the AC power source. Batteries do not have to be installed to operate the instrument from AC. When operated from the UBC without a battery installed in the instrument, disregard any battery charge status indications from the UBC charge indicator. The instrument can be operated while a Li-Ion battery is being charged, but is not recommended while charging Ni-MH batteries or operating scanners.

1.7.1   *UBC Specifications*

Power Requirements: 100 to 240 volts, 47 to 63 Hz

The UBC contains an internal fuse.

Nickel Metal Hydride battery charging system: Sequentially charges two DR-35 style (Ni-MH) batteries. Charges at approximately 1 ampere rate. A pair of 3.8 AH batteries take about 8 hours to fully charge.

Lithium Ion battery charging system: Charges one Li-Ion battery. Charges at approximately 1.5 ampere rate. A 6.6 AH battery charges in approximately 6 hours.

Temperature range: Batteries should be charged between 40° to 100° F (4° to 38° C) for best results.
If the batteries become too hot, the battery charger will terminate the charging process.
If the batteries are being charged while using the instrument, the heat from normal operation of the instrument may cause the battery charger to terminate the charging process before the batteries are fully charged.
To start a charge cycle, the charger can be reset by disconnecting and reconnecting either the instrument or AC power to the UBC.

1.7.2   *Charger Status Indicators*

The charger status is indicated by a red/green LED lamp

The light may blink red or green for a few seconds when first connected to either AC power or an instrument. It will then light steady red as the charging process starts. This is normal as the circuits initialize. If a problem is detected during charging, the light will blink red. Reset the charger by disconnecting the AC power for a few seconds and re-connect. If the problem persists, service is required.

UBC Charger (P/N #9522153)

Charge Status	Light Code
No Battery	OFF
Charge Error	Blinking red
Charging	Red
Charging Complete	Green

1.7.3   *Charger Operation Instructions*

Connect the UBC to a source of AC power

Connect either the single battery Li-Ion or dual Ni-MH cable to the instrument and charger.

Ni-MH batteries: The red charging indicator will light, indicating that the batteries are charging. The charger will charge one battery and automatically switch to the second battery when the first is charged. The indicator will turn green when both batteries are charged. If only charging one battery, the green "charge complete" indicator will not light. The red charging lamp will go out when the battery is charged. Ni-MH batteries generate heat while in use, especially during charging. This heat, added to that generated by the instrument, can cause the charger to terminate the charge cycle before the batteries are fully charged. It is not recommended that NiMH batteries be charged while operating the instrument, especially with scanners as these demand more power and create more heat inside the instrument. This is not due to power supply capacity, but heat build up within the instrument.

Ni-MH batteries receive a continuous trickle charge whenever they are connected to the UBC. If the instrument is being used on AC power for long periods of time, the batteries should be removed from the instrument. They should be re-installed and recharged and then removed at regular intervals to keep them fresh. 30 to 60 day intervals are recommended.

Lithium-Ion batteries: The red charging indicator will light, indicating that the batteries are charging. The indicator will turn green when the battery is charged.

The charger circuits can be reset if a problem occurs by disconnecting either the AC power for at least 15 seconds or the UBC to instrument cable (either end) and then re-connecting. Li-Ion batteries are sensitive to over charge. For this reason, the full charge detection system is very sensitive and may shut off the charging process before the charge is complete. If this happens, reset the charger.

During use, the UBC case will become warm.

The charger is designed to shut off after a Li-Ion battery is fully charged (the instrument power is always available). It does not provide a maintenance charge, because Li-Ion batteries can be damaged by trickle charging. To recharge a Li-Ion battery, reset the charger by either disconnecting the AC supply or instrument for a few seconds to reset the charger circuit. Li-Ion batteries have a long shelf life and should only require recharging after many months of storage if not used.

1.7.4   *Battery Safety*

Old batteries that will no longer deliver satisfactory service should be disposed of in a legal and environmentally friendly manner. In the USA, call 1-800-8BATTERY for the nearest battery recycle center. If there is no convenient battery recycle center, the batteries may be returned to Staveley Instruments for proper disposal.

No battery should be disposed of by fire or abused by puncturing its case or disassembled. All batteries contain potentially hazardous chemicals, however neither Ni-MH or Li-Ion batteries contain lead, cadmium or mercury.

Lithium-Ion batteries contain an internal safety circuit. Both Nickel-Metal Hydride and Lithium-Ion batteries contain internal fuses. If this fuse blows or the safety circuit shuts off the battery, the battery is no longer fit for service. The internal safety circuits are not serviceable.

Staveley Instruments purchases batteries from reputable vendors. Although Staveley Instruments tests and qualifies the batteries for use in Staveley products, Staveley can not guarantee that batteries obtained from other sources will be satisfactory or that Staveley supplied batteries will work in non Staveley products.

The Universal Battery Charger is designed to work with Staveley equipment *only.*

1.7.5   *Battery Characteristics*

Most batteries will not deliver their full charge on first use or after extended storage. Use them until the instrument shuts off after full discharge (automatic low battery shut off) and recharge. This will recondition the battery. This is especially prudent with Ni-MH batteries.

The battery is considered by the manufacturer to be beyond its service life when it delivers less than 80% of its rated capacity. A Ni-MH battery should have a life expectancy of 500 charge/discharge cycles and Li-ion batteries, 300 cycles. These specifications are obtained under laboratory conditions and real world usage will be different.

Battery life will be prolonged if they are not subjected to harsh temperatures, either hot or cold, and stored in a charged condition. Ni-MH batteries should be recharged periodically. They should not be left in the instrument when not being used over extended time.

Batteries have reduced capacity at low temperatures. Exact percentages are not specified but operation below freezing is not recommended.

Newer versions of Li-Ion batteries, also known as "SMBus Smart Batteries," have a microprocessor built into them that monitors the batteries usage and displays the condition on a gas gage in the battery. It is possible to accumulate errors over time due to temperature extremes, aging, self discharge, and other factors.

The gas gage in the battery is not the same as the one in the instrument. There is no way for the instrument to read the gas gage in the battery.

The Li-Ion external charger has a "recalibration" feature that charges, discharges, re-charges, and stores updated information in the microprocessor within the "SMB" capable batteries. This process is only needed when the gas gage in the battery does not show the proper information. Examples like after running the instrument for a short time and the battery gas gage has one or no bars showing or when fully charged, the gas gage has four or less bars showing.

Refer to the instructions provided with the external charger for proper operation and usage.

1.7.6   *UBC Spare Parts*

Part Description	Part Number
Universal Battery Charger (UBC)	9522153
DIN connector cable for single battery instruments (Li-Ion battery)	9122229
7 pin Fischer cable for dual battery instruments (Ni-MH battery)	9122230
AC power cable (US three prong to IEC320)	0205959
AC power cable (UK 13 amp to IEC320)	0222159
AC power cable (Australian 3 conductor to IEC 320)	0222245
DR35 Nickel Metal Hydride Battery	0119447
Lithium Ion Battery	0119451

NOTE:

Scanners draw enough current from the batteries to significantly shorten battery life and operation of the instrument. Loading a scanner can activate the automatic low battery shutoff circuit when the batteries are nearly discharged.

1.8   Operating Environment

The Nortec® 2000D is designed as a portable instrument and, as such, requires no special site preparation before operation. When operating, the instrument should be firmly supported 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.

IMPORTANT!

The test instrument and reference standard should be allowed to stabilize to the same temperature as the parts or material to be tested. To check for temperature drift, take several readings at timed intervals until the values have stabilized. Always check the calibration before taking a reading.

A 15 minute warmup period before calibration is recommended.

NOTE:

Poor quality or excessively long cable, while not detrimental to the instrument, can adversely affect signal-to-noise ratio. For best results, use quality cables no longer than necessary for the operation.

2.0 Nortec® 2000D Technical Data

What's in this section?

2.1   Nortec® 2000D Technical Specifications
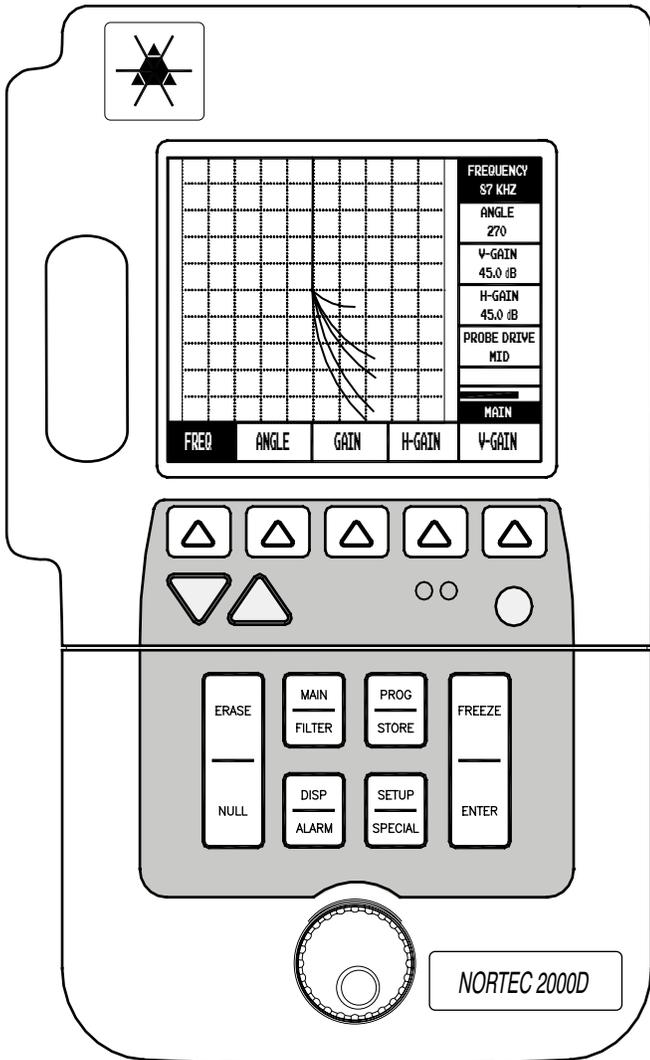
2.1   Nortec® 2000D Technical Specifications

Basic Performance

Frequency Range   100Hz to 12MHz

Gain   0 to 90.0dB, readout in 0.1dB steps. Horizontal and vertical gain may be adjusted separately or together.

Sensitivity   Adjustable to 200 volts per ohm. (High probe drive)

Flaw Response   0 to 2000Hz nominal.

Digitizing Rate   6000 samples/sec. maximum

Rotation   Variable from 0 to 360° in 1° steps.

Sweep   Variable from 0.005 to 4 seconds per division

Low Pass Filter   10Hz to 500Hz with 1Hz increments, 500Hz to 2000Hz in 50Hz increments, WB setting of approx. 4KHz. Greater than 4 pole response.

High Pass Filter   0 (dc), 2, 4, 6, 8, &10 to 500Hz in 1Hz increments. Two pole response available in frequency 1 only.

Probe Drive   Adjustable in three steps (low, mid, & high) corresponding to 2,6, and 12 volts peak to peak into 75Ω, ±0.5 volt.

Null   Three-stage digital null.

Variable Persistence   Screen persistence can be varied from 0.1 to 5 seconds in 0.1 second steps, or the operator may select a complete periodic screen erase at intervals of up to 1 minute. Basic stored screen time is infinite with manual erase.

Probe Types   Absolute and Differential in either bridge or reflection configuration, I.D., O.D., Bolthole, Sliding, and Custom Special Product Orders (SPO). Instrument is fully compatible with STAVELEY PowerLink™ Probes.

Scanner Drive   Will drive PS-5AL, MiniMite, Spitfire 2000, or RA 2000 scanners at the following speeds:

PS-5AL scanner — 40 to 240 rpm
MiniMite scanner — 600-3000 rpm
Spitfire 2000 — 600 to 3000 rpm
RA 2000 — 600 to 2400 rpm

Alarms   Alarms may be individually set to trigger when the signal enters the alarm area (positive polarity) or is outside the alarm area (negative polarity).

Alarm Modes   Impedance Plane Display. 1 to 3 independent box gates. 1 polar (circular) gate. Sweep Display — high and low threshold gates.

Waterfall Display   4 to 64 lines with 32 lines max. display simultaneously.105 to 210 points/sweep recorded. Active only with PS-5AL scanner.

Conductivity Accuracy   ±0.5% IACS accuracy from 0.9% to 62% IACS

±1.0% IACS accuracy over 62%. Liftoff accuracy from 0 - 15mil ±1mil. Conductivity measurements with greater than 10mil of lift-off have reduced accuracy.

Basic Performance (cont'd)

**Non-conductive
Coating
Thickness**   Can measure non-conductive coating thickness from 0.00" to 0.025". Accuracy ±0.001" over 0.00 to 0.015"

**Trace
Storage**   Up to 20 different traces can be stored for recall at a later time. These locations may store any combinations of frozen screens or movement of the impedance spot for up to 60 seconds.

Capture of 2.5 to 60 seconds of data, sweep replay or waterfall replay. Waterfall storage may require more than one (1) storage location. The date and time of storage is recorded and available for the operator to view. Each of the 20 locations may be labeled with alphanumeric names up to 29 characters long.

**Program
Storage**   120 instrument setups may be saved and recalled. The date and time of storage are recorded and available for the operator to view. Each of the 120 locations may be labeled with alphanumeric names up to 29 characters long. The instrument should maintain program storage for at least one (1) year with the batteries removed, providing the internal memory backup battery is functional.

**Serial
Interface**   RS-232 compatible serial interface, adjustable from 2400 to 57600 baud, with 9600 baud as the default setting.

Communicates with external computer or serial printer. All instrument parameters except power ON/OFF may be controlled through the serial interface. In addition, all program and stored screen locations are accessible through this interface.

Printout   Hardcopy printout is available with optional serial printer. Additional printers may be compatible with an optional serial to parallel converter. Text on the printout may be customized by the user from either the front panel or an external computer.

**Supported
Printers**   Canon Inkjet, Epson compatible, Pentax Pocket Jet, Pentax II Pocket Jet, and other HP-PCL compatible.

Inputs / Outputs

Power 7-pin connector (2000D), 8-pin connector (2000D+) to operate the instrument from AC power and charge the internal batteries.

RS232C DB9P connector for bidirectional serial data by way of RS232C links to external computers, terminals, or printers.

Outputs DB9F connector provides analog out for vertical and horizontal signals (±5V, 10mA max. 1V per/div.)on both Frequency 1 & Frequency2 and 5TTL compatible (3V logic) active high alarm output.

Probe Connector 16 pin LEMO connector with flush mount adapters.

Additional Features

Report Fields User defined 40-character report header, up to 7 user defined 40-character report fields and 26 character labels, up to 3 user defined 26 character report entries may be downloaded to the RS232 port or entered through the report edit function.

Clock, calendar time, and date information stored and printed with each waveform. Instrument ID, manuf. name, and model printed with each waveform. International menu selectable languages including English, Spanish, French, and German

Conductivity

Frequency 60kHz or 480kHz

Probe Type Staveley Conductivity Probe

Digital Conductivity Specification Digital conductivity display from 0.9% to 110% IACS. Accuracy within ±0.5% IACS from 0.9% to 62% IACS and within ±1.0% of values over 62%. Meets or exceeds BAC 5651. Conductivity measurements with greater than 10 mils of lift-off have reduced accuracy.

Alarms Independent high and low limit alarms can be set for conductivity lift-off. The alarms can be set to trigger when the signals are inside the limits (positive) or outside of the limits (negative).

Dual Frequency

Second Frequency 100 Hz to 3MHz, 2nd frequency is an exact division of the 1st frequency in ratios of ½ (F1< 6MHz), 1/4, and even divisors to 1/32.

Display Frequency 1 only, Frequency 2 only, sum of frequencies 1 & 2, difference between frequency 1 & frequency 2, split screen with selected combinations of frequency 1 & 2 and mixed frequencies.

	General

Dimensions   9.5" L x 5.5" W x 3.6" D
(241mm x 140mm x 92mm)

Weight   2000D: 6lbs. (2.7Kg) with batteries installed.

2000D+: 4.6lbs (2.09Kg) with battery installed.

3.6 lbs. (1.6Kg) without batteries.

**Display
(EL)**   EL (electroluminescent), 4.7" x 3.5" (5.7" diagonal) (120mm x 90mm [145mm diagonal]) active display area. 320 H x 240 V pixel display resolution. 72Hz refresh rate.

**Display
(LCD)**   Monochrome LCD (liquid crystal display), 3.0" x 3.8" (5" diagonal) (76mm x 96mm [122mm diagonal]), 320 H x 240 V pixel. 72Hz refresh rate. Backlight is adjustable for different viewing conditions.

**Display
(Color LCD)**   Available as option for 2000D+ models. Color LCD (liquid crystal display), 3.0" x 3.8" (5" diagonal), (76mm x 96mm [122mm diagonal]) 320 H x 240 V pixel. 72Hz refresh rate. Backlight is adjustable for different viewing conditions.

**Operating
Temp**   -4° to 140° F (-20° to 60° C)

**Storage
Temp**   -40° to +176°F (-40° to +80°C)

Power

    DC   Two 10.8V DR35 NiMH batteries (2000D) One 10.8V Li-Ion battery (2000D+), optional "D" cell belt pack, or optional external DR35 pack.

    AC   External charger/adapter. Will fully charge batteries in approximately 6 hours and operate the instrument simultaneously. Line voltage 100 to 240VAC,47-63Hz.

Low Battery   Front panel display, a warning message indicates less than ½ hour operating time remaining.

**Operating
Time**   8 hours typical at 75°F (24°C) with EL display. 7 hours typical with LCD display. Estimated operating time remaining is indicated by an icon on the status display.
With optional belt mounted battery pack, 8 hours typical.

Humidity   MIL-STD-28800 — Safe operation in exposure to Class 3 temperature/humidity environment (-10°C to 55°C at 95% ±5% relative humidity non-condensing).

**Altitude
(Max.
Operating):**   15,000 ft. (4,572 m) above sea level.

**Altitude
(Max. Non-
operating):**   40,000 ft. (12,192 m) above sea level.

**Hazardous
Area
Operation**   Safe operation in explosive atmosphere as defined by Class 1, Division 2, Group D, as found in the National Fire Protection Association Code 70 (NFPA 70), Section 500 and tested using MIL-STD-810E, Method 511.3, Procedure 1.

This page intentionally left blank

3.0 Nortec® 2000D Control Descriptions

What's in this section?

Instrument Controls

This section covers the operational controls of the Nortec® 2000D.

Signal Display

Status Display

Menu Display

Battery Level Indicator

Soft Keys

INC/DEC (up/down arrow) Keys

Alarm LEDs

Power Button

Immediate Execution Keys

Function Keys

VGA Output Connector *

SmartKnob™

FREQUENCY
500 kHz

ANGLE
142°

H-GAIN
64.0 dB

V-GAIN
64.0 dB

PROBE DRIVE
MID

PRESS ENTER

MAIN

FREQ   ANGLE   GAIN   H-GAIN   V-GAIN

ERASE   MAIN / FILTER   PROG / STORE   FREEZE

NULL   DISP / ALARM   SETUP / SPECIAL   ENTER

NORTEC 2000D

* only available on 2000D+ models. This connector is only active when a color display is installed.

3.1   Power Button

The *Power* button toggles instrument power on and off. Immediately after power is turned ON, an initialization routine is started. The instrument's microprocessor determines the instrument configuration, performs power up diagnostics and calibration, and readies the instrument for operation. The instrument will normally attempt to restore its last configuration, but can be made to load factory default settings by pressing and holding the ERASE key while the instrument powers up.

The display contains a symbol indicating remaining battery life. When the unit has approximately one half hour operating time remaining a status message in the battery level window indicates a low-battery condition. A low battery cut-off circuit will automatically switch off the unit to protect the batteries from excessive discharge.

> ### *NOTE:*
> If the instrument is powered off, then immediately back on, there is a possibility that the display will remain blank. To remedy this, turn off the instrument for ~30 seconds to allow the microprocessors to fully reset.

3.2   Soft Keys

The *soft keys* located directly below the display are used to select instrument parameters for adjustment (using the arrow keys and the SmartKnob™). For some parameters the *soft keys* when pressed repeatedly will toggle through specific parameter settings (discrete steps). The first time a *soft key* is pressed, the parameter located in the display box directly above the key, will be highlighted using inverse video.

3.3   INC/DEC Arrow Keys

The *Increase/Decrease arrow* keys may also be used to change parameter settings.
The parameter being adjusted will be displayed in inverse video directly above one of the menu soft keys.

3.4   LCD/EL Display

The instrument may be configured with either an Electroluminescent (EL) display, Monochrome or Color Liquid Crystal Display (LCD). (Color LCD only available on 2000D+ models)   All display types offer 240H X 320V resolution.

The LCD/EL Display shows the eddy current signal, menu sidebar, status bar, annunciators, and when required full screen text.

