

# Battery-Powered EMC Field Probes

HI-6023, HI-6006, HI-6053

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## User Manual

PN: 399395

February, 2023

Rev F

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### Revision Record

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B	Updated range for HI-6105 and HI-6006	February, 2018
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E	Removed obsoleted HI-6105 and HI-6122 and HI-6153	July, 2022
F	Corrected voltage on battery chargers	February, 2023

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## NOTES, CAUTIONS AND WARNINGS

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	<b>Note:</b> Denotes helpful information intended to provide tips for better use of the product.
	<b>CAUTION:</b> Denotes a hazard. Failure to follow instructions could result in minor personal injury and/or property damage. Included text gives proper procedures.
	<b>WARNING:</b> Denotes a hazard. Failure to follow instructions could result in <b>SEVERE</b> personal injury and/or property damage. Included text gives proper procedures.

\*All notes, cautions, and warnings will be located on the left column area of the page.






See the ETS-Lindgren *Product Information Bulletin* for safety, regulatory, and other product marking information



## SAFETY INFORMATION

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	See the ETS-Lindgren <i>Product Information Bulletin</i> for safety, regulatory, and other product marking information.
	Waste Electrical and Electronic Equipment (WEEE) Directive: (European Union) At end of useful life, this product should be deposited at an appropriate waste disposal facility for recycling and disposal. Do not dispose of with household waste.
	Recyclable Products: This product includes rechargeable batteries. At end of useful life, please recycle the used batteries, or dispose of them safely and properly. Many cities collect used batteries for recycling or disposal. You may contact your local waste disposal agency for information on battery recycling and disposal.



See the ETS-Lindgren *Product Information Bulletin* for safety, regulatory, and other product marking information.



ETS-Lindgren may substitute a similar part or new part number with the same functionality for another part/part number. Contact ETS-Lindgren for questions about part numbers and ordering parts.



Only qualified personnel should operate (or service) this equipment. If you have any questions concerning maintenance, contact ETS-Lindgren Technical Support. Warranty may be voided if housing is opened.

## INTRODUCTION

The **ETS-Lindgren Battery Powered EMC Field Probes** utilize three orthogonal sensors to provide an isotropic reading of the electric field. The HI-60XX Series uses either the HI-4413P Fiber Optic Modem or the HI-4413USB Fiber Optic to USB Converter to communicate with ProbeView II™ software through a port on the computer. Model numbers covered in this manual:

- HI-6023
- HI-6006
- HI-6053

### Standard Configuration

With each field probe model you receive the following:

- Fiber Optic Cable (10-meter)
- Fiber Optic Coupling (2)
- Battery Charger
- Carrying Case

### ETS-Lindgren Product Information Bulletin

See the ETS-Lindgren *Product Information Bulletin* included with your shipment for the following:

- Safety, regulatory, and other product marking information
- Steps to receive your shipment
- Steps to return a component for service
- ETS-Lindgren calibration service
- ETS-Lindgren contact information

### Readout Options

#### EMCenter 2 + 7 Slot with 7007-001 Card

The EMCenter 2 and 7 can be used as a Field Monitor in addition to its capability as a system level platform. The EMCenter 2 and 7 can interface with TILE! and most third party software packages for remote operation. All EMCenter 2 and 7 models include LAN and USB communication with GPIB as an option.



EMCenter



7007-001



For information on reducing measurement uncertainties and selecting the best field probe for your application, see *Practical Considerations for Radiated Immunities Measurement using ETS-Lindgren EMC Probes* located in the white papers section on the ETS-Lindgren website.



For complete information on setting up and operating the field monitor, software, and other devices available for field probes, please see the documentation provided with those products.



Keep all conductive objects away from field probes. Conductive objects in the proximity of the probe can distort the near field and compromise measurement accuracy. If the application requires measurements from a fixed position, always mount the probe on a non-metallic platform using non-metallic screws.

### HI-4413P Fiber Optic Modem

The HI-4413P Fiber Optic Modem connects the probes to the computer.

### HI-4413 USB Fiber Optic To USB Converter

The HI-4413USB Fiber Optic to USB converter connects the probe through a USB port on the computer.



HI-4413P Fiber Optic Modem



HI-4413USB Fiber Optic to USB Converter

### Additional Options

#### H-491009 Tripod

The H-