In normal operation, the left side of the display shows the eddy current signal and is divided into 10 graticule divisions in both directions. The display 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.
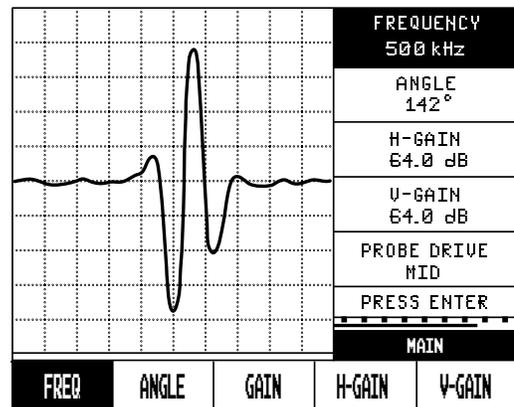
Figure 3-1. *N2000D Display*

To the right of the impedance plane display area is the menu sidebar. The menu sidebar displays parameters that can be adjusted.

The menu displayed is determined by which *menu soft key* is pressed. To select a parameter function, press the *menu soft key* corresponding to the function. That menu parameter will be highlighted. Depending on the characteristics of the function selected, the function can be adjusted or executed using the SmartKnob™ or by pressing the *menu soft key*. Certain functions may require pressing the ENTER key to continue, this will be highlighted on the Status Bar.

The Status Bar is a multi-purpose text display located across the bottom of the screen. Alarms and battery annunciators, program information, and status messages are displayed in inverse video on this line.

> ## CAUTION!
> **The Nortec® 2000D has user-interchangeable displays. Failure to turn off power before exchanging displays will result in loss of stored programs, and may cause other memory corruption errors.**

TURN OFF POWER
BEFORE CHANGING DISPLAYS

LOOSEN
SCREWS
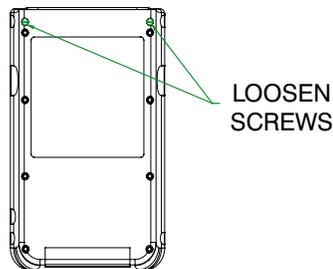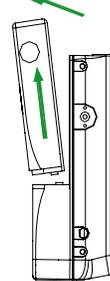
DISPLAY REMOVAL

Figure 3-2. *Display Removal*

> ## WARNING!
> **DO NOT attempt to plug a VGA monitor into the 15 pin "D" connector. This will result in a damaged instrument and/or VGA monitor.**

NOTE:

Placing the LCD display in direct sunlight will result in temporary fade due to the elevation of internal liquid temperature beyond design specification. Shade or angle the display away from the sun to assure optimal function.

3.4.1   *EL Hi-Brite Display*

The EL Hi-Brite Display feature is capable of switching from a 100% to 30% brightness level. This feature is accessed by highlighting the Contrast block in the (Special Menu) and then by pressing the ENTER button.

NOTE:

The EL Hi-Brite Display may go blank for approximately 1 second after connecting or disconnecting the Universal Battery Charger. This is normal operation.

3.5   SmartKnob™

The primary function of the SmartKnob™ is to change the selected instrument parameters. The parameter being adjusted will be displayed in inverse text directly above one of the *menu soft keys.* In some instances the SmartKnob™ may be used to respond to various prompts.

3.6   Immediate Execution Keys

The *Immediate Execution* keys (see ***Figure 3-3,*** next page) perform a specific function as soon as the key is pressed. For example, 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 LCD/EL display.

The **Freeze** key allows the operator to temporarily store the on screen signal. To activate, press the Freeze key once. To clear, press the Freeze key again. However, if in the Impedance mode, press the Erase key to clear.

The **Enter** key may be used to execute or confirm an instrument operation or respond to an instrument prompt.

3.7   Function Keys

The *Function* keys (again, see ***Figure 3-3,*** next page) are used to activate an operating menu on the instrument. These keys are normally pressed first before changing values using the SmartKnob™ or *menu soft keys.*

The basic functions are found in the **Main /Filter** menus. These are the functions that affect the basic eddy current operation of the instrument.

The **Program/Store** menus contain all the functions to store, recall, name, and delete data & programs.

The **Disp/Alarm** menus contain all the functions for alarm operation, null position, sweep settings, and erase functions.

The **Setup/Special** menus contain controls for parameters relating to the initial user settings, alarm dwell/ scanner RPM and sync angle, waterfall settings, report set-up, clock, reference memory, and other limited use features.
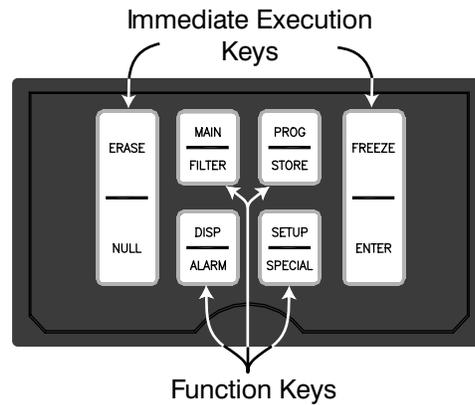
Figure 3-3. *Immediate Execution/Function Keys*

MAIN	Provides the menu that controls Frequency 1 and Frequency 2, Angle, Gain, H-Gain, and V-Gain parameters.
FILTER	Enables setting of the Low Pass and High Pass filters, Continuous Null, and Auto Liftoff.
PROG	Allows access to Store, Name, Erase, Print, and Recall of 100 test setups and to recall or print any of the test setups used in the 20 stored display locations.
STORE	Allows access to functions for Saving, Recalling, Naming, and Printing stored displays, up to 20 separate sets of displays may be accessed for review.
DISP	Control settings that set the way in which the eddy current signal is displayed on the screen, as well as Timed Erase.
ALARM	Contains the menu that relates to the instrument alarm setup and parameters.
SETUP	Used to set the Date and Time, and to clear all or part of the instrument settings, data storage areas, programs, custom report text, and probe drive settings.
SPECIAL	Allows access to the special functions for the instrument.

3.7.1   *Menu Tree*

Nortec® 2000D Menu Tree

MAIN	PROG	DISP	SETUP
FILTER	STORE	ALARM	SPECIAL

| FREQ ANGLE GAIN H-GAIN V-GAIN | LPF HPF CONT NUL A LIFT | RECALL ERASE NAME PRINT STORE | RECALL ERASE NAME PRINT CAPT . . . | SWEEP V-POS H-POS SCRN . . . DUAL . . .* | TYPE +/- OFF HORN SIZ/POS BOX 1,2,3 | VERSION ALM DWL RPM SYNC ANG WTRFL . . . |

FREQ 2
ANGLE 2
GAIN 2
H-GAIN 2
V-GAIN 2   *

FREEZE
CAP TIME
CAP ONCE
CAP CONT
CAP WFAL

MAIN DSP   *
SPL SCRN
TRACKING

PERSIST
DISP ERS
SWP ERS
DOT/BOX
GRAT

WTRFL
SWP MIN
SWP MAX
WTRF ANG
DEPTH

* when dual frequency
mode is selected

** only appears on '+'
instruments with a color
LCD display installed

REPORT	CLOCK	DEFAULT		
LANGUAGE ENGLISH	BAUD 9600	PRINTER HP-PCL	LOCK OFF	CONTRAST 15
FREQ SINGLE	REF MEM OFF		PRBE DRV MID	COLOR** 1

3.8   Basic Functions

•	GAIN	•	DISPLAY
•	FREQUENCY	•	SWEEP
•	ANGLE	•	POSITION
•	FILTER	•	SCREEN MENU
•	CONT NULL	•	PERSIST *(variable persistence)*
•	AUTO LIFT	•	SWEEP ERASE
•	NULL	•	DISPLAY ERASE
•	ERASE	•	DOT/BOX
		•	GRATICULE

GAIN   *Gain* for the Nortec® 2000D 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) PROB DRV MID, instrument sensitivity is 100 volts/ohm as measured on the side panel horizontal and vertical outputs, or 100 screen divisions per ohm on the display. (10 division display represents an impedance change of 0.1 ohm)

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 pressing the INC/DEC arrow keys. With each press of the GAIN key, the gain increases by 5 dB. This can be both vertical and horizontal together, or independently.

To adjust both horizontal and vertical gain, press the MAIN key, then the GAIN *menu soft key*, then adjust with the SmartKnob™ or toggle the soft key. The selected value will be applied to the horizontal and vertical gain and the difference between horizontal and vertical gains will remain the same, i.e. they will "track" together. The instrument gain adjustment range is from 0dB to 90dB.

To adjust the horizontal gain without changing the vertical gain, press the H GAIN *menu soft key*. Now, any value entered will adjust only the horizontal gain. Likewise, to adjust only the vertical gain, press the V GAIN *menu soft key.* The SmartKnob™ will now adjust only the vertical gain.

FREQUENCY   The *Frequency* setting determines the frequency of the eddy current probe drive signal. This is adjustable from 100 Hz (0.1 kHz) to 12 MHZ. Frequency may be entered into the instrument by either rotating the SmartKnob™ or pressing the INC/DEC arrow keys.

To adjust the frequency, simply press the MAIN key to enter the MAIN menu. Press the FREQ *menu soft key*, then adjust to the desired value.

ANGLE   The *Phase Angle* (or rotation) of the eddy current signal is set in the ANGLE menu. Rotation may be set in 1 degree increments from 0 through 359 degrees. The phase angle may be adjusted using the SmartKnob™ or using the INC/DEC arrow keys.

To adjust phase angle, simply press the MAIN key and the ANGLE *menu soft key*, then enter the desired value.

FILTER   The *Filter* menu allows adjustment of the high or low pass filters. Low pass filters may be set from 10 Hz to 500 Hz with 1 Hz increments and then 50 Hz increments up to 2000 Hz. High pass filters may be set from 0 Hz to 500 Hz with 1 Hz increments.

Low pass: 10 Hz, - 500 Hz, 550 Hz - 2000 Hz, WB (Wideband)
High pass: 0 Hz - 500 Hz

Filter settings may be entered using the SmartKnob™ or by pressing the corresponding *soft key.*

Press the FILTER key to enter the FILTER menu. Select either the LP FILT or the HP FILT to adjust the filter settings.

Once the filter has been selected, adjust the SmartKnob™ to select the desired value.

CONT NULL   Allows a very low frequency high pass filter to be turned on. This filter has either a 0.1 Hz, 1.0 Hz, 5.0 Hz, or 10 Hz high pass filter when turned on.

AUTO LIFTOFF   Auto Lift (auto liftoff) will automatically adjust the phase angle produced from the liftoff. To access the Auto Lift feature, go to the FILTER menu and press the Auto Lift *softkey.* If Auto Lift is highlighted, press the ENTER key to start the Auto Lift compensation process.

To use Auto Lift:

• Using an eddy current probe, maintain contact with the material, and press Auto Lift.
• The probe will Null... when LIFT appears in the display, slowly tilt the probe off the material.
• When the instrument beeps, the Auto Lift process is finished. The liftoff trace now points toward the left of the screen horizontally.

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* function will perform a screen erase when the ERASE key is pressed during normal operation. This operation clears all data from the screen and is useful to eliminate screen clutter. To erase the screen at any time the eddy current signal is displayed, press the ERASE key.

NOTE:

The instrument is also capable of automatically erasing the screen by using the *ERASE* or *VARIABLE PERSISTENCE* functions.

DISPLAY   The *Display* feature contains menu parameters that control the Sweep display, and signal position. The Screen menu allows access for adjusting the persistence, erase, dot shape, and graticule. The Display menu is accessed by pressing the DISPL key. If in dual frequency mode, the Display menu allows access to the dual display menu as well.

SWEEP   The *Sweep* feature on the Nortec® 2000D instrument is controlled under the Display menu. Sweep moves the signal horizontally at a fixed rate selected from the front panel, continually retracing across the screen. External synchronizes the sweep to the rotation of the scanner. When sweep is turned off, the display reverts to the impedance plane mode of operation.

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 0.055 seconds/division and longer the display will update in an incremental fashion. In **split-screen** mode, External Sync is on the *left,* and Impedance Plane is on the *right.* Any adjustment to the Impedance Plane signal is linked to the External Sweep display.

To change the Sweep mode, press the DISP key. Press the SWEEP *menu soft key* and adjust the time per division by rotating the SmartKnob™ or toggle the INC/DEC arrow keys.

POSITION   The *Position* feature 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 DISP key. Select the desired axis by pressing either the V POS or the H POS *menu soft key* corresponding to vertical or horizontal position, respectively. Once the axis has been selected, then rotate the SmartKnob™ to change position.

SCREEN MENU   The *Screen* Menu contains parameters that control variable persistence, erase, dot shape, and graticule. This menu is accessed by pressing the DISP key. Then press the SCRN... *menu softkey*.

PERSIST   *Persist (Variable Persistence)* is a mode of automatic screen erase. It allows the operator to set an impedance plane (not sweep) display so that the signal traces on the screen will be erased after a selected amount of time. This time may be set from 0.1 to 5 seconds, in 0.1 second increments.

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 manually erasing the screen. This function is not allowed when DISPLAY ERASE is activated. Be sure SWEEP function is off.

To select the variable persistence function, press the DISP key, select the SCRN... *menu soft key,* and then select PERSIST. Rotate the SmartKnob™ or toggle the INC/DEC arrow keys until the menu display reads the desired value.

PERSIST may be turned off by rotating the SmartKnob™ counterclockwise or by toggling the INC/DEC arrow keys until PERSISTENCE OFF is displayed on the menu display.

SWEEP
ERASE   The *Sweep Erase* function erases the sweep display once per trace. In the Sweep Mode, traces that are set for 0.055 seconds (55 milliseconds) per division or longer, 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 erase function only applies to the sweep mode. Refer the above explanation of SWEEP for further information on this function, and how to activate it. When the erase function is turned off, the sweep display will have to be erased manually.

When the instrument is loaded with its default settings LOAD DEF, the Sweep Erase function is already ON, which is the normal mode of operation.
To turn the Sweep Erase function on or off, select the DISPLAY menu by pressing the DISP key. Go to the screen menu by selecting the SCRN... *menu soft key.* Press the SWP ERS key and turn the SmartKnob™ or toggle the INC/DEC arrow keys until the menu display reads SWP ERS ON.

DISPLAY
ERASE   *Display Erase* is a function that will erase the eddy current display at intervals set by the operator. The available range for the display erase function is from 0.1 to 60 seconds in 0.1 second intervals. This function differs from variable persistence in that the screen is completely erased at each interval, rather than incrementally erased.

The Display Erase function is not allowed when variable persistence is turned on.

To activate Display Erase, select the DISP key, press the SCRN... *menu soft key,* and activate the DISP ERS *menu soft key* by pressing it. The desired value may be entered by rotating the SmartKnob™ or toggling the INC/DEC arrow keys until the desired value appears on the menu display.

Display Erase may be turned off by rotating the SmartKnob™CCW until DISP ERS OFF appears on the menu display.

DOT/BOX   The *Dot/Box* feature allows the operator to change the shape of the signal focal spot. The default is the larger square box. A smaller dot is also obtainable.

To change the size of the dot, enter the screen menu by pressing DISP key, then SCRN...*menu soft key.* Once the DOT/BOX *menu soft key* has been selected, the SmartKnob™ or the INC/DEC arrow keys may be used to select between a larger box and a smaller dot.

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

3.9   Alarm Operation

The Nortec® 2000D will operate using either a box or polar (circular) alarm in the impedance plane mode. 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. An internal audible alarm horn may be turned on, and will respond to the alarm condition subject to the dwell function settings. Finally, flashing LEDs will also display in concert with the alarm condition.

Only one alarm type, either box or polar, may be used at a time in impedance plane mode. One polar alarm is available, but three simultaneous box alarms may be used at a time. When the instrument is placed into the sweep mode, only a threshold (sweep) alarm is available.

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 are controlled from the ALARM menu. The ALARM key enables the user to enter the ALARM menu to turn the alarm on/off, set its type, polarity and dwell. By going one menu deeper by pressing the SIZ/POS *menu soft key*, the extent and position of the alarm can be defined. The SmartKnob™ or INC/DEC arrow keys are used to change actual numeric values for the alarm thresholds.

ALARM TYPE   Prior to adjusting the alarm, the proper *Alarm Type* needs to be selected. The available alarm types are the box, polar (circular) and sweep.

To select the alarm type, press ALARM key, then press the TYPE *menu soft key*. Either toggle the INC/DEC arrow keys or rotate the SmartKnob™ to cycle through the alarm types.

Each alarm is turned on/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/off and set to positive or negative polarity through the ALARM menu. For further details refer to the individual alarm functions on the next pages.
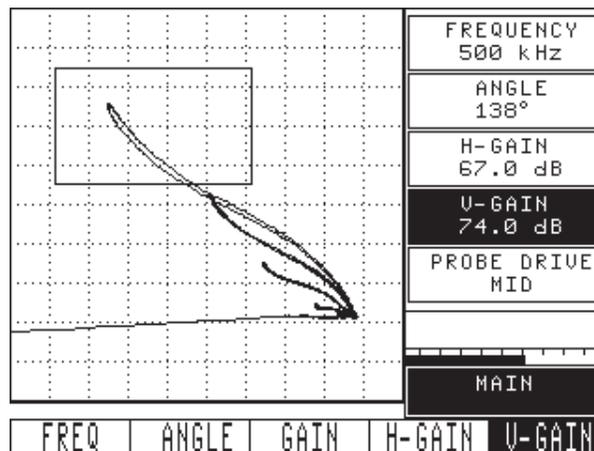
Figure 3-4. *Box Alarm Display*

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. (see **Figure 3-4,** above)

The box alarm on the Nortec® 2000D 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 BOX *menu soft key* repeatedly until the menu bar 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 pressing the +/- /OFF *menu soft key* and rotating the SmartKnob™ or pressing the INC/DEC arrow keys .

To adjust the limits of the alarm go to the SIZE/POS menu by pressing the SIZE/POS... *menu soft key*. The side of the alarm to be adjusted may be selected by pressing either the TOP, BOTTOM, RIGHT, or LEFT *menu soft key.*

Once the side to be adjusted has been selected, the SmartKnob™ will allow movement of that side. The menu display will indicate as a percentage of the screen the location of the side of the alarm.

Once in the SIZE/POS menu, the entire alarm box may be moved by using the MOVE *menu soft key*. Press the MOVE *menu soft key* to select vertical or horizontal alarm movement. When the desired direction of movement is displayed, rotate the SmartKnob™ until the alarm box is positioned correctly. The axis of movement may be changed by pressing the MOVE *menu soft key* as needed.
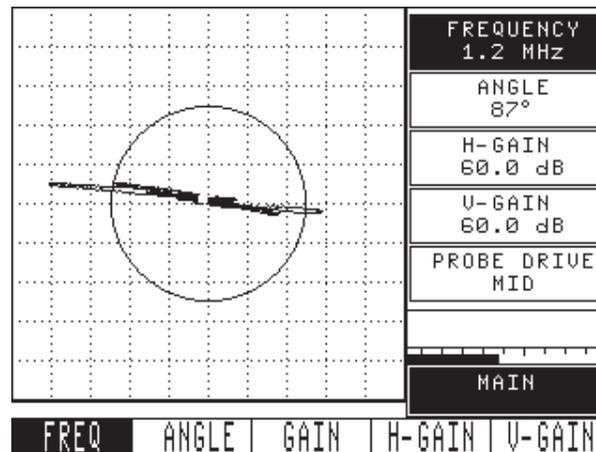
Figure 3-5. *Polar Alarm Display*

**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. (see *Figure 3-5.*)

To activate the polar alarm, make sure the alarm type is set to polar as described above. Then toggle the +/- /OFF *menu soft key* to select positive or negative polarity as desired.

Once the alarm appears on the screen, its size may be adjusted by selecting the SIZ/POS... *menu soft key*. Press the RADIUS *menu soft key* and rotate the SmartKnob™ until the alarm is the desired size. The alarm may be moved by selecting the desired direction by pressing either the H MOVE or the V MOVE *menu soft key*, then turning the SmartKnob™ to move it. The menu display will indicate the screen position.
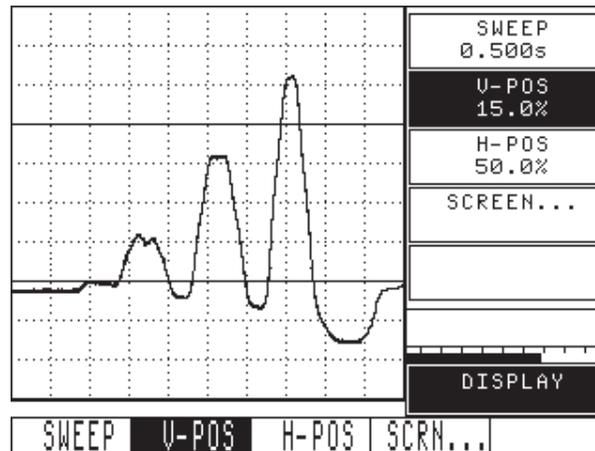
Figure 3-6. *Sweep Alarm Display*

**SWEEP
ALARM**   A simple high/low threshold alarm is available, when the Nortec® 2000D instrument is oper-
ated in Sweep Mode. This alarm is automatically selected when the display mode is set to
Sweep Mode. (see **Figure 3-6.**)

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.

The ALARM key allows the operator to turn the alarm on/off and set polarity. To activate the
alarm, press ALARM and press the *+/ – /OFF menu soft key*, rotate the SmartKnob™ or
press the INC/DEC arrow keys until the menu readout displays POSITIVE or NEGATIVE as
appropriate.

The SIZ/POS menu allows the operator to adjust the top and bottom threshold. Pressing the
TOP or BOTTOM *menu soft key*, followed by rotation of the SmartKnob™ will change the
selected threshold.

**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 Alarm Horn is turned on/off by pressing the HORN *menu soft key* and rotating the SmartKnob™ or pressing the INC/DEC arrow keys until the menu display reads HORN ON.

To turn the horn OFF, select ALARM as above. Press the HORN *menu soft key* and rotate the SmartKnob™ or press the INC/DEC arrow keys until the menu display reads HORN OFF.

**ALARM
DWELL**

***NOTE**:*

Alarm Dwell function is found in the Special Function Menu.

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 0.2 second from 0.0 to 10.0 seconds.

Dwell applies to the Display LEDS, and the Alarm Horn (if on).

To change Alarm Dwell, select the SPECIAL key, then press the ALRM DWL *menu soft key.* Once Alarm Dwell is activated, the value may be entered by rotating he SmartKnob™ or by toggling the INC/DEC arrow keys.

3.10   Dual Frequency Mode

The operation of a Dual Frequency Nortec® 2000D is an extention of single frequency operation. Parameters that are adjustable for the second frequency are Frequency, Gain, and Rotation.   In the SETUP menu, the FREQ selection toggles between SINGLE and DUAL. When this is set to DUAL, two additional menus are available to control the dual frequency specific operations. These two menus are described below.

> ### NOTE:
>
> The Nortec® 2000D instrument always powers up in the **Single Frequency** mode.
>
> Dual frequency must be invoked *each time* the instrument is turned ON.

MAIN 2 Menu   The *MAIN 2 Menu* controls the frequency, phase angle, and gain of the Frequency 2 signal processing path. The second frequency of the Nortec® 2000D instrument must be a fraction (division of an even integer up to 32) of Frequency 1. Thus the second frequency is 1/2, 1/4, 1/6, 1/8 ... 1/32 of Frequency 1. The Nortec® 2000D automatically calculates the appropriate values for Frequency 2. The second frequency is always displayed in the menu in Hz.

FREQUENCY 2   The *Frequency 2* menu option controls the frequency of the secondary frequency. The allowable range for this setting is ½ to 1/32 of the main frequency.

To change the Frequency 2 setting, press the MAIN/FILTER key until the MAIN 2 menu is displayed. Press the FREQ2 *menu softkey*, and adjust the Frequency 2 setting by rotating the SmartKnob™ or toggling the INC/DEC arrow keys.

ANGLE 2   The *Angle 2* option controls the phase angle of Frequency 2. However, if TRACKING is ON (see below), the Angle 2 option controls the phase angle of both Frequency 1 and Frequency 2. The phase angle for Frequency 2 is always displayed.

To change the angle setting for Frequency 2, press the MAIN/FILTER key until the MAIN 2 menu is displayed. Press the ANGLE 2 *menu softkey* and adjust the Frequency 2 angle setting by rotating the SmartKnob™ or toggling the INC/DEC arrow keys.

GAIN 2   The *Gain 2* option controls the gain applied to the frequency 2 signal, or if TRACKING is ON, the gain of both frequency 1 and frequency 2. The gain setting on Frequency 2 is always displayed.

To change the gain setting for Frequency 2, press the MAIN/FILTER key until the MAIN 2 menu is displayed, then press the GAIN2 *menu softkey*. Adjust the gain of Frequency 2 by rotating the SmartKnob™ or toggling the INC/DEC arrow keys.

H-GAIN 2   The *H-Gain 2* option controls the horizontal gain of Frequency 2, or if TRACKING is ON, the horizontal gain of both Frequency 1and Frequency 2. The horizontal gain of Frequency 2 will always be displayed.

To change the horizontal gain setting for Frequency 2, press the MAIN/FILTER key until the MAIN 2 menu is displayed, then press the H-GAIN 2 *menu softkey*. Adjust the gain of Frequency 2 by rotating the SmartKnob™ or toggling the INC/DEC arrow keys.

V-GAIN 2   The *V-Gain 2* option controls the vertical gain of Frequency 2, or if TRACKING is ON, the vertical gain of both Frequency 1and Frequency 2. The vertical gain of Frequency 2 will always be displayed.

To change the vertical gain setting for Frequency 2, press the MAIN/FILTER key until the MAIN 2 menu is displayed, then press the V-GAIN2 *menu softkey*. Adjust the gain of Frequency 2 by rotating the SmartKnob™ or toggling the INC/DEC arrow keys.

DUAL DISPLAY   The second menu associated with the dual frequency mode is the *Dual Display* menu, a submenu of the DISPLAY menu. To access the DUAL DISPLAY menu, press the DISP/ALARM key until the DISPLAY menu appears, then press the DUAL *menu softkey*. The DUAL DISPLAY menu will appear, which has functions associated with displaying the dual frequency eddy current data. The controls are:

MAIN DISPLAY   The *Main Display* controls the data on the main display. The main display is the only display when SPLIT SCREEN is OFF, or the left side of the display when SPLIT SCREEN is ON. The selections available are as follows:

F1   display frequency 1 data
F2   display frequency 2 data
F1+F2   display sum of frequency 1 and frequency 2 data
F1-F2   display difference of frequency 1 and frequency 2 data

To change the MAIN DISPLAY setting, press the DISP/ALARM key until the DISPLAY menu appears, then press the DUAL *menu softkey*. Press the MAIN DSP *menu softkey* and adjust the setting by either rotating the SmartKnob™ or toggling the INC/DEC arrow keys.

SPLIT SCREEN   The *Split Screen* controls whether only the main display is shown, or the main and second display screens are shown in a split screen format. Split screen is only available in Impedence Plane mode, and is automatically set to OFF if the Sweep mode is turned on.

IMPORTANT!

When SPLIT SCREEN is set to ON, variable persistance does **not** function. In addition, alarms are not active when the SPLIT SCREEN mode is ON. However, timed DISP ERASE does work.

Change the SPLIT SCREEN setting, by pressing the DISP/ALARM key until the DISPLAY menu appears, then press the DUAL *menu softkey*. Press the SPL SCRN *menu softkey* and adjust the setting by either rotating the SmartKnob™ or toggling the INC/DEC arrow keys.

If SPLIT SCREEN is ON, the following menu item will appear:

**SECND
DISPLAY**   The *Secnd Display* controls the data on the second display. The second display is the right side of the display when SPLIT SCREEN is ON. The selections available are as follows:

F1	display frequency 1 data
F2	display frequency 2 data
F1+F2	display sum of frequency 1 and frequency 2 data
F1-F2	display difference of frequency 1 and frequency 2 data

Change the SECND DISPLAY setting, by pressing the DISP/ALARM key until the DISPLAY menu appears, then press the DUAL *menu softkey*. Press the 2ND DSP *menu softkey* and adjust the setting by either rotating the SmartKnob™ or toggling the INC/DEC arrow keys.

**ANGLE/GAIN
TRACKING**   The *Angle/Gain Tracking* feature controls either the Angle/Gain parameters (MAIN 2 menu) for both Frequency 1 & 2, or only the Frequency 2 gain and rotation. If this feature is ON, any adjustment to angle affects both frequency 1 and 2 angles, adjusting horizontal gain on the MAIN 2 menu affects both frequency 1 and 2 horizontal gain, and so forth.

To change the ANGLE/GAIN TRACKING feature, press the DISP/ALARM key until the DIS-PLAY menu appears, then press the DUAL *menu softkey*. Press the TRACKING *menu softkey* and adjust the setting by either rotating the SmartKnob™ or toggling the INC/DEC arrow keys.

NOTE:

If both the Main display and Second display are set to display the same data,

only one dot will be live, the other will not move.

3.11   Program Storage

The Nortec® 2000D is capable of storing and retrieving 120 complete instrument setups. The setups are recorded with date and time, and may be named using up to 29 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 by using the PROG function. Additional storage locations numbered *101 to *120 are actually settings saved using the data storage STORE function. These are listed with the stored programs to make it convenient to recall the instrument settings used when data was stored. Notice that the listings are preceded by a * mark to avoid confusing them with regular program settings. These special locations may be recalled, named, and printed from the program menu, but must be stored, and erased from the storage STORE 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 display. The current setting will be highlighted in inverse video. Since there are a large number of storage locations, multiple screens are required to list them all. 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 pressing the appropriate *menu soft key* and then ENTER.

After performing the desired operation, one of the function keys, such as, MAIN/FILTER, DISP/ALARM, etc. 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 select 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 STORE *menu soft key* and press ENTER to store the program. The display screen will be redrawn and the selected location will be listed with no name (blank) with the date on the far right of the display. If it is desired to name the program setting, perform the NAME function outlined in this section.
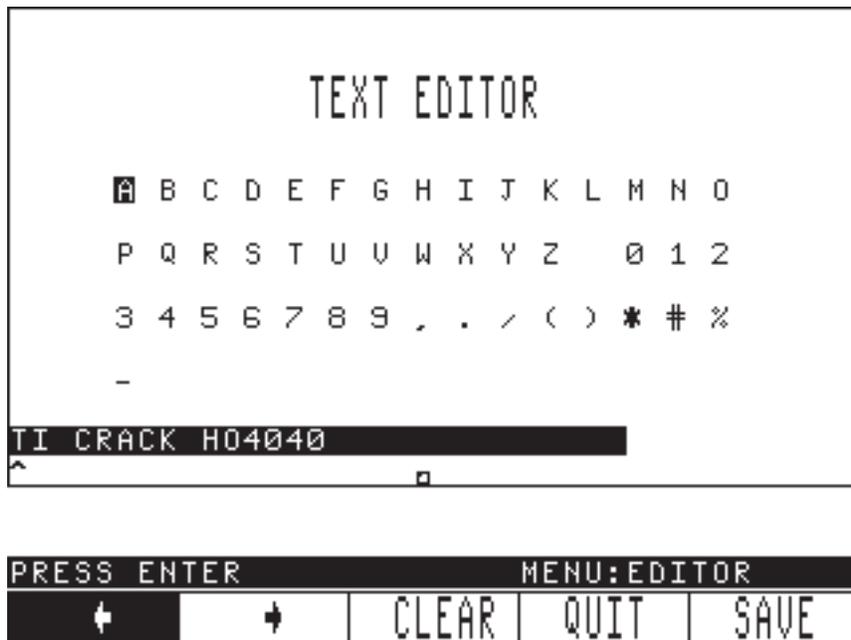
Figure 3-7. *Text Editor*

NAME

The *Name* function allows the operator to enter a name of up to 29 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 the figure on the right will appear, displaying a list of available characters, and a highlighted entry line with an (^) arrow used to point to the current character being entered.

Pressing the CLEAR *menu soft key* will erase the entire line, so new text may be entered. Rotating the SmartKnob™ moves the selection highlight from character to character. Pressing ENTER selects the character and moves the (^) arrow on the entry line to the right one character.

The SAVE *menu soft key* will record the name changes made into the current program setting.

The QUIT *menu soft key* will eliminate any changes made, retain its original value, and exit the NAME function.

RECALL   *Recall* function 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, press the PROG key, then rotate the SmartKnob™ until the display highlights the desired setting.

Once the location has been selected, press the RECALL *menu soft key* then press ENTER to read the program settings into the instrument.

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, press CLR PROG under the SPCL-DEFAULT Menu.

In order to erase a program setting, press the PROG key and then select ERASE. The SmartKnob™ is then rotated until the proper program storage location is highlighted. Once this is done, the ENTER key is pressed. An option to Cancel or Confirm the erase appears in the status bar, rotate the SmartKnob™ or press the INC/DEC arrow keys to select the desired option and press ENTER.

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. If a printer is not properly connected, selecting the print function will cause the error message
* PRINT ERROR * to display on the status line.

Printing a program setting requires first that the desired program number be selected. Then, simply pressing the PRINT *menu soft key* and the ENTER key will start the printout.

3.12   Data Storage

The Nortec® 2000D has an extensive selection of data storage capabilities. Data may be stored using one of three 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*, *captured data or waterfall 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.

```
    1.(EMPTY)
    2.(EMPTY)
F   3.TI CRACK  H04040          11/25/02
C   4.SPO-380G                  11/25/02
F   5.COND CURVE G01924         11/25/02
C   6.CORROSION G01922          11/25/02
F   7.STEEL CRACK G01971        11/25/02
F   8.THINNING G01944           11/25/02
F   9.SCANNER                   11/25/02
   10.(EMPTY)
   11.(EMPTY)
F  12.EEEEE                     12/11/02
   13.(EMPTY)
   14.(EMPTY)
F  15.                          01/09/03
   16.(EMPTY)
   17.(EMPTY)
   18.(EMPTY)
   19.(EMPTY)
   20.(EMPTY)
ENTER TO RECALL        MENU:STORE
RECALL │ ERASE │ NAME │ PRINT │ CAPT...
```

Figure 3-8. *STORE Menu*

Waterfall data is data captured from a waterfall (multiple sweep) display using a PS-5AL scanner. It is the only data that can be modified after it is captured (see Section 3.15 on Waterfall Display). All methods of saving will record the current date and time of storage.

The captured data may be recorded using one of two modes.

1) Capture once starts recording the capture as soon as the operation is selected, and will automatically end when the selected time has been reached.

2) 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 ENTER key.

When the continuous capture is ended, the information stored is the information that was being recorded at the end of the capture.

Once data has been stored through either the frozen, capture or waterfall methods, the following list provides the various options for the stored data.

• Data may be recalled to the screen for viewing

• The data may be printed out on an inspection report

• The instrument settings in effect when the data was stored may be reviewed or restored to the instrument as outlined in Section 3.10, *Program Storage*

• The data and/or instrument settings may be downloaded to an external computer for further processing.

Twenty data storage locations are available. When any of the storage functions are selected, the status line shows both the storage location number and the status of the storage:

The functions available through the STORE key are: Recall, Erase, Name, Print, Freeze, Cap Time, Cap Once (capture once), Cap Cont (capture continuous), and Cap Wfal (capture waterfall).

All data storage may be erased using the Clr Data function under the SPCL-DEFAULT Menu.
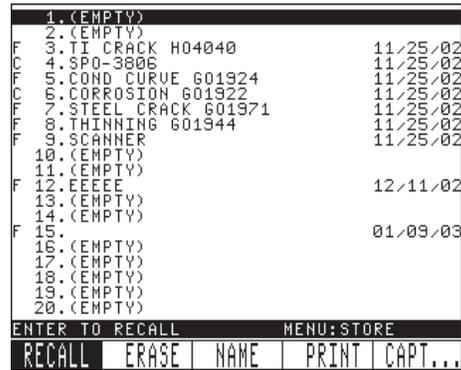
FREEZE The screen *Freeze* function will store the information as it exists on the screen. This is analogous to taking a "snapshot" of the screen, as might be done with an oscilloscope camera.

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

To invoke the freeze function, first press the STORE key and highlight the desired memory location, then press the CAPT...*menu soft key*. To produce the desired curve or trace then press the FREEZE *menu soft key.*

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

CAPTURE TIME *Capture time* is set by pressing STORE, CAPT..., CAP TIME. 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 re-played. 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 LOAD DEF (load default) will reset this function back to 10 seconds.

To set the capture time, first press the STORE key, then the CAPT...*menu soft key*, and finally the CAP TIME *menu soft key*. Once the capture time function is selected, rotate the SmartKnob™ to select a new length of time.

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 STORE key to select an appropriate empty storage location using the SmartKnob™. Press the CAP ONCE *menu soft key* and then the ENTER key.

After pressing the Enter key the capture feature will be initiated. At this time produce the trace or curve to capture. Pressing the STORE key during the capture time will stop the capture, but the data will remain valid up to that point.

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

**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.

To perform a continuous capture function, first press the STORE key and select an empty memory location then press the CAPT... *menu soft key*. Press the CAP CONT *menu soft key* (if not already highlighted.)

Press ENTER to start the capture. The capture will then continue until the ENTER key is pressed.

**CAPTURE
WATERFALL** *Capture Waterfall* allows storage of waterfall data that has been captured in the Waterfall submenu under the Special menu. This type of data capture will use a variable number of storage locations. Once data has been captured within the Waterfall menu, press the STORE key, CAPTURE *menu soft key* and then CAP WFAL *menu soft key* to store the waterfall data into the data storage location(s) selected. Additional data storage locations may be necessary.

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.

Regardless of the type of information stored, the menu sidebar display 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:

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 STORE key. Then select the desired storage location using the SmartKnob™.

Press the RECALL *menu soft key* (if not already highlighted) to activate this function.

Press ENTER to recall the data.

Frozen data will be displayed immediately, while captured (replay) data will be displayed at the same rate it was recorded. If the stored data type is waterfall, the display will go to the Waterfall submenu of the Special Menu. The waterfall data can be examined as described in the Waterfall section of this manual. Once the display is finished, press the ENTER key to revert the display back to the listing of stored data.

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 desired to erase all storage locations, CLR DATA under the SPCL-DEFAULT menu may be used instead of erasing one at a time. CLR DATA will clear all storage locations.

In order to perform the erase function, press the STORE key. The screen will display the list of storage locations, highlighting the one currently selected. Select the erase function with the ERASE *menu soft key*.

Next, rotate the SmartKnob™ until the desired location is selected. Once the location number is selected, press the ENTER key, the status line will display **ERASE: CANCEL** this allows you to change your mind before continuing. Press ENTER if you do NOT want to erase.

If you want to erase, rotate the SmartKnob™ until **CONFIRM** appears on the status line. Again press the ENTER key, the status line will momentarily display the message **Erasing...**, then the display will redisplay the list with the selected location listed as EMPTY.

NAME   The *Name* function for stored data allows the operator to enter a name of up to 29 characters for STORE and PROG menu file locations and 38 characters for the Report Header . Names may be used to describe the test results that are stored, reference a written test procedure, and so on. Only file 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 function is selected, a screen similar to the *figure* at the right will appear, displaying a list of available characters, and a highlighted entry line with an (^) arrow used to point to the current character space.

Figure 3-8. *Text Editor*

The CLEAR *menu soft key* will clear the entire line, so new text may be entered. Rotating the SmartKnob™ moves the highlight from character to character.

Pressing ENTER selects the character and moves the arrow on the entry line to the right one character.

The SAVE *menu soft key* will record the changes made to the current stored data number.

The QUIT *menu soft key* will return the name to its original value prior to selecting this function.

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 to suit individual needs.

To use this feature, a serial printer must be properly attached and operating. If a printer is not properly connected, selecting the print function will cause the error message
* PRINT ERROR * to display on the status line.

Printing stored data requires first pressing STORE. Then, the desired location number is selected by rotating the SmartKnob™. After this is done, simply press the PRINT *menu soft key* and then the ENTER key will start the printout.

3.13   Setup Menu

The *Setup* menu allows the user to set and load defaults for the Nortec® 2000D These include the report customization, language, frequency mode, clock, baud rate, reference memory, printer type, several reset functions, lock, and probe drive.

```
REPORT   CLOCK  DEFAULT
LANGUAGE  BAUD   PRINTER  LOCK   CONTRAST
ENGLISH   38400  HP-PCL   OFF      15
  FREQ   REF MEM          PRBE DRV COLOR
SINGLE    OFF               MID     1*



PRESS ENTER            MENU:SETUP
   ↓      ↓      ↓       ↓      ↓
```

Figure 3-9. *SETUP Menu*

```
STAVELEY INSTRUMENTS INSPECTION REPORT

COMPANY
ADDRESS


OPERATOR
JOB NUMBER
JOB AND PART NAME
PROBE MAKE,MODEL,SERIAL #


ENTER TO EDIT            MENU:REPORT
 EDIT   CLEAR  DEFAULT  QUIT
```
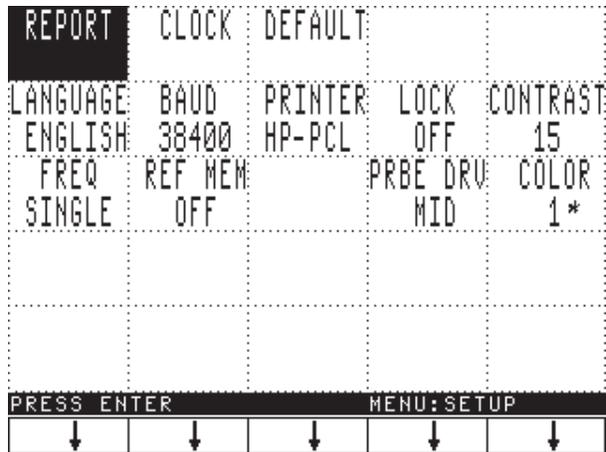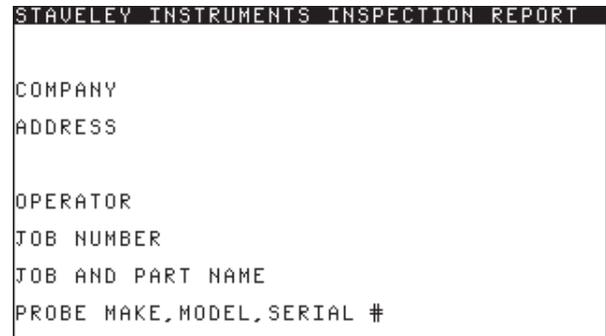
Figure 3-10. *Inspection Report Header*

**CUSTOMIZE
REPORT**   The *Customize Report* feature of the Nortec® 2000D allows the operator to change the title, and entry fields on the data printout report. Information such as company name, operator name, test procedure used, and so on may be entered or blanked so that it prints on every report.

The customize report information is divided into 3 types as shown.

- *Header* The header is printed in double-width type at the top of the report. It is 38 charaters wide, and is printed on all report types, unless blanked.

- *Label* A label describes a line of information, such as *COMPANY NAME* or *ADDRESS*. There are 18 available label fields or lines in the Report Header screen. If a label is left blank, nothing will print at its location.

- *Field* Each field (line) is 26 characters wide. (refer to **Figure 3-11**)

The header may be up to 38 characters long, while the label and fields may be up to 26 characters in length.

The customize report function is selected using the REPORT *menu soft key*. To select this feature, press SETUP, then REPORT.... and ENTER.

Once the customize report function is selected, the display screen will show the current settings for each item.
The SmartKnob™ selects an item and highlights it. Once the desired item is selected (highlighted), press the EDIT *menu soft key* and then ENTER key to enter or change text.

Once an item is selected for editing, an alphanumeric entry screen similar to the figure on the right appears, showing a list of available characters including all capital letters, the numbers

* only appears on 2000D+ models with the color display installed.

0 through 9, several special characters (, - / # %), and a blank space.

Also appearing are the SAVE and QUIT *menu soft keys*, these are 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 a carat (^) indicating the character position where the next entry will take place.
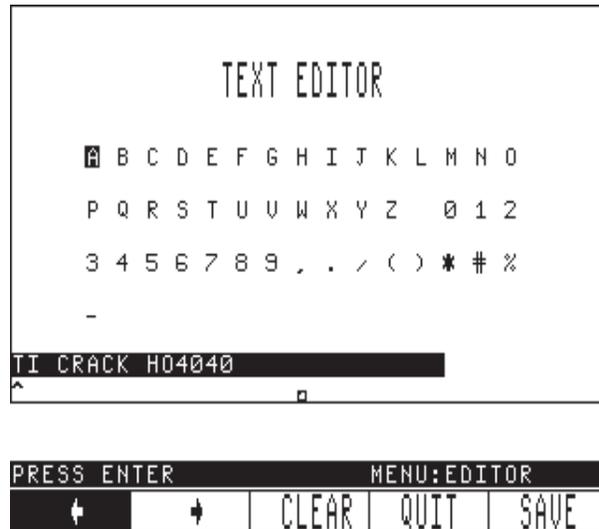
The CLEAR *menu soft key* will clear the entire line, so new text may be entered. Rotating the SmartKnob™ moves the highlight from character to character. Pressing ENTER selects the character and moves the carat (^) on the entry line to the right one character.
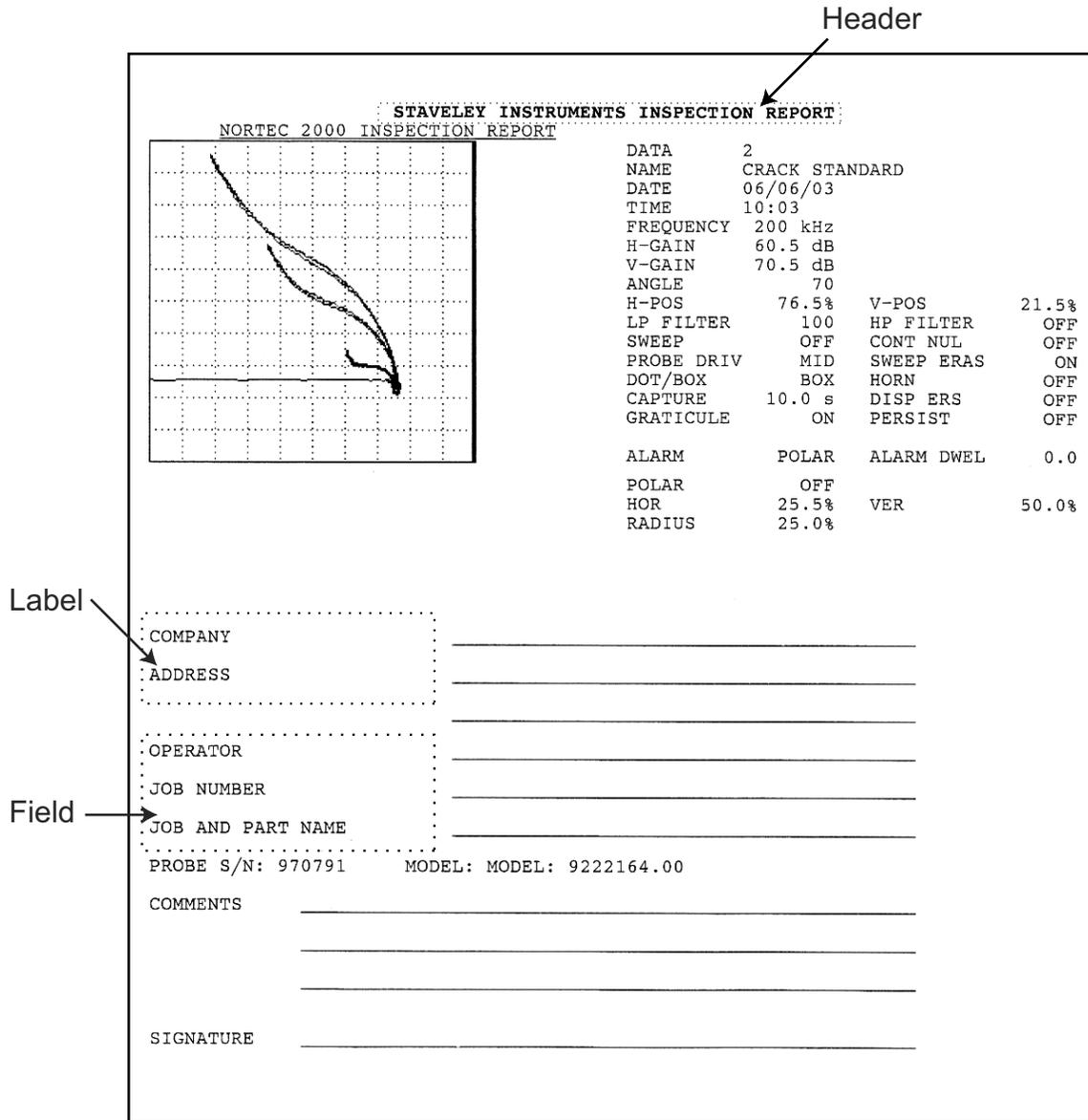
Figure 3-11. *Sample Data Printout*

> **NOTE:**
>
> CLR DATA, clear stored data, will reset the items to default and clear all 20 stored
> data areas. (See *Reset and Clear Functions* in this section for more details.)

LANGUAGE   Sets the language used for menu text. Selections include English, Spanish, French, German, and Italian.

CLOCK   *Date* and *time* are kept internally in the Nortec® 2000D instrument. This information is shown on program and data printouts, and the date is also shown on the 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. The information below will describe the functions that allow such changes to be made.

DATE   The *Clock* menu allows the operator to change the date entry. Date is kept in the format month, day, year, such as, **01/31/1997.**

To change the date setting, select SETUP, then CLOCK *menu soft key* and ENTER. To set the day, press the DAY *menu soft key*. The day may be changed by pressing the INC/DEC arrow keys or by rotating 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 MONTH *menu soft key*. Toggle the INC/DEC arrow keys or rotate the SmartKnob™ to set the month.

After the month is set, press the YEAR *menu soft key*. Toggle the INC/DEC arrow keys or turning the SmartKnob™ will change the year.

TIME   The *Clock* menu also selects the time change function. The time is kept in hours and minutes. *12:58*. Hours are in 24 hour format, with numbers greater than 12 indicating afternoon.

To update the currently stored time, press the SETUP key, then CLOCK *menu soft key* and then ENTER.

To change hours press the HOUR *menu soft key* and rotate the SmartKnob™ or toggle the INC/DEC arrow keys.

Once the hour is set, press MINUTE *menu soft key*. Rotate the SmartKnob™ to change the minutes setting

BAUD RATE   The *Baud Rate* of the RS-232 port is defaulted at 9600. The range of options includes 2400, 4800, 9600, 19200, 38400, and 57600. Adjustment is accessed through the SETUP menu. To select a different baud rate press SETUP, then BAUD *menu soft key*. Toggle the INC/DEC arrow keys or rotate the SmartKnob™ until the baud rate is at the desired level.

REF MEM   The *Reference Memory* function allows the operator to recall a saved waveform, then compare the "REF MEM" with a live eddy current signal. (Refer to Section 3.12, *DataStorage* for information on storing data for recall as REF MEM).

To use REF MEM, select the SETUP menu, then using the softkeys, select REF MEM. Using the SmartKnob, select the memory location you wish to superimpose upon the live signal. (only frozen waveform data (F) may be recalled by REF MEM) Press ENTER, then MAIN. The stored wavefom data is now superimposed on the live signal. The stored waveform is displayed "dimmed".

On 2000D+ models with the color LCD installed, the stored waveform data is displayed in a different color.
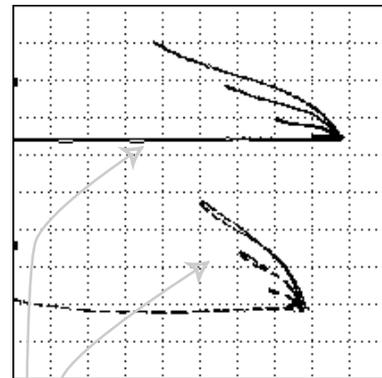
Stored Waveform Data (REF MEM)

Live Waveform Data

Figure 3-12. *REF MEM Display*

DEFAULT   The *Default* function allows various degrees of reset for instrument settings and stored information. Select using the SmartKnob™ or the ENTER key. Four functions are provided to afford a great deal of flexibility when such operations are necessary.

The four levels of Reset are:

- *Clear Programs*   Clears all 100 stored program settings, resetting them to EMPTY.

- *Clear Data*   Clears the 20 eddy current data storage locations.

- *Clear Instrument*   Invoking this function will clear the entire instrument, including current function settings, programs, stored eddy current data, and the customize report text.

- *Load Defaults*   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.

To clear all stored programs, first select SETUP, then DEFAULT *menu soft key*, and ENTER, and then CLR PROG *menu soft key*, and press ENTER.

The Status line will display **ERASE ? CANCEL** this allows you to change your mind before continuing. Press ENTER if you do NOT want to Erase. If you want to Erase, rotate the SmartKnob™ until **CONFIRM** appears on the Status line. Again, press the ENTER key, the programs are cleared, and the instrument returns to the Default menu.

CLEAR DATA
The *Clear Data* function clears all 20 stored data areas in the Nortec® 2000D and resets any text that may have been entered using the customize report text feature to default.

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.

To clear all stored data, first select the SETUP key, then the DEFAULT *menu soft key*, and ENTER, then CLR DATA *menu soft key*, then ENTER.

The Status line will display **ERASE ? CANCEL** this allows you to change your mind before continuing. Press ENTER if you do NOT want to Erase. If you want to Erase, rotate the SmartKnob™ until **CONFIRM** appears on the Status line. Again, press the ENTER key.

CLEAR INST
The *Clear Inst* 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 INST function should be done after assuring that all stored information is no longer useful or has been recorded to an external computer using EddyMaster software.

In order to clear the instrument, select the SETUP key, then the DEFAULT *menu soft key*, and ENTER, then CLR INST *menu soft key,* then ENTER.

The Status line will display **ERASE ? CANCEL** this allows you to change your mind before continuing. Press ENTER if you do NOT want to Erase. If you want to Erase, rotate the SmartKnob™ until **CONFIRM** appears on the Status line. Again, press the ENTER key, the status line will momentarily display the message **Erasing**..., then the display will redisplay the list with the selected location listed as EMPTY.

PRINTER SELECTION
The *Printer Selection* function is also in the SETUP menu. The printer selection includes Epson, HP-PCL, Canon, and Pentax II. Each of these selections may be used with a wide range of printers.

To select a particular printer setup, press the SETUP key, the PRINTER *menu soft key*.

Toggle the INC/DEC arrow keys or rotate the SmartKnob™ until the correct printer selection is displayed on the menu display.

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.

For use with parallel printers, a **Powered Serial to Parallel Converter (P/N 9522102)** is required.

The following paragraphs explain the printer mode for each selection.

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)
Canon BJ-30	(2/3 reduction)

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-350	(use factory configuration)
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)

CANON supports Canon Bubblejet printers directly. The following is a list of printers that have been tested with this selection.

Canon BJ-30	(use factory configuration)
Canon BJC-80	(use factory configuration)

Pentax II supports the Pentax II PocketJet printer.

LOCK   The *Lock* feature is a keyboard lock out function. This feature prevents accidental changes of the setup parameters. LOCK is frequently used when operating the Nortec® 2000D through the RS-232 port.

To set LOCK to the "ON" position, press SETUP, then the *menu softkey.*
Rotate the SmartKnob™ until LOCK is set to the proper value.

PROBE

DRIVE   The Nortec® 2000D instrument 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, respectively.

Mid probe drive (default) is normally sufficient for most eddy current testing. However, there are certain instances where high probe drive is desirable:

- Insufficient gain at lower probe drive setting
- Testing lower conductivity materials
- Finding smaller flaws in the test material
- Deeper penetration into test material

To set the probe drive level, press the SETUP key, then the PRBE DRV *menu soft key* until PRBE DRV is highlighted. Once the probe drive function is selected, it may be changed by rotating the SmartKnob™ or by pressing the INC/DEC arrow keys until the desired level is selected.

CONTRAST   Adjusts the LCD display backlight. Turning down the backlight increases battery life.

COLOR*   Changes the color scheme on Nortec® 2000D+ models. Highlight the COLOR softkey, then rotate the SmartKnob™ to choose between color schemes 1-8.

1   Black Background, White Text / Graticule, Green Signal

2   Black Background, White Text / Graticule, Red Signal

3   Blue Background, Black Text / Graticule, Red Signal

4   Blue Background, Black Text / Graticule, White Signal

5   White Background, Blue Graticule, Black Text, Green Signal

6   Black Background, Red Text / Graticule, White Signal

7   Black Background, White Text / Graticule, Blue Signal

8   Black Background, White Text / Graticule, Cyan Signal

* This softkey only shows on 2000D+ models with a color display installed.

**LOAD
DEFAULT**   The *Load Default* settings function 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 Nortec® 2000D instrument are as follows:

Parameter	Default Setting
Display (DISPL)	SWEEP OFF
Graticule	ON
Frequency	100 kHz
Gain	40.0 dB, horizontal and vertical
Angle	0 degrees
Position	50 %, horizontal and vertical (middle of screen)
Filter	Lowpass = 100 Hz Highpass = 0 Hz
Probe Drive	MID
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%
Polar Alarm	Middle of screen, 25% radius
Dot Type	Box
Baud Rate	9600
Printer Selection	HP-PCL

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 SETUP key, then the DEFAULT *menu soft key*, ENTER, LD DEFLT *menu soft key*, then ENTER.

The Status line will display **LD DEFLT? CANCEL** this allows you to change your mind before continuing. Press ENTER if you do NOT want to load the default settings.

If you want to load the defaults, rotate the SmartKnob™ until **CONFIRM** appears on the Status line. Press the ENTER key again.

3.14 Special Functions

The *Special Functions* menu is provided for our customers to help meet their requirements and for future instrument expansion.

VERSION The *Version* feature displays the instrument configuration.

To access this feature, press the SPECIAL key, and then the VERSION *menu soft key* and ENTER. This will display the CPU revision, AQU revision, VPU revision, NAPU revision, and instrument power source.

ALARM DWELL *Alarm Dwell* is used for keeping the alarm on for a set period after the event that caused the alarm. 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 0.2 second from 0.0 to 10.0 seconds.

Dwell applies to the display LEDS, and the alarm horn (if on). Dwell is applied independently to each alarm when multiple box alarms are selected.

To change alarm dwell, select the SPECIAL key, then press the ALRM DWL *menu soft key.* Once Alarm Dwell is activated, the value may be entered by rotating he SmartKnob™ or by toggling the INC/DEC arrow keys.

SCAN RPM The *Scan RPM* function is used to set the RPM of the rotating scanner connected to the instrument. The instrument will automatically detect the type of scanner connected during PowerLink™, and set the range of RPM accordingly.

The RPM increments are dependent on the type of scanner attached. The Spitfire and RA2000 scanner are controlled in increments of 10 RPM, the PS-5 scanner is adjusted in increments of 1 RPM. The 19/RA scanner has a fixed speed of 1200 RPM and is NOT adjustable.

To change scanner RPM, select the SPECIAL key, then press the RPM *menu soft key.* Once SCAN RPM is activated, the value may be changed by rotating the SmartKnob™ or by toggling the INC/DEC arrow keys.

SYNC ANGLE The *Sync Angle* function is used to adjust the display synchronization with respect to scanner position. If the flaw is displayed at the edge of the display in the external sync sweep mode, changing the sync angle to 180 degrees will move the flaw to the middle of the display.

To change Sync Angle, select the SPECIAL key, then press the SYNC ANG *menu soft key.* Once Sync Angle is activated, the value may be changed by rotating the SmartKnob™ or by toggling the INC/DEC arrow keys.

3.15   Waterfall Display Function

The *Waterfall Display Function* is used in conjunction with a PS-5AL scanner and Nortec® 2000D. The term Waterfall is descriptive of the type of screen display that 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. This menu will only function if a PS-5AL scanner is attached to a Nortec® 2000D instrument.

To select the Waterfall display function, press the SPECIAL key, and then the WTRFL *menu soft key*.

**WATERFALL
MENU**
Select SPECIAL key, then press the WTRFL *menu soft key* to turn ON/OFF. Notice that the waterfall display function will only turn ON if a PS-5AL scanner is attached to the instrument.

In order to generate a waterfall display, set external sweep to ON by pressing the SWEEP *softkey TWICE.* WATERFALL must be set to ON, and the ERASE key must be pressed. The scanner must be rotating to generate a waterfall display.

Notice that the PS-5AL scanner and Nortec® 2000D instrument keyboard have an ERASE button. Press the ERASE button on either the PS-5AL or the ERASE key on the Nortec® 2000D instrument to restart the waterfall display.

To change the Waterfall setting, first select the SPECIAL key, and then press the WTRFL *menu soft key.* Once the WATERFALL *softkey* is activated, it may be turned on or off by rotating the SmartKnob™ or by toggling the INC/DEC arrow keys.

**SWEEP
MIN**
The *Sweep Min* function allows adjustment of the first sweep displayed during the waterfall scan.

**SWEEP
MAX**
The SWEEP MAX function allows adjustment of the last sweep displayed during the water-fall scan.

**WTRF
ANGLE**
The *WTRF Angle* (waterfall angle) allows the data captured in a waterfall display to be examined using XY coordinate display angles. Adjusting this value will redisplay the water-fall display with selected impedence plane angle.

To change WTRF ANGLE, select the SPECIAL key, then press the WTRFL *menu soft key,* then press the WTRF ANGLE *menu soft key.* Once SWEEP MAX is activated, the value may be changed by rotating the SmartKnob™ or by toggling the INC/DEC arrow keys.

DEPTH
The *Depth* feature selects which Waterfall scanline is highlighted or displayed. For the PS-5AL scanner each rotation of the probe while indexing (translating) represents 0.025 inches of travel in or out of the hole. So adjusting the depth control with the SmartKnob™ will highlight a selected scan line and list its depth from the starting point of the waterfall scan to the highlighted scanline.

To change the DEPTH, select the SPECIAL key, WTRFL *menu soft key,* and then press the DEPTH *menu soft key.* Once DEPTH is activated, selection of scan lines may be changed by rotating the SmartKnob™ or by toggling the INC/DEC arrow keys.

***NOTE**:*

For data evaluation, the WTRF ANGLE (waterfall angle) and DEPTH *menu soft keys* are used after the waterfall display has been generated. After highlighting one of these keys, pressing it again will cycle through displaying the whole waterfall scan, or displaying the highlighted scan by itself, or displaying the highlighted scan as an impedence plane signal.

3.16   Conductivity Mode

The Nortec® 2000D instrument is capable of automatically detecting the existence of a Nortec® 16-pin 60kHz or 480kHz conductivity probe, and will reconfigure the operating parameters to allow for conductivity measurements. This operating mode will differ from the normal operating mode, in that there is no display of the signal dot.

However, after completing the calibration, the conductivity readings in percent IACS (International Annealed Copper Standard) and lift-off readings in mils (thousandths of an inch) will be displayed instead. An eddy current instrument, such as, the Nortec® 2000D is highly sensitive to probe lift-off. This is useful for reading the thickness of a non-conducting layer, such as, a paint layer on top of a conducting metal.

Upon connection of a PowerLink™ conductivity probe, the following screen will be displayed. Select CONFIRM with the SmartKnob™ to accept the PowerLink™ program, and press MAIN. The screen will change to look like *Figure 3-14.*

Figure 3-13. *Conductivity PowerLink™*

MAIN/
FILTER   The *Main* key provides access to the Conductivity Main menu, which allows the operator to perform a conductivity calibration. In addition, the Conductivity Main menu allows the operator to set the Nortec® 2000D instrument for updating conductivity and liftoff data either continuously or when the ENTER key is pressed. In the Conductivity mode, *capture type* refers to whether the Nortec® 2000D updates the conductivity and liftoff readings continuously when the probe is in contact with the material under test (CAP TYPE "CONT"), or only takes a reading when the ENTER key is pressed. (CAP TYPE "ENTER")

The *Filter* option is not available when a conductivity probe is connected.

CAP TYPE   The *Cap Type* feature is for selecting conductivity and liftoff data continuously or only when the ENTER key is pressed. Enter type will hold the reading until ENTER is pressed again and another reading taken.

Figure 3-14. *Conductivity Display*

Continuous mode will update the reading every time the probe is in contact with the material under test.

To change CAP TYPE, press MAIN key, then CAP TYPE *menu soft key.* Once CAP TYPE is highlighted, the value may be changed by rotating the SmartKnob™ or by toggling the INC/DEC arrow keys.

CAL PT   The *Cal Pt* feature displays the calibration point that is currently being taken. If recalibration is desired, this feature should be set to 1 and then repeat the Calibration procedure.

To change the CAL PT, press the MAIN key, then CAL PT *menu soft key*. Once CAL PT is activated, the value may be changed by rotating the SmartKnob™ or by toggling the INC/DEC arrow keys.

CONDUCT   The *Conduct* feature allows for adjustment in order to match the conductivity of the calibration standard. To identify materials by their conductivity, reference standards will be required that have conductivities above and below the conductivity of interest.

The minimum and maximum values are set to the range. (±0.5% IACS accuracy from 0.9% to 62% IACS and ±1.0% IACS from 62% to 110% IACS — liftoff accuracy from 0 -15mil ±1mil). This must be set to the proper value before performing calibration. The conductivity value shown for CAL PT 1 is the conductivity for the lowest conductivity sample, and the conductivity value shown for CAL PT 2 is the conductivity for the highest conductivity sample.

VALUE   To change CONDUCT, press the VALUE *menu soft key*. Once VALUE is highlighted, the value may be changed by rotating the SmartKnob™ or by toggling the INC/DEC arrow keys.

SAVE   The *Save soft key* (when highlighted and pressed) will store the calibration data for the calibration point shown in CAL PT. If this key is highlighted, ENTER will also store the calibration points.

DISP/ALARM The *Disp/Alarm* key toggles between the Conductivity Alarm Menu and the Liftoff Alarm Menu with successive key presses.

1. Connect a Nortec® conductivity probe to access the conductivity menu, and press MAIN/FILTER.

2. Set conductivity value for **Cal Point 1**. Press Value, rotate the smart knob to change the CONDUCT value to match the value of the lowest conductivity standard in the IACS range you are testing.

3. Place the conductivity probe on the sample and Press the SAVE key twice. Nulling will appear in the status display and the unit will then proceed to **Cal PT 2**.

4. Set conductivity value for **Cal Point 2**. Press Value, rotate the smart knob to change the CONDUCT value to match the value of the highest conductivity standard in the IACS range you are testing.

5. Place the conductivity probe on the sample and Press the SAVE key twice. Save will appear in the status display and the unit will then proceed to **Cal PT 3**.

6. Place a 4 mil (0.004") non-conductive shim over the first sample (from **CAL PT 1**). Place the probe on top of the shim and press the SAVE key. Save will be displayed in the status bar and unit will proceed to **Cal PT 4**.

7. Place a 4 mil (0.004") non-conductive shim over the second sample (from **CAL PT 2**). Place the probe on top of the shim and press the SAVE key.

8. CAL VALID will appear on the top of the conductivity display. Conductivity readings may now be taken.

9. The cap type is in "Enter mode" the ENTER key must be pressed to take a reading. To change to continuous readings Press CAP TYPE and rotate the SmartKnob until CAP TYPE CONT. is displayed in the upper right of the display.

NOTE:

If the Capture Mode is set to ENTER, be sure that the SAVE CAL *menu softkey* is NOT highlighted before pressing Enter. If the SAVE CAL is highlighted and ENTER is pressed, the Nortec® 2000D instrument will assume that calibration data should be collected, which will invalidate the calibration just completed.

CND LOW   The *Conductivity Low* alarm limit is in %IACS, which directly compares with the conductivity reading on the display.

To change CND LOW, select the ALARM key, then press CND LOW *menu soft key*. Once CND LOW is activated, the value may be changed by rotating the SmartKnob™ or by toggling the INC/DEC arrow keys.

CND HIGH   The *Conductivity High* alarm limit is in %IACS, which directly compares with the conductivity reading on the display.

To change CND HIGH, select the ALARM key, then press the CND HIGH *menu soft key*. Once CND HIGH is activated, the value may be changed by rotating the SmartKnob™ or by toggling the INC/DEC arrow keys.

+ / − / OFF   The *+ / − / OFF* feature changes the alarm between positive polarity and negative polarity. Both alarm types can be used together or individually. Positive polarity forces the alarm to be ON when the liftoff or conductivity is inside the upper and lower limits set. Whereas, the negative polarity activates the alarm when the liftoff or conductivity is outside the set alarm threshold. And Alarm OFF.

To change the alarm polarity, select the ALARM key, then press the + / − / OFF *menu soft key*. Once + / − / OFF is highlighted, the value may be changed by rotating the SmartKnob™ or by toggling the INC/DEC arrow keys.
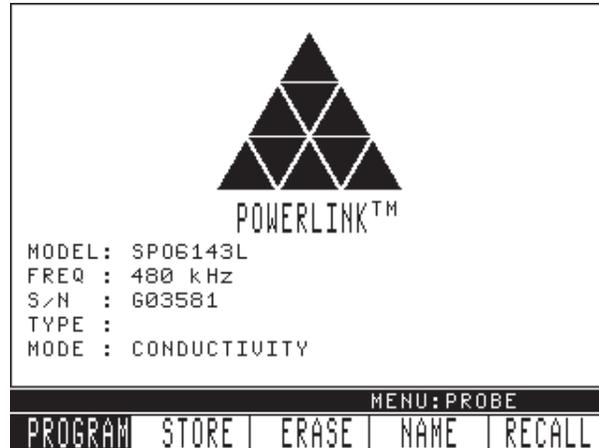
To change from CND LOW/HIGH to LIFT LOW/HIGH, press the DISPLAY/ALARM key <u>again.</u>

LIFT LOW   The *Low Limit* for the liftoff alarm is in mils (0.001"), this directly correlates with the liftoff reading on the display.

To change LIFT LOW, select the ALARM key, then press the LIFT LOW *menu soft key*. Once LIFT LOW is activated, the value may be changed by rotating the SmartKnob™ or by toggling the INC/DEC arrow keys.

LIFT HIGH   The *High Limit* for the liftoff alarm is in mils (0.001"), this directly correlates with the liftoff reading on the display.

To change LIFT HIGH, select the ALARM key, then press the LIFT LOW *menu soft key*. Once LIFT LOW is highlighted, the value may be changed by rotating the SmartKnob™ or by toggling the INC/DEC arrow keys.

+ / – / OFF   The *+ / – / OFF* feature will change the alarm between positive polarity (alarm will occur if liftoff is between the low and high alarm limits) and negative polarity (alarm will occur if liftoff is outside of the low and high alarm limits). And Alarm OFF.

To change the liftoff alarm polarity, select the ALARM key, then press the + / – / OFF *menu soft key*. Once + / – /OFF is highlighted, the value may be changed by rotating the SmartKnob™ or by toggling the INC/DEC arrow keys.

4.0 Nortec® 2000D Applications

What's in this section?

4.1   Impedance Plane Display-Conductivity Curve

1.   *Equipment Used:*

Nortec SL/1kHz-50 kHz/.31 PowerLink™ Surface Probe   Staveley P/N # 9222161
Nortec Conductivity Samples (set of six)   Staveley P/N # 1902474
CL/SC/6 Cable   Staveley P/N # 9122083

2.   Connect the probe. The PowerLink™ screen will appear. Rotate the SmartKnob™ to (▲) **Confirm**, and press ENTER. The screen will display information about the probe. Press the MAIN key to proceed with the test setup.

3.   Adjust the frequency to 25kHz if necessary. Press the FREQ *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until 25kHz appears in the FREQUENCY box.

4.   Adjust the phase angle to approximately 55°. Press the ANGLE *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until 55° appears in the ANGLE box.

5.   Adjust the gain to approximately 43.5dB. Press the GAIN *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until 43.5dB appears in the H GAIN and V GAIN boxes.

6.   Hold the probe in air, away from the conductivity sample, and press the NULL button and ERASE keys.

7.   Touch the probe to the middle of each of the six samples on the conductivity sample. The display should look similar to *Figure 4-1*.

8.   These settings are only guidelines. Some fine tuning may be necessary. This is accomplished by using the GAIN and ANGLE button and then the SmartKnob™.

▲   CONFIRM — Rotating the SmartKnob™ to select *Confirm* downloads the information from the probe or scanner to the instrument.

▲   CANCEL — Rotating the SmartKnob™ to select *Cancel* retains the instruments previous settings.

STAVELEY INSPECTION REPORT
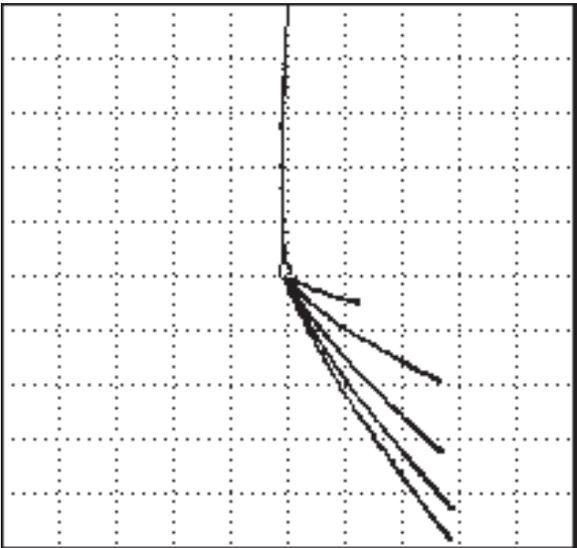
Figure 4-1. *Conductivity Curve*

Nortec 2000D INSPECTION REPORT

NAME:	CONDUCTIVITY CURVE		
DATE:	02/15/2003		
TIME:	18:12		
FREQ:	25kHz		
H GAIN:	43.5dB		
V GAIN:	43.5dB		
ANGLE:	55°		
H POS:	50%	V POS:	50%
LP FILT:	100	HP FILT:	0
SWEEP:	OFF	HPF POLE:	2-POLE
PROB DRV:	MID	SWP ERAS:	ON
DOT/BOX:	DOT	HORN:	OFF
CAPTURE:	10.0 s	DISP ERS:	OFF
GRATICULE:	ON	PERSIST:	OFF
ALARM:	BOX	DWELL:	0.0 s
BOX 1	OFF		
TOP:	75%	BOTTOM:	25%
LEFT:	25%	RIGHT:	75%
BOX 2	OFF		
TOP:	75%	BOTTOM:	25%
LEFT:	25%	RIGHT:	75%
BOX 3	OFF		
TOP:	75%	BOTTOM:	25%
LEFT:	25%	RIGHT:	75%

COMPANY:_____

ADDRESS:_____

OPERATOR:_____

JOB NUMBER:_____

JOB AND PART NAME:_____

PROBE MAKE, MODEL, SERIAL #:_____

COMMENTS:_____

4.2   Surface Flaw Detection

1.   *Equipment Used:*

Nortec PL/100kHz-500kHz/A PowerLink™ Surface Probe   Staveley P/N # 9222180

Nortec TB-S1 EDM Standard, with .040", .020",

and .008" deep notches   Staveley P/N # 1902510

CL/SC/6 Cable   Staveley P/N # 9122083

2.   Connect the probe. The PowerLink™ screen will appear. Rotate the SmartKnob™ to (▲) **Confirm**, and press ENTER. The screen will display information about the probe. Press the MAIN key to proceed with the test setup.

3.   Adjust the frequency to 200kHz if necessary. Press the FREQ *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until 500kHz appears in the FREQUENCY box.

4.   Adjust the phase angle to 69°. Press the ANGLE *menu soft key.* Rotate the SmartKnob™ or press the INC/DEC arrow keys until 69° appears in the ANGLE box.

5.   Adjust the horizontal gain to 60.0dB and the vertical gain to 70.0dB. Press the H GAIN *menu soft key.* Rotate the SmartKnob™ or press the INC/DEC arrow keys until 60.0dB appears in the H GAIN box. Now, press the V GAIN *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until 70.0dB appears in the V GAIN box.

6.   Adjust the horizontal position to 80% and the vertical position to 20%. Press the DISP key. Press the H POS *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until 80% appears in the H POS box. Now, press the V POS *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until 20% appears in the V POS box.

7.   Place the probe on the TB-S1 crack standard away from the cracks and engraving. Now, press the NULL and ERASE keys.

8.   Slide the probe smoothly over the three EDM notches. The response should look similar to *Figure 4-2*.

9.   These settings are only guidelines. Some fine tuning may be necessary. This is accomplished using the GAIN, ANGLE, and SmartKnob™.

STAVELEY INSPECTION REPORT

Figure 4-2. *Surface Flaw Detection*

Nortec 2000D INSPECTION REPORT

NAME:	TB-S1 ALUMINUM EDM STANDARD
DATE:	02/16/2003
TIME:	12:48

FREQ:	200kHz
H GAIN:	60.0 dB
V GAIN:	70.0 dB
ANGLE:	69°

H POS:	80%	V POS:	20%
LP FILT:	100	HP FILT:OFF	
DISPLAY:	OFF	HPF POLE:	2-POLE
PROB DRV:	MID	SWP ERAS:	ON
DOT/BOX:	DOT	HORN:	OFF
CAPTURE:	10.0 s	DISP ERS:	OFF
GRATICULE:	ON	PERSIST:	OFF

ALARM	BOX	ALARM DWEL:	0.0 s
BOX 1:	OFF		
TOP:	75%	BOTTOM:	25%
LEFT:	25%	RIGHT:	75%
BOX 2:	OFF		
TOP:	75%	BOTTOM:	25%
LEFT:	25%	RIGHT:	75%
BOX 3:	OFF		
TOP:	75%	BOTTOM:	25%
LEFT:	25%	RIGHT:	75%

COMPANY:_____

ADDRESS:_____

OPERATOR:_____

JOB NUMBER:_____

JOB AND PART NAME:_____

PROBE MAKE, MODEL, SERIAL #:_____

COMMENTS:_____

4.3   Second Layer Crack Detection

Second layer crack detection 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-3806L Sliding/Reflection Probe	Staveley P/N # 9222242
Nortec SPO-3932 Second Layer Crack Sample	
(1/16" Al on 1/16" Al)	Staveley P/N # 1916915
Detachable Cable-CL/SC/6	Staveley P/N # 9122083

2.   Connect the probe. The PowerLink™ screen will appear. Rotate the SmartKnob™ to (▲) **Confirm**, and press ENTER. The screen will display information about the probe. Press the MAIN key to proceed with the test setup.

3.   Adjust the frequency to 2.5kHz.   Press the FREQ *menu soft key.* Rotate the SmartKnob™ or press the INC/DEC arrow keys until 2.5kHz appears in the FREQUENCY box.

4.   Adjust the phase angle to 270°. Press the ANGLE *menu soft key.* Rotate the SmartKnob™ or press the INC/DEC arrow keys until 270° appears in the ANGLE box.

5.   Adjust the horizontal gain to 60dB and the vertical gain to 65dB. Press the H GAIN *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until 60dB appears in the H GAIN box. Now, press the V GAIN *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until 65dB appears in the V GAIN box.

6.   Adjust the horizontal position to 75% and the vertical position to 15%. Press the DISP key, and then the H POS *menu soft key.* Rotate the SmartKnob™ or press the INC/DEC arrow keys until 75% appears in the H POS box. Press the V POS menu *soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until 15% appears in the V POS box.

7.   Turn OFF the screen graticule. Press the DISP key, and then the SCRN *menu soft key.* Now press the GRAT *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until OFF appears in the GRATICULE box.

8.   The display should look similar to ***Figure 4-3.***

9.   These settings are only guidelines. Some fine tuning may be necessary. This may be accomplished using the GAIN, ANGLE, and SmartKnob™.

STAVELEY INSPECTION REPORT

Figure 4-3. *Second Layer Crack Detection*

Nortec 2000D INSPECTION REPORT

NAME: SECOND LAYER CRACK DETECTION
DATE: 02/16/2003
TIME: 18:03

FREQ: 2.5kHz
H GAIN: 60dB
V GAIN: 65dB
ANGLE: 270°

H POS:	75%	V POS:	15%
LP FILT:	100	HP FILT:	OFF
DISPLAY:	OFF	HPF POLE:	2-POLE
PROB DRV:	MID	SWP ERAS:	ON
DOT/BOX:	DOT	HORN:	OFF
CAPTURE:	10.0 s	DISP ERS:	OFF
GRATICULE:	OFF	PERSIST:	OFF

ALARM BOX   ALARM DWEL: 0.0 s

BOX 1:	OFF		
TOP:	75.0%	BOTTOM:	25.0%
LEFT:	25.0%	RIGHT:	75.0%
BOX 2:	OFF		
TOP:	75.0%	BOTTOM:	25.0%
LEFT:	25.0%	RIGHT:	75.0%
BOX 3:	OFF		
TOP:	75.0%	BOTTOM:	25.0%
LEFT	25.0%	RIGHT	75.0%

COMPANY:_____

ADDRESS:_____

OPERATOR:_____

JOB NUMBER:_____

JOB AND PART NAME:_____

PROBE MAKE, MODEL, SERIAL #:_____

COMMENTS:_____

4.4   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 SL/100Hz-20kHz/.62 Surface Probe	Staveley P/N # 9222193
Nortec SPO-4304 Tapered Aluminum Standard	Staveley P/N # 1916914
CL/SC/6 Cable	Staveley P/N # 9122083
Staveley/Nortec Eddy Current Slide Rule	Staveley P/N # 3306888

2.   Connect the probe. The PowerLink™ screen will appear. Rotate the SmartKnob™ to (▲)*Confirm*, and press ENTER. The screen will display information about the probe. Press the MAIN key to proceed with the test setup.

3.   Adjust the frequency to 1kHz.   Press the FREQ *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until 1kHz appears in the FREQUENCY box.

4.   Adjust the phase angle to 41°. Press the ANGLE *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until 41° appears in the ANGLE box.

5.   Adjust the gain to approximately 58dB. Press the GAIN *menu soft key*. Rotate the SmartKnob™ or press either the INC/DEC arrow keys until 58dB appears in the H GAIN and V GAIN boxes.

6.   Adjust the horizontal position to 78.5% and the vertical position to 60%. Press the DISP *menu soft key* , and then the H POS *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until 78.5% appears in the H POS box. Now, press the V POS *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until 60% appears in the V POS box.

7.   Place the probe approximately 1.5" in from the thin end of the sample. Press the NULL and ERASE keys.

8.   Place the probe at various locations representing different thicknesses. Now, carefully slide the probe down the entire length of the taper (this will produce the curve).

9.   The display should look similar to ***Figure 4-4b***.

10.   These settings are only guidelines. Some fine tuning may be necessary. This may be accomplished using the GAIN, ANGLE, and SmartKnob™.
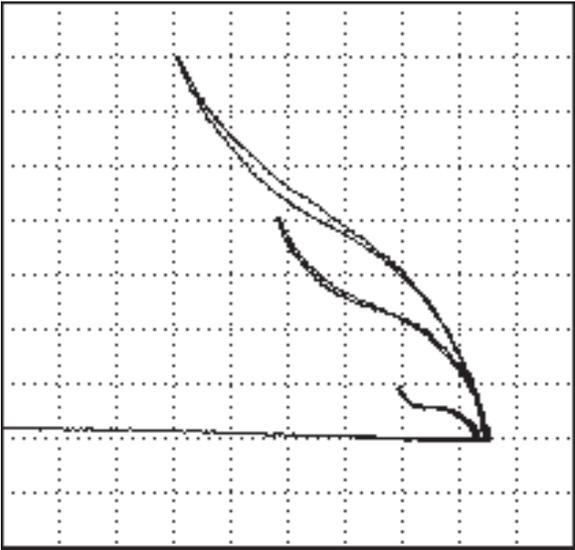
STAVELEY INSPECTION REPORT
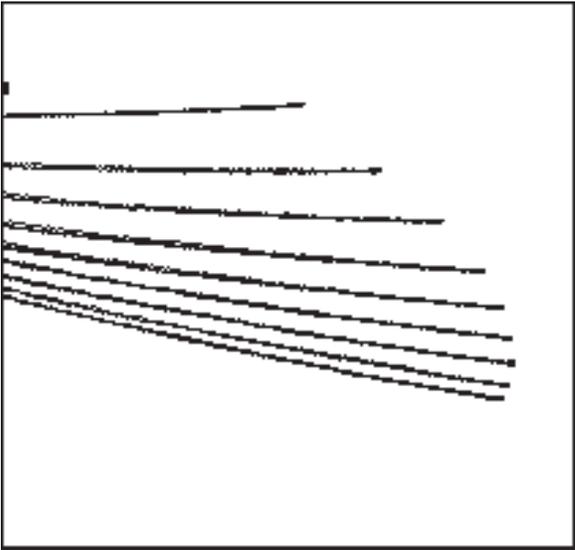
Figure 4-4a. *Thickness Measurement*

Nortec 2000D INSPECTION REPORT

NAME:	THICKNESS (corrosion)
DATE:	02/15/2003
TIME:	16:43

FREQ:	1kHz
H GAIN:	58dB
V GAIN:	58dB
ANGLE:	41°

H POS:	78.5%	V POS:	60%
LP FILT:	100	HP FILT:	OFF
DISPLAY:	OFF	HPF POLE:	2-POLE
PROB DRV:	MID	SWP ERAS:	ON
DOT/BOX:	BOX	HORN:	OFF
CAPTURE:	10.0 s	DISP ERS:	OFF
GRATICULE:	ON	PERSIST:	OFF

ALARM:	BOX	ALARM DWEL:	0.0
BOX 1:	OFF		
TOP:	75.0%	BOTTOM:	25.0%
LEFT:	25.0%	RIGHT:	75.0%
BOX 2:	OFF		
TOP:	75.0%	BOTTOM:	25.0%
LEFT:	25.0%	RIGHT:	75.0%
BOX 3:	OFF		
TOP:	75.0%	BOTTOM:	25.0%
LEFT	25.0%	RIGHT	75.0%

COMPANY:_____

ADDRESS:_____

OPERATOR:_____

JOB NUMBER:_____

JOB AND PART NAME:_____

PROBE MAKE, MODEL, SERIAL #:_____

COMMENTS:_____

Figure 4-4b.

4.5   Conductivity — Sorting

1.   *Equipment Used:*

   Nortec SL/1kHz-50kHz/0.31 PowerLink™ Surface Probe   Staveley P/N # 9222161
   Nortec Conductivity Standards - set of six   Staveley P/N # 1902474
   CL/SC/6 Cable   Staveley P/N # 9122083

2.   Connect the probe. The PowerLink™ screen will appear. Rotate the SmartKnob™ to (▲) **Confirm**, and press ENTER. The screen will display information about the probe. Press the MAIN key to proceed with the test setup.

3.   Adjust the frequency to 50kHz if necessary.   Press the FREQ *menu soft key.* Rotate the SmartKnob™ or press the INC/DEC arrow keys until 50kHz appears in the FREQUENCY box.

4.   Adjust the phase angle to 133°. Press the ANGLE *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until 133° appears in the ANGLE box.

5.   Adjust the horizontal gain to 55dB and the vertical gain to 63dB. Press the H GAIN *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until 55dB appears in the H GAIN box. Now, press the V GAIN *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until 63dB appears in the V GAIN box.

6.   Adjust the horizontal position to 75%. Press the DISP key then the H POS *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until 75% appears in the H POS.

7.   Place the probe on the 7075-T6 sample and press the NULL and ERASE keys.

8.   Place the probe on the MAG, 7075-T6 and 7075-0 samples. The display should look similar to *Figure 4-5*.

9.   These settings are only guidelines. Some fine tuning may be necessary. This may be accomplished using the GAIN, ANGLE, and SmartKnob™.

STAVELEY INSPECTION REPORT
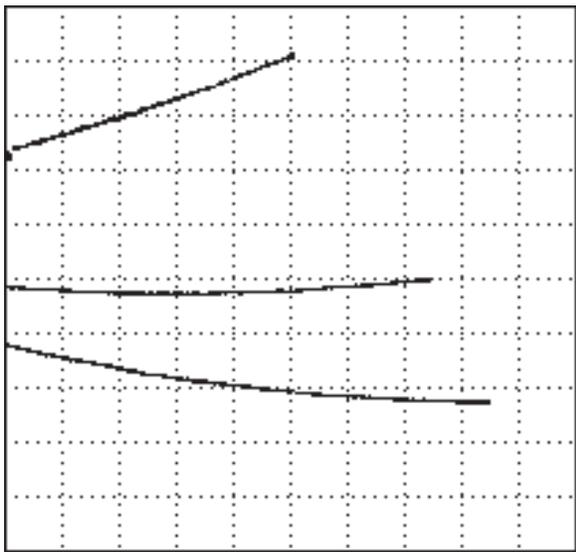
Figure 4-5. *Conductivity Sorting*

Nortec 2000D INSPECTION REPORT

NAME: CONDUCTIVITY - SORTING
DATE: 02/16/2003
TIME: 17:09

FREQ: 50kHz
H GAIN: 55 dB
V GAIN: 63 dB
P ANGLE: 133°

H POS:	75%	V POS:	50%
LP FILT:	100	HP FILT:	OFF
DISPLAY:	OFF	HPF POLE:	2-POLE
PROB DRV:	MID	SWP ERAS:	ON
DOT/BOX:	DOT	HORN:	OFF
CAPTURE:	10.0 s	DISP ERS:	OFF
GRATICULE:	ON	PERSIST:	OFF

ALARM:	BOX	ALARM DWEL: 0.0	
BOX 1:	OFF		
TOP:	75.0%	BOTTOM:	25.0%
LEFT:	25.0%	RIGHT:	75.0%
BOX 2:	OFF		
TOP:	75.0%	BOTTOM:	25.0%
LEFT:	25.0%	RIGHT:	75.0%
BOX 3:	OFF		
TOP:	75.0%	BOTTOM:	25.0%
LEFT	25.0%	RIGHT	75.0%

COMPANY:_____

ADDRESS:_____

OPERATOR:_____

JOB NUMBER:_____

JOB AND PART NAME:_____

PROBE MAKE, MODEL, SERIAL #:_____

COMMENTS:_____

4.6   Conductivity — Liftoff Measurement   (Paint Layer Thickness Measurement)

The conductivity/non-conductive liftoff feature of the Nortec® 2000D can only be accessed by connecting a Nortec® conductivity probe.

Equipment Used:

Nortec 60kHz Conductivity probe with cable

Nortec Conductivity Standards -(certified % IACS)

NOTE:

Recommended operating ranges. Best performance can be obtained by using the probes in the following ranges:

0.9% IACS to 20% IACS using a 480kHz probe

9% IACS to 110% IACS using a 60kHz probe

For best accuracy, the material to be measured should be at least one standard depth of penetration thick at the frequency of the probe used.

---

1.   The Nortec® 2000D should be calibrated before performing the lift-off measurement. Press the MAIN function key. The side bar will display CAP TYPE (capture type), CAL PT (calibration point), CONDUCT (conductivity), and SAVE CAL (save calibrations). Notice at the bottom of the screen, five *menu soft keys* have the same notation as the side bar.

NOTE:

The *softkeys*, SmartKnob™, and INC/DEC arrow keys are used for selecting and adjusting parameters.

---

2.   Select CAL PT = 1. Press the CAL PT *menu soft key,* and rotate the SmartKnob™ or press the INC/DEC arrow keys until a "1" appears in the CAL PT box.

3.   Set the VALUE to *lowest* value on the conductivity standard set. Rotate the SmartKnob™ or press the INC/DEC arrow keys until the *lowest* value of the conductivity standard set appears in the VALUE box. Place probe on lowest standard with lowest conductivity value. Press SAVE *twice.* Notice at the bottom of the screen a message will appear "NULLING". . .and the side bar will display "SAVE". When both messages disappear, the 1st CAL PT has been captured.

4.   The Nortec® 2000D instrument should increment automatically to CAL PT 2. If not, press the CAL PT *menu soft key,* and rotate the SmartKnob™ or press the INC/DEC arrow keys until a "2" appears in the CAL PT box.

5.   Set the VALUE to the *highest* value on the conductivity standard set. Press the VALUE *menu soft key*. Rotate the SmartKnob™ or press the INC/DEC arrow keys until the *highest* value of the conductivity standard set appears in the VALUE box.

6.   Place the probe on the standard set with the highest conductivity value, and press the SAVE *menu soft key* <u>twice</u>.

7.   The Nortec® 2000D instrument should increment automatically to CAL PT 3. If not, press the CAL PT *menu soft key,* and rotate the SmartKnob™ or press the INC/DEC arrow keys until CAL PT 3 appears in the CAL PT box. Note that VALUE box changes to LIFTOFF with a default value of 4 mils (0.004").

8.   Position a 4 mil (0.004") non-conductive shim on the *lowest* value of the conductivity standard set and place probe on top. Press SAVE *menu soft key* to set CAL PT 3.

9.   The Nortec® 2000D instrument should increment automatically to CAL PT 4. Position the same 4 mil (0.004") non-conductive shim on the *highest* value (%I.A.C.S.) of the conductivity standard set and place probe on top. Press SAVE *menu soft key* to set CAL PT 4.

10.   CAL VALID will appear at the top of the screen. The Nortec® 2000D instrument and the probe can now be used to measure the conductivity of the test material as well as the thickness of the non-conductive paint layer on the test material. (See **Section 3.16, Conductivity Mode** for complete operating instructions.)

4.7 Corrosion Detection with Dual Frequency

Equipment Used:

CL/SC/6 Cable	Staveley P/N # 9122083
SPO 5327L	Staveley P/N # 9222343
SPO 5851 Corrosion STD.	Staveley P/N # 1918643

1. With the Nortec® 2000D instrument turned ON and probe connected, press the SETUP/SPECIAL key to access the Setup Menu.

2. Press the farthest left hand *menu soft key* until FREQ/SINGLE is highlighted. Rotate the SmartKnob™ until FREQ DUAL is displayed. Next, *Exit* the Setup Menu by pressing the MAIN/FILTER key.

3. Press the FREQ *menu soft key* and rotate the SmartKnob™ until FREQ 1 at 3kHz is displayed.

4. Press the MAIN/FILTER key to display the FREQ 2 menu. Press FREQ 2 *menu soft key* and rotate the SmartKnob™ until FREQ 2 at 1.5kHz is displayed. Press the MAIN/FILTER key.

5. Set the Low Pass Filter to 30, by pressing the LPF *menu soft key* and rotating the SmartKnob™ until LP Filter 30 is displayed.

6. Press the MAIN/FILTER key to return to the Main Menu.

7. To move the Null point to the upper left of the display, press the DISP/ALARM key, then V-POS *menu soft key* and rotate the SmartKnob™ until the V-POS is 80.0%.

8. Press the H-POS *menu soft key*, and rotate the SmartKnob™ until H-POS is 20.0%.

9. Place probe on corrosion STD at Position 1 and press NULL key. See *Figure 4-6* on the following page.

10. Slowly, lift probe off STD, and observe signal.

11. The Liftoff signal must be rotated to move from left to right.

12. Press MAIN/FILTER key, then ANGLE *menu soft key* and rotate SmartKnob™ until the Liftoff signal moves from left to right in a horizontal direction.

13. Press GAIN *menu soft key* and rotate SmartKnob™ until Liftoff signal moves off screen. If necessary, re-adjust the Angle to obtain a horizontal Liftoff signal. (see **Figure 4-7**).

14. Place probe on Position 2 and increase the Gain until the signal moves down (vertically) 6 divisions.

Nortec® SPO 5851 Corrosion Standard
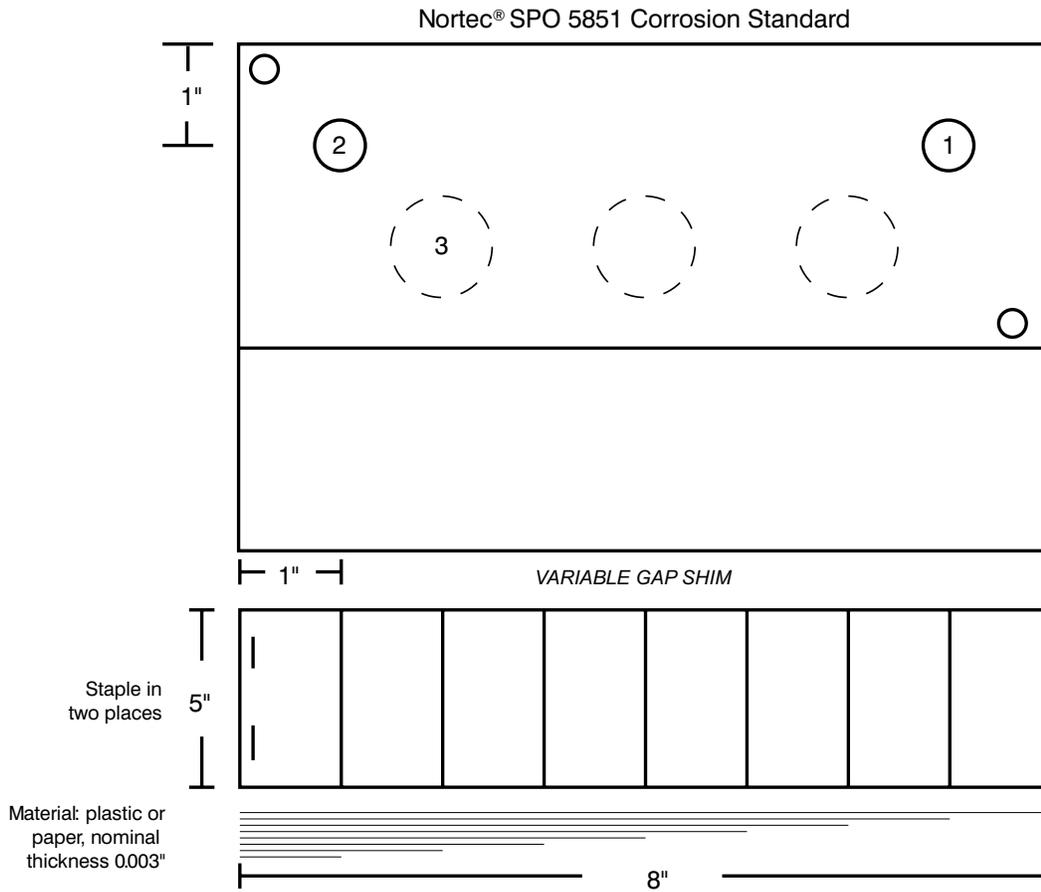
Figure 4-6. *Dual Frequency Eddy Current for Second Layer Corrosion Standard*
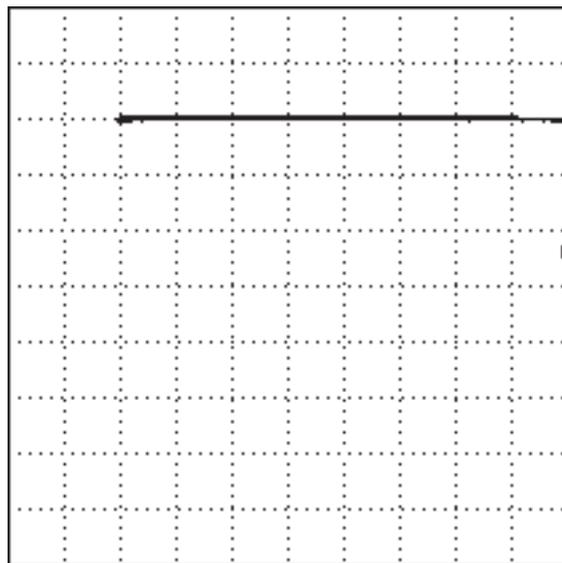
Figure 4-7.

15.   Place probe on Position 1 and press NULL key.

16.   Place probe back on Position 2 and adjust Gain so that the signal moves down (vertically) 6 divisions. If necessary, re-adjust the Angle so that the Liftoff line is horizontal. (see ***Figure 4-8***).
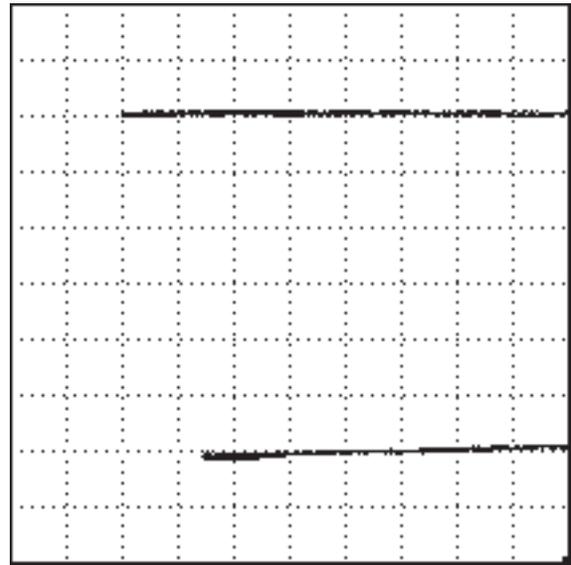
17.   Press the DISP/ALARM key twice to display the Frequency 2 signal. Press the DUAL *menu soft key* and rotate the SmartKnob™ until MAIN DISPL F2 is displayed in the upper right hand corner..

18.   Press the MAIN/FILTER key, GAIN2 *menu soft key* and rotate the SmartKnob™ until H-GAIN2 is 60.0dB and V-GAIN2 is 60.0dB.

Figure 4-8

19.   Place probe on Position 1 and press NULL key, then press the ANGLE *menu soft key* and rotate SmartKnob™ until the Liftoff signal moves from left to right in a horizontal direction.

20.   Place probe on Position 2 and increase the Gain2 until the signal moves down (vertically) 6 divisions from the Null point. Move the probe back to Position 1, and press Null.

21.   Move probe back to Position 2 and adjust Gain or Angle, if necessary. (see ***Figure 4-9***).
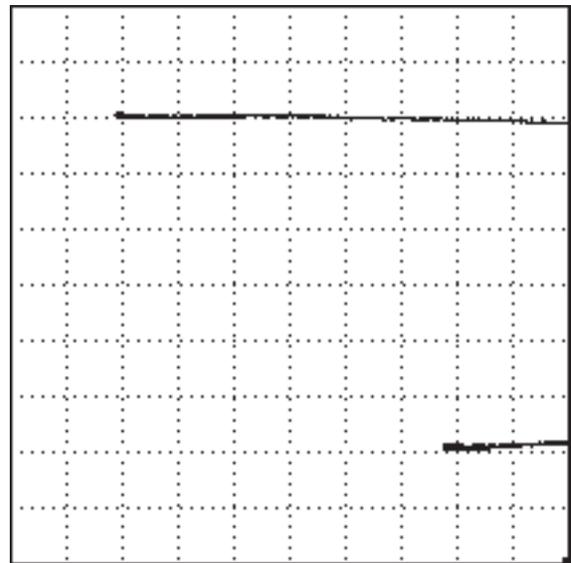
22.   Press the DISPLAY/ALARM key. Change the Null point by pressing the V-POS *menu soft key* and rotate the SmartKnob™ until the V-POS is 20%. Press the H-POS *menu soft key* is 80.0%.

23.   Press the DUAL *menu soft key* and rotate the SmartKnob™ until MAIN DISPL F1-F2 appears. Press the MAIN/FILTER key to return to the Main Menu.

24.   Place probe on Position 1 and press NULL key. Lift probe off STD.

Figure 4-9.

25.   If signal moves to the right, decrease the FREQ1 Horizontal Gain until the signal moves to the left and is almost horizontal.

26.   Press the MAIN/FILTER key twice to access the Frequency 1 Menu. Press the H-GAIN *menu soft key* until the Liftoff signal moves from right to left and is horizontal.

27.   Place probe on Position 2. If the Null point is more than 3 divisions away horizontally, then decrease the Horizontal Gain for Frequency 2.

28.   Rotate the SmartKnob™ until the dot is 3 divisions from the Position 1 Null point.

29.   Place probe on Position 1 and press NULL key.

30.   Tilt probe and observe Liftoff line. If the signal moves from left to right, decrease the H-Gain for Frequency 1 until signal is almost horizontal from right to left. Slide probe to Position 2. This is the gap signal.

31.   If the gap signal is below the Liftoff line, increase the Vertical Gain on Frequency 2.

32.   If the gap signal is above the Liftoff line, decrease the Vertical Gain on Frequency 2.

33.   Press the V-GAIN 2 *menu soft key* and adjust as necessary to make the gap signal parallel to the Liftoff line.

34.   Place the probe on Position 1 and press NULL key.

35.   Slide the probe down the center of the STD, over the simulated corrosion and observe the signals. (see **Figure 4-10**).

36.   To increase the size of the signals, press the SETUP/SPECIAL key.

37.   Press the *menu soft key* below the PRBE DRV MID to highlight and rotate the SmartKnob™ to change from MID to HIGH.

38.   Press the MAIN/FILTER key to return to the Main Menu.

39.   Place the probe on Position 1 and press NULL key.

40.   Slide the probe over the simulated corrosion and decrease the H-Gain2 if gap signal moves off screen.

Figure 4-10.

41.   To increase signal further, increase the V-Gain 2 with the probe on position 2 to move up 4 divisions.

42.   Increase the V-Gain 1 to bring the signal back to the liftoff line. (see **Figure 4-11,** next page).
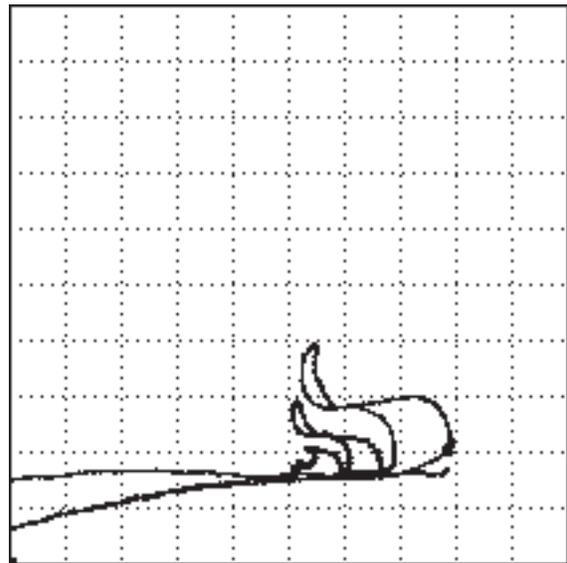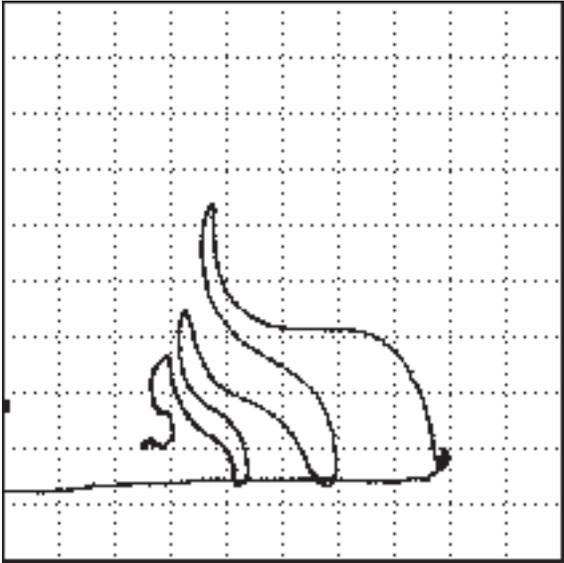
Figure 4-11.

4.8 Scanner Operation

The Nortec® 2000D will operate any of the following optional scanners: RA 2000, Spitfire 2000, PS-5AL, MiniMite, and 19/RA. Simply connect the scanner to the Nortec® 2000D, and the PowerLink™ feature will recognize the existence of the scanner (except the 19/RA, which does not PowerLink™). Turn the SmartKnob™ to confirm the default parameters associated with the scanner. The scanner will be in impedance mode. After preliminary adjustments are made to the flaw display signal, External Sweep must be turned on. Press the DISPLAY/ALARM key, then press the SWEEP *softkey* three times to activate the external sweep.

The MiniMite scanner is variable speed, rotating at 600-3000 RPM, the Spitfire 2000 rotation speed is adjustable from 600-3000 RPM, the PS-5AL rotation speed is adjustable from 40-240 RPM, and the RA 2000 scanner rotation speed is adjustable from 600-2400 RPM (The 19/RA rotation speed is fixed at 1200 RPM). These five scanners are typically used for inspection of fastener holes.

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 shows a vertical displacement. The horizontal position of this indication shows the angular position of the 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 toward the handle.

When using the sweep display, only the vertical channel is displayed. Thus, the instrument rotation should normally be set for maximum displacement of the flaw in the vertical direction in the impedance plane before proceeding to the Sweep setting. However, it might also be a good idea to eliminate the noise in vertical displacement display by changing the angle until the noise signal on the impedance plane becomes horizontal.

Units with software version R01M or Higher can use the Split Screen display for setup. To do this, attach the scanner and confirm PowerLink™ setup. Press the DISPLAY/ALARM key, then the SWEEP *softkey* twice. The split screen will appear. On the **left** side of the display is external sweep, on the **right** the display is impedance plane. Any adjustment of angle on the impedance plane display is linked to the external sweep display. To go to full screen in external sweep, press the SWEEP *softkey* one more time.

PS-5 AL Scanner
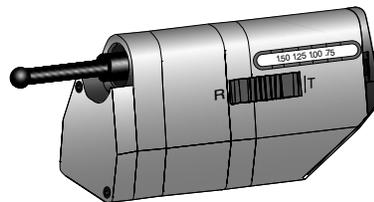
RA-2000 Scanner   Spitfire 2000 Scanner

MiniMite Scanner

4.9   Waterfall Display Functions

The *Waterfall* mode of operation is used in conjunction with a PS-5AL scanner. The PS-5AL type of scanner not only rotates the sensor head, but also gradually moves the sensor head in an axial direction. When the PS-5AL scanner is used in a fastener hole, the rotation provides a sweep of the hole at a certain depth and the vertical movement of the sensor head provides consecutive sweeps at different depths. These two movements combined provides 3-dimensional information of the flaws in the hole.

The term *Waterfall* is descriptive of the type of screen display that appears when this mode is used. This display 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, initiated by a sync pulse supplied by the scanner in use. The *figure* below illustrates a typical waterfall screen resulting when the probe is running in clear air.

The number of sweeps is adjustable from a minimum of 4 to a maximum of 64 using the waterfall display function. The default value is 32 sweeps. A test setup that necessitates the use of more than 32 sweeps automatically places the first 32 lines on one screen display and the remainder on a second screen.

When a scanner with a fixed pitch is used, 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 PS-5AL, the sweep lines only represent the relative forward movement of the probe through a hole.

To start the waterfall display, press the ERASE button. The waterfall screen is then started and the instrument captures a new waterfall. The PS-5AL scanner has two buttons to remotely erase or null the display screen on the Nortec® 2000D.

Clear Waterfall Display

Any waterfall display 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, the impedance plane mode, or one line at a time in the sweep mode**. A sidebar adjacent to the screen display shows the parameters of the stored display including rotation angles, the maximum and minimum depth of the displayed lines, and the depth of the selected line. Section 4.8, *Scanner Operation* should be read before using the Waterfall mode.

The following steps should be taken to setup the Nortec® 2000D instrument for operation in the Waterfall mode with the Staveley PS-5AL:

* and indexing of 0.025"/Revolution
** using the Depth Function controls

1. Insert a probe into the PS-5AL scanner, check for correct switch settings. (Note the following switch settings)

Position the switches as follows:

Probe	Reference Coil Switch	Probe Type Switch
Reflection Absolute	External	Reflection
Differential	External	Bridge
Reflection Differential	External	Reflection
3-Pin Absolute *	External	Bridge
Absolute	Internal 1 or 2	Bridge
2-Pin Gulton	Internal 1 or 2	Bridge

2. With the instrument turned ON, connect the scanner cable to the scanner, then connect the scanner cable to the PROBE connector on the Nortec 2000D instrument.

3. The PowerLink™ function will automatically recognize the existence of the scanner and setup the parameters associated with the scanner. The settings are LPF 40, HPF 8, and RPM 240. Press the MAIN/FILTER key to proceed to the impedance plane display.

4. Setting the operating frequency. Press the FREQ *soft key* and rotate the SmartKnob™ to the correct value. Set the scanner to rotate mode ON. Turn ON the switch.

5. Place the scanner into a reference standard with the coil rotating over an EDM notch. A signal will appear on the display.

6. Press the ANGLE *soft key* and rotate the SmartKnob™ until the signal is vertical. To increase gain for maximum signal, press the GAIN *soft key* and rotate the SmartKnob™ until the maximum signal is achieved.

7. Turn ON the Sweep. Press the DISP/ALARM key until the Display Menu appears. Press the SWEEP *soft key* **twice** to activate Sweep External.

8. Press the SETUP/SPECIAL key to SPECIAL, press the WTFL .. key to access the Waterfall menu. This menu allows the user to adjust the PS-5 scanner RPM, Sync Angle, and activate the Waterfall Display. For additional information see Section 3.14, *Special Functions*.

* Dual coil using reference coil in probe body.

9. Press the WTRFL. . . *soft key* and rotate the SmartKnob™ to the ON position. The Waterfall Display is now active. Press the ERASE key to start the Waterfall. For additional information see Section 3.15, *Waterfall Display Function*.

10. To scan a hole, place the probe tip at the entrance to a hole. Press the ERASE key and slide the shifter from rotate to translate. See figure to the right, *Sample Defect In a Hole Standard.*
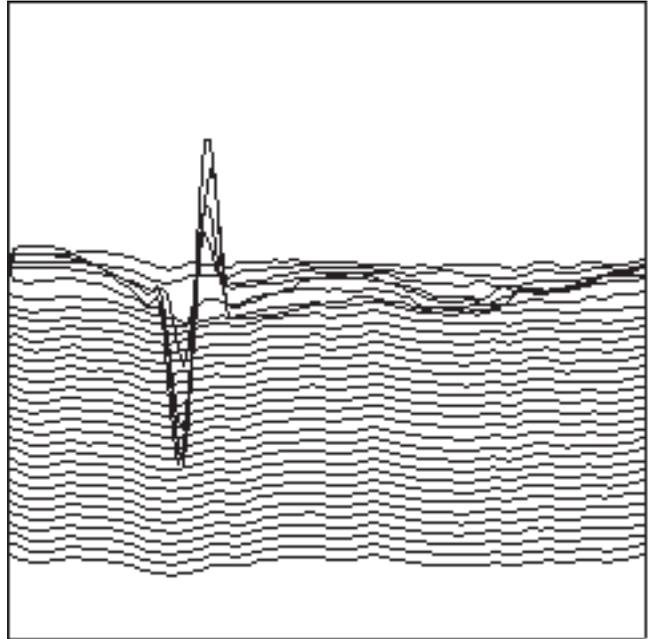
Sample Defect in a Hole Standard

CAUTION!

Care should be taken when operating 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.

This page intentionally left blank

5.0 Nortec® 2000D Computer Interface

What's in this section?
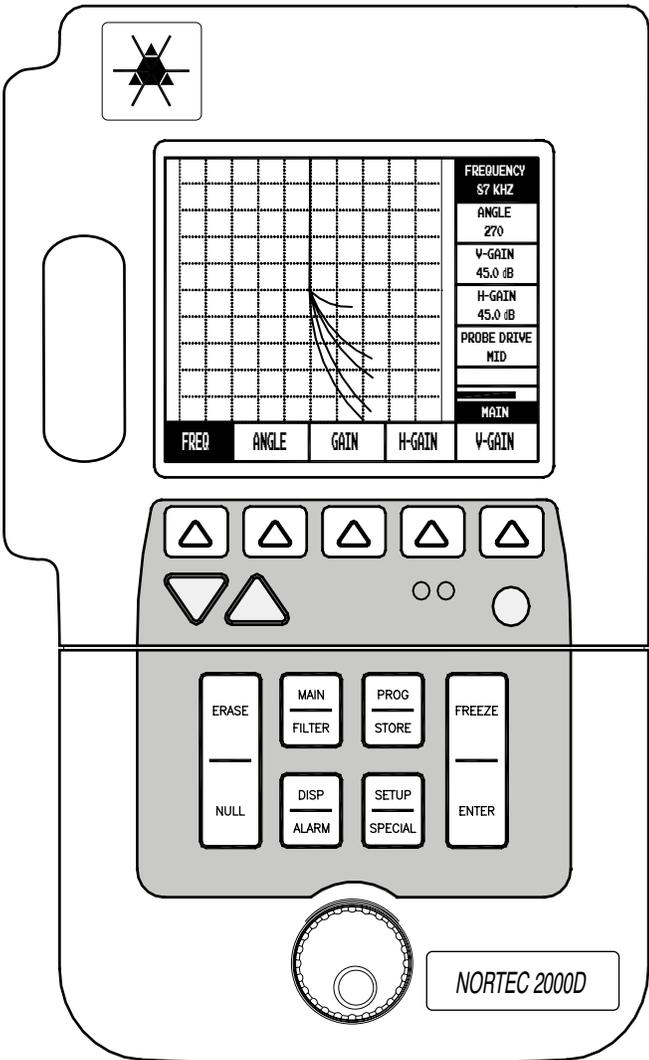
5.1   Description

The Nortec® 2000D Eddyscope 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® 2000D. 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.

5.2   RS-232C Communication

The Nortec® 2000D 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® RS-232 Protocol
Baud Rate	9600 bps *
Word Size	8
Parity	NONE
Stop Bits	1

* Default Setting

The Nortec® 2000D baud rate may be set from 2400 to 57600 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

5.3   DB9S Connector

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 serial printer. Interface cables are also available from Staveley.

Proper connection of the serial port to various devices is tabulated below:

Nortec® Instrument Serial Connector (9 pin male)	Serial 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)

The Nortec® 2000D instrument includes a 9-pin D connector, located on top of the instrument between the RS-232 and probe connectors. The 9-pin D connector adds 3V TTL alarm outputs along with horizontal & vertical analog outputs.

Pin No.	Output Signal	Signal Type
1	Box 3 Alarm	3V TTL
2	Box 1 Alarm	3V TTL
3	Sweep Alarm	3V TTL
4	F2 Horizontal out	±5V
5	F1 Horizontal out	±5V
6	Box 2 Alarm	3V TTL
7	Polar Alarm	3V TTL
8	F2 Vertical out	±5V
9	F1 Vertical out	±5V
Shell	- - -	Ground

9-pin I/O connector
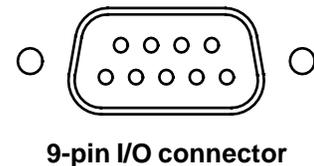
5.4   Modes of Operation

The Nortec® 2000D 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® 2000D 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 Nortec® 2000D responds to serial input differs.

TERMINAL MODE

In terminal mode, the Nortec® 2000D 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® 2000D 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® 2000D 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® 2000D responds (carriage return for HOST mode; prompt, carriage return, and line feed for TERMINAL mode). All commands to the Nortec® 2000D must be terminated by a carriage return **(0D Hex)**. All information sent by the Nortec® 2000D is terminated according to the serial mode (carriage return for HOST mode; carriage return and line feed for TERMINAL mode).

5.5   Command Strings

All communication from an external device to the Nortec® 2000D 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.

Parameter Specification   A three character code that identifies the instrument item or function (See RS-232 Command Set).

Command Specification   A one character code that identifies the operations as READ **'?'**, WRITE **'='**, or EXECUTE **(carriage return)**.

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® 2000D 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® 2000D does NOT process a command string until a carriage return is received.

Rev 6 (3/2005)

5.6   Status Reporting

After receiving a command, the Nortec® 2000D 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® 2000D 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® 2000D 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® 2000D will return **"C?"** terminated with a carriage return (and line feed for terminal mode). If a bad value is received (parameter value), the Nortec® 2000D will return **"V?"** terminated with a carriage return (and line feed for terminal mode).

5.7   RS-232 Command Set

The Nortec® 2000D 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® 2000D 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 on the next several pages.

5.7.1   *Instrument Parameter Commands*

SWEEP ENABLE

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"SWP?"	"OFF" "AUTO" "EXTERNAL"	"SWP=OFF" "SWP=AUTO" "SWP=EXTERNAL"	Prompt	Not Applicable

AUTO-SWEEP TIME

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"AST?"	"#.###"	"AST=#.###"	Prompt	Not Applicable
#.### 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	Not Applicable
#### is a number in the range of 0.10 through 1200 kHz The instrument only implements "Frequency 1" to 2 significant digits.				

FREQUENCY 2

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"FR2?"	"1/2" "1/4" "1/6" "1/8" "1/16"	"FR2=1/2" "FR2=1/4" "FR2=1/6" "FR2=1/8" "FR2=1/16"	Prompt	Not Applicable
Frequency 2 is actually Frequency 1 multiplied by the selected fraction.				

SINGLE/DUAL

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"FSD?"	"SINGLE" "DUAL"	"FSD=SINGLE" "FSD=DUAL"	Prompt	Not Applicable

ANGLE 1

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"AN1?"	"###"	"AN1=###"	Prompt	Not Applicable
### is a number in the range of 0 through 359				

ANGLE 2

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"AN2?"	"###"	"AN1=###"	Prompt	Not Applicable
### is a number in the range of 0 through 359				

LOW FILTER

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"FLO?"	"###" "WB"	"FLO=###" FLO="WB"	Prompt	Not Applicable
### is a number in the range of 10 through 2000 WB is for wideband				

HIGH FILTER

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"FHI?"	"###"	"FHI==###"	Prompt	Not Applicable
### is a number in the range of 0 through 500				

MAIN DISPLAY

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"MSD?"	"F1" "F2" "F1+F2" "F1-F2"	"MSD=F1" "MSD=F2" "MSD=F1+F2" "MSD=F1-F2"	Prompt	Not Applicable

SPLIT SCREEN

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"SPL?"	"OFF" "ON"	"SPL=OFF" "SPL=ON"	Prompt	Not Applicable

SECOND DISPLAY

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"SSD?"	"F1" "F2" "F1+F2" "F1-F2"	"SSD=F1" "SSD=F2" "SSD=F1+F2" "SSD=F1-F2"	Prompt	Not Applicable

COMBINED GAIN 1

Read Command	Returned Value	Write Command	Returned Value	Execute Command
n/a	n/a	"GN1=##.#"	Prompt	Not Applicable
##.# is a number in the range of 0.0 to 90.0 dB. This command sets frequency 1 horizontal and vertical gain values to ##.# dB.				

COMBINED GAIN 2

Read Command	Returned Value	Write Command	Returned Value	Execute Command
n/a	n/a	"GN2=##.#"	Prompt	Not Applicable
##.# is a number in the range of 0.0 to 90.0 dB. This command sets frequency 2 horizontal and vertical gain values to ##.# dB.				

HORIZONTAL GAIN 1

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"HG1?"	"##.#"	"HG1=##.#"	Prompt	Not Applicable
##.# 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	Not Applicable
##.# is a number in the range of 0.0 through 90.0 dB.				

HORIZONTAL GAIN 2

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"HG2?"	"##.#"	"HG2=##.#"	Prompt	Not Applicable
##.# 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	Not Applicable
##.# 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	Not Applicable
###.# 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	Not Applicable
###.# is a number in the range of 0.0 through 100.0 %				

CAPTURE TIME

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"CCT?"	"##.#"	"CCT=##.#"	Prompt	Not Applicable
##.# 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" "MID" "HI"	"PDR=LOW" "PDR=MID" "PDR=HI"	Prompt	Not Applicable

PROBE DESCRIPTION STRING

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"DSC?"	"Probe Description String"	"DSC= probe description"	Prompt	Not Applicable

PROBE TYPE STRING

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"PTP?"	"Probe Type String"	"PTP=Probe type string"	Prompt	Not Applicable

PROBE SERIAL NUMBER STRING

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"PBN?"	"Probe Serial #"	Not Applicable	Prompt	Not Applicable

VARIABLE PERSISTENCE

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"VAP?"	"##"	"VAP=##"	Prompt	Not Applicable
## is a number in the range of 0 (OFF) through 5.0 seconds				

AUTO-SWEEP ERASE

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"ASE?"	"OFF" "ON"	"ASE=OFF" "ASE=ON"	Prompt	Not Applicable

TIMED DISPLAY ERASE

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"CTE?"	"##"	"CTE=##"	Prompt	Not Applicable
## 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" "POLAR" "SWEEP"	"ALT=BOX" "ALT=POLAR" "ALT=SWEEP"	Prompt	Not Applicable

ALARM DWELL

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"ADW?"	"##.#"	"ADW=##.#"	Prompt	Not Applicable
##.# is a number in the range of 0.2 up to 10.0 seconds				

ALARM HORN

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"HRN?"	"OFF" "ON"	"HRN=OFF" "HRN=ON"	Prompt	Not Applicable

GRATICULE

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"GRT?"	"OFF" "ON"	"GRT=OFF" "GRT=ON"	Prompt	Not Applicable

CLOCK TIME

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"TIM?"	"hh:mm:ss"	Not Applicable	N/A	Not Applicable
Instrument time is expressed as hh:mm:ss, where: **hh** is the hours (0-23) **mm** is the minutes (0-59) **ss** is the seconds (0-59)				

HOURS

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"HR.?"	"##"	"HR.=##"	Prompt	Not Applicable
## 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	Not Applicable
## 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	Not Applicable
## is an number in the range of 0 through 59 seconds				

CLOCK DATE

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"DAT?"	"ddmmyy"	Not Applicable	N/A	Not Applicable
Instrument date is expressed as **ddmmyy**, where: **dd** is the day (1-31) **mm** is the month (1-12) **yy** is the year (0-99)				

DAY

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"DAY?"	"##"	"DAY=##"	Prompt	Not Applicable
## is a number in the range of 0 through 31 days				

MONTH

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"MON?"	"##"	"MON=##"	Prompt	Not Applicable
## is a number in the range of 1 through 12 months				

YEAR

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"YR.?"	"##"	"YR.=##"	Prompt	Not Applicable
## is a number in the range of 0 through 99 year				

READ REPORT HEADER

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"RHD=1"	"AAAAA"	Not Applicable
"AAAAA" is an ASCII string of 26 characters in length.				

SET REPORT HEADER

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"SHD=1" "AAAAA"	Prompt	Not Applicable
"AAAAA" is an ASCII string of no more than 26 characters in length. Note that the Nortec® 2000D 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 header: 1. Host sends "Report Header" command (SHD=1) 2. Host waits for the Nortec® 2000D to respond with a carriage return (0DHex) 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
Not Applicable	Not Applicable	"RLB=#"	"AAAAA"	Not Applicable
# 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
Not Applicable	Not Applicable	"SLB=#" "AAAAA"	Prompt	Not Applicable
# 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® 2000D 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® 2000D to respond with a carriage return (0DHex) 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
Not Applicable	Not Applicable	"RFL=#"	"AAAAA"	Not Applicable
# 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
Not Applicable	Not Applicable	"SFL=#" "AAAAA"	Prompt	Not Applicable

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® 2000D 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® 2000D to respond with a carriage return (0DHex) or an error prompt. 3. If no error was encountered, the host sends the 40 character string and waits for a prompt

CLEAR PROGRAMS

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"CLP"	Prompt

CLEAR DATA

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"CLD"	Prompt

CLEAR DATA STORED

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"CLS"	Prompt

CLEAR REPORT

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"CLR"	Prompt

CLEAR INSTRUMENT

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"CLI"	Prompt
The host should expect a 5 to 10 second delay before receiving a response from this command. After this command, the RS232 interface reverts to **HOST** mode.					

LOAD DEFAULT

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"LOD"	Prompt
The host should expect a 5 to 10 second delay before receiving a response from this command.					

UPLOAD WATERFALL DATA

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"WUP=##"	Binary data	Not Applicable
## is a number in the range of 1 through 20				

DOWNLOAD WATERFALL DATA

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"WDN=##"	CR	Not Applicable
## is a number in the range of 1 through 20 , Program and Data				

WATERFALL ENABLE ON/OFF

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"WEN?"	"ON" "OFF"	"WEN=ON" "WEN=OFF"	Prompt	Not Applicable

WATERFALL FIRST SWEEP

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"WMN?"	"1-63"	"WMN=#"	Prompt	Not Applicable
# = number 1-63				

WATERFALL LAST SWEEP

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"WMX?"	"4-64"	"WMX=#"	Prompt	Not Applicable
# = number 4-64				

WATERFALL ANGLE

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"WAN?"	"0-359"	"WAN=#"	Prompt	Not Applicable
# = number of degrees (0-359)				

WATERFALL DEPTH INDICATOR

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"WHI?"	"0.025, 0.050 . . ."	"WHI=0, 1, . . ."	Prompt	Not Applicable
WHI Number = depth/0.025				

WATERFALL DISPLAY MODE

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"WDM?"	"MAP" "SWP" "IMP"	"WDM=0, 1, 2 "	Prompt	Not Applicable
0 = MAP 1 = SWP 2 = IMP				

BOX 1/2/3 TOP

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"B1T?" "B2T?" "B3T?"	"###.#"	"B1T=###.#" "B2T=###.#" "B3T=###.#"	Prompt	Not Applicable
###.# 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?" "B2L?" "B3L?"	"###.#"	"B1L=###.#" "B2L=###.#" "B3L=###.#"	Prompt	Not Applicable
###.# 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?" "B2B?" "B3B?"	"###.#"	"B1B=###.#" "B2B=###.#" "B3B=###.#"	Prompt	Not Applicable
###.# 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?" "B2R?" "B3R?"	"###.#"	"B1R=###.#" "B2R=###.#" "B3R=###.#"	Prompt	Not Applicable
###.# is a number in the range of 0.0 through 100.0 % The alarm box right setting must obey the following inequality: **alarm box left < ###.# <= 100.0**				

BOX 1/2/3 ENABLE

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"B1E?" "B2E?" "B3E?"	"AAA"	"B1E=AAA" "B2E=AAA" "B3E=AAA"	Prompt	Not Applicable
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 TOP

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"SWT?"	"###.#"	"SWT=###.#"	Prompt	Not Applicable
###.# is a number in the range of 0.0 through 100.0 % The sweep alarm top setting must obey the following inequality: **sweep alarm bottom < ###.# <= 100.0**				

SWEEP ALARM BOTTOM

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"SWB?"	"###.#"	"SWB=###.#"	Prompt	Not Applicable
###.# is a number in the range of 0.0 through 99.5 % The sweep alarm top setting must obey the following inequality: **0.0 <= ###.# <= sweep alarm top**				

SWEEP ALARM ENABLE

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"SWE?"	"AAA"	"SWE=AAA"	Prompt	Not Applicable
AAA is the OFF/POLARITY state of the sweep alarm. AAA must be one of the 3 following strings: **"OFF", "POSITIVE", "NEGATIVE"**				

X COORDINATE

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"POX?"	"###.#"	"POX=###.#"	Prompt	Not Applicable
###.# is a number in the range of 0.0 through 100 % The polar alarm X coordinate must obey the following inequality: **polar alarm radius <= ###.# <= 100.0 - polar alarm radius**				

Y COORDINATE

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"POY?"	"###.#"	"POY=###.#"	Prompt	Not Applicable
###.# is a number in the range of 0.0 through 100 % The polar alarm Y coordinate must obey the following inequality: **polar alarm radius <= ###.# <= 100.0 - polar alarm radius**				

RADIUS

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"POR?"	"###.#"	"POR=###.#"	Prompt	Not Applicable
###.# is a number in the range of 0.0 through 100 % The polar alarm radius must obey the following inequality: **###.# <= polar X position,** **###.# <= 100.0 - polar X position** **###.# <= polar Y position** **###.# <= 100.0 - polar Y position**				

POLAR ALARM ENABLE

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"POE?"	"AAA"	"POE=AAA"	Prompt	Not Applicable
AAA is the OFF/POLARITY state of the polar alarm. AAA must be one of the 3 following strings: **"OFF", "POSITIVE", "NEGATIVE".**				

PROGRAM NUMBER

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"PGM?"	"###"	"PGM=###"	Prompt	Not Applicable
### is a number in the range of 1 through 120					

PROGRAM STATUS

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"PEF=###"	"E", "F", "W", or "R"	Not Applicable
### is a number in the range of 1 through 120 The returned values are defined as follows: "E" Program is *EMPTY* "F" Program is *FULL*					

STORE PROGRAM

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"PST=###"	Prompt	Not Applicable
### is a number in the range of 1 through 100					

RECALL PROGRAM

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"PRC=###"	Prompt	Not Applicable
### is a number in the range of 1 through 100					

ERASE PROGRAM

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"PER=###"	Prompt	Not Applicable
### is a number in the range of 1 through 100					

READ PROGRAM NAME

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"PRN=###"	"AAAAA"	Not Applicable
### is a number in the range of 1 through 100 "AAAAA" is an ASCII string 26 characters in length.					

SET PROGRAM NAME

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"PSN=###" "AAAAA"	Prompt	Not Applicable

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® 2000D 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 "Program Name" command (PSN=1)
2. Host waits for the Nortec® 2000D to respond with a carriage return
   (0DHex) 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
Not Applicable	Not Applicable	"PPR=###"	"PPPPP"	Not Applicable
### is a number in the range of 1 through 100 PPPPP represents printer formatted data that will consist of a stream of text and EPSON compatible escape codes.				

UPLOAD PROGRAM (BINARY)

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"PUP=###"	SSB..BC	Not Applicable
### is a number in the range of 1 through 100. 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® 2000D. 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
Not Applicable	Not Applicable	"PDN=###" SSB..BC	Prompt	Not Applicable

is a number in the range of 1 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® 2000D. The Nortec® 2000D 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® 2000D 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 LOCATION

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"DAL?"	"##"	"DAL=##"	Prompt	Not Applicable
## is a number in the range of 1 through 20					

DATA STATUS

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"DEF=###"	"E", "F", "W", or "R"	Not Applicable
## is a number in the range of 1 through 20 The returned values are defined as follows: 1. Data is EMPTY 2. Data is FROZEN 3. Data is WATERFALL 4. Data is REPLAY					

FREEZE DATA

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"DAF=##"	Prompt	Not Applicable
## is a number in the range of 1 through 20					

DATA CAPTURE (ONCE)

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"DC1=##"	Prompt	Not Applicable
## is a number in the range of 1 through 20					

BEGIN DATA CAPTURE (CONTINUOUS)

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"DCB"	Prompt

END DATA CAPTURE (CONTINUOUS)

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	"DCE=##"	Prompt	Not Applicable	Not Applicable
## is a number in the range of 1 through 20					

RECALL DATA

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"DRC=##"	Prompt	Not Applicable
## is a number in the range of 1 through 20				

ERASE DATA

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"DER=##"	Prompt	Not Applicable
## is a number in the range of 1 through 20				

READ DATA NAME

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"DRN=##"	"AAAAA"	Not Applicable
## 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
Not Applicable	Not Applicable	"DSN=##" "AAAAA"	Prompt	Not Applicable
## 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® 2000D 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 Data Name" command (DSN=1) 2. Host waits for the Nortec® 2000D to respond with a carriage return (0DHex) or an error prompt. 3. If no error was encountered, the host sends the 26 character string and waits for a prompt				

UPLOAD DATA (BINARY)

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"DUP=##"	SSB..BC	Not Applicable
## 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® 2000D. 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 DATA (BINARY)

Read Command	Returned Value	Write Command	Returned Value	Execute Command
Not Applicable	Not Applicable	"DDN=##" SSB..BC	Prompt	Not Applicable
## 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 program data, acquired using the program upload command, back to the Nortec® 2000D. The Nortec® 2000D 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 Data" command (DDN=1) 2. Host waits for the Nortec® 2000D 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				

SCREEN DUMP (BIT MAP)

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"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 display 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.

COLOR *('+' models with color display installed only)*

Read Command	Returned Value	Write Command	Returned Value	Execute Command
"CSH?"	"#"	"CSH= #"	Prompt	Not Applicable

is a number in the range of 1-8

1. Black Background, White Text / Graticule, Green Signal

2. Black Background, White Text / Graticule, Red Signal

3. Blue Background, Black Text / Graticule, Red Signal

4. Blue Background, Black Text / Graticule, White Signal

5. White Background, Blue Graticule, Black Text, Green Signal

6. Black Background, Red Text / Graticule, White Signal

7. Black Background, White Text / Graticule, Blue Signal

8. Black Background, White Text / Graticule, Cyan Signal

ALARM CONDITION

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
"ALC?"	"##"	Not Applicable	Not Applicable	Not Applicable	Not Applicable

is a number in the range of 0 through 16 based on the alarm type:

BOX alarm	0-2	bit 0	box 3
POLAR alarm	0 or 1	bit 1	box 2
		bit 2	box 1
		bit 3	polar
		bit 4	sweep

INSTRUMENT VERSION

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
"VER?"	"R##A"	Not Applicable	Not Applicable	Not Applicable	Not Applicable

The instrument firmware version is R##A, where:

R   ...   Indicates Revision
...   Indicates major revision level (00-99)
A   ...   Indicates minor revision level (A-Z)

BATTERY STATUS

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
"BAT?"	"LOW" "OK"	Not Applicable	Not Applicable	Not Applicable	Not Applicable

HOST MODE

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"HST"	Prompt

TERMINAL MODE

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"TRM"	Prompt

INSTRUMENT NAME

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
"NAM?"	"Nortec® 2000D"	Not Applicable	Not Applicable	Not Applicable	Not Applicable

REMOTE NULL

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"NUL"	Prompt

REMOTE ERASE

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"ERS"	Prompt

REMOTE ENTER

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"ENT"	Prompt

REMOTE MAIN

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"KMN"	Prompt

REMOTE MAIN 2

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"KM2"	Prompt

REMOTE FILTER

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"KFL"	Prompt

REMOTE DISPLAY

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"KDS"	Prompt

REMOTE ALARM

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"KAL"	Prompt

REMOTE PROGRAM

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"KPR"	Prompt

REMOTE STORE

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"KST"	Prompt

REMOTE SETUP

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"KSE"	Prompt

REMOTE SPECIAL

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"KSP"	Prompt

REMOTE SOFT KEY 1

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"KS1"	Prompt

REMOTE SOFT KEY 2

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"KS2"	Prompt

REMOTE SOFT KEY 3

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"KS3"	Prompt

REMOTE SOFT KEY 4

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"KS4"	Prompt

REMOTE SOFT KEY 5

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"KS5"	Prompt

REMOTE UP ARROW

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"KUA"	Prompt

REMOTE DOWN ARROW

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"KDA"	Prompt

INSTRUMENT RESET

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
Not Applicable	Not Applicable	Not Applicable	Not Applicable	"RST"	Prompt
The host should expect a 5 to 10 second delay before receiving a response from this command. After this command, the RS232 interface reverts to **HOST** mode.					

FLYING DOT TYPE

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
"FDT?"	"DOT" "BOX"	"FDT=DOT" "FDT=BOX"	Prompt	Not Applicable	Not Applicable

SCANNER RPM

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
"RPM?"	"####"	"RPM=####"	Prompt	Not Applicable	Not Applicable
#### is a number in the range 40 through 3000					

SYNC SWEEP ANGLE

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
"SCZ?"	0-359	"SCZ=###"	Prompt	Not Applicable	Not Applicable
0 through 359 degrees					

X-Y AVERAGE (ASCII)

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
"AVA?"	"XXXX YYYY"	Not Applicable	Not Applicable	Not Applicable	Not Applicable
XXXX and YYYY are ASCII numbers in the range 0 through 127, 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	Returned Value
"AVB?"	"XXXX YYYY"	Not Applicable	Not Applicable	Not Applicable	Not Applicable
XXXX and YYYY are ASCII numbers in the range 0 through 127, 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	Returned Value
Not Applicable	Not Applicable	"BPS=2400" "BPS=4800" "BPS=9600" "BPS=19200" "BPS=38400" "BPS=57600"	Prompt	Not Applicable	Not Applicable

PRINTER SELECTION

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
"PRT?"	"EPSON" "HP-PCL" "24-PIN" "PENTAXII"	"PRT=EPSON" "PRT=HP-PCL" "PRT=24-PIN" "PRT=PENTAXII"	Prompt	Not Applicable	Not Applicable

KEYBOARD SELECTION

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
"RLK?"	"OFF" "ON"	"RLK=OFF" "RLK=ON"	Prompt	Not Applicable	Not Applicable

LCD CONTRAST

Read Command	Returned Value	Write Command	Returned Value	Execute Command	Returned Value
"CNT?"	"0-31"	"CNT=0-31"	Prompt	Not Applicable	Not Applicable

5.8   RS-232 Quick Reference

Parameter	Command	RWX	Parameter	Command	RWX
Sweep Enable	SWP	RW	Alarm Box 3 Right	B3R	RW
Auto-Sweep Time	AST	RW	Alarm Box 1 Enable	B1E	RW
Frequency 1	FR1	RW	Alarm Box 2 Enable	B2E	RW
Frequency 2	FR2	RW			
Angle 1	AN1	RW	Alarm Box 3 Enable	B3E	RW
Angle 2	AN2	RW			
Lowpass Filter	FLO	RW	Sweep Alarm Top	SWT	RW
Highpass Filter	FHI	RW	Sweep Alarm Bottom	SWB	RW
Combined Gain 1	GN1	W	Sweep Alarm Enable	SWE	RW
Combined Gain 2	GN2	RW			
Horizontal Gain 1	HG1	RW	Alarm Horn	HRN	RW
Horizontal Gain 2	HG2	RW			
Vertical Gain 1	VG1	RW	Display Graticule	GRT	RW
Vertical Gain 2	VG2	RW			
Horizontal Position	HPO	RW	Instrument Time	TIM	R
Vertical Position	VPO	RW	Hours	HR.	RW
Capture Time	CCT	RW	Minutes	MIN	RW
Probe Drive	PDR	RW	Seconds	SEC	RW
Probe Description String	DSC	RW			
Probe Type String	PTP	RW			
Probe Serial Number String	PBN	R	Color ('+' instruments with color display *only*)	CSH	RW
Variable Persistence	VAP	RW	Instrument Date	DAT	R
Auto-Sweep Erase	ASE	RW	Day	DAY	RW
Timed Erase	CTE	RW	Month	MON	RW
Alarm Type	ALT	RW	Year	YR.	RW

Parameter	Command	RWX	Parameter	Command	RWX
Alarm Dwell	ADW	RW	Read Print Header	RHD	WO
Alarm Box 1 Bottom	B1B	RW	Set Print Header	SHD	WO
Alarm Box 2 Bottom	B2B	RW	Read Print Label	RLB	WO
Alarm Box 3 Bottom	B3B	RW	Set Print Label	SLB	WO
Alarm Box 1 Top	B1T	RW	Read Print Field	RFL	WO
Alarm Box 2 Top	B2T	RW	Set Print Field	SFL	WO
Alarm Box 3 Top	B3T	RW	Keyboard Lockout	RLK	RW
Alarm Box 1 Left	B1L	RW	LCD Contrast	CNT	RW
Alarm Box 2 Left	B2L	RW	Freq. Mode	FSD	RW
Alarm Box 3 Left	B3L	RW	Clear Programs	CLP	X
Polar Alarm X	POX	RW	Clear Data Stored	CLS	W
Polar Alarm Y	POY	RW	Clear Report	CLR	X
Polar Alarm Enable	POE	RW	Clear Data	CLD	X
			Clear Instrument	CLI	X
Upload Program (BIN)	PUP	W	Load Default	LOD	X
Data Storage Location	DAL	RW	Upload Waterfall Data	WUP	W
Data Status	DEF	W	Download Waterfall Data	WDN	W
Freeze Data	DAF	W	Waterfall Enable On or Off	WEN	RW
Data Capture End	DCE	W	Waterfall First Sweep	WMN	RW
Recall Data	DRC	W	Waterfall Last Sweep	WMX	RW
Erase Data	DER	W	Waterfall Angle	WAN	RW
Read Data Name	DRN	W	Waterfall Depth Indicator	WHI	RW
Set Data Name	DSN	W	Waterfall Display Mode	WDM	RW
Upload Data (BIN)	DUP	W	Set Program Name	PSN	W

Parameter	Command	RWX	Parameter	Command	RWX
Download Data (BIN)	DDN	W	Print Program	PPR	W
Screen Dump	SCR	X	Alarm Condition	ALC	R
Program Number	PGM	RW	Instrument Version	VER	R
Program Status	PEF	W			
Store Program	PST	W	Battery Status	BAT	R
Recall Program	PRC	W	Host Mode	HST	X
Erase Program	PER	W	Terminal Mode	TRM	X
Read Program Name	PRN	W	X-Y Average Binary	AVB	R
Reset Instrument	RST	X	Instrument Name	NAM	R
Scanner RPM	RPM	RW	Instrument Options	OPT	R
Sync Sweep Angle	SCZ	RW	Remote Null	NUL	X
Baud Rate	BPS	W	Remote Erase	ERS	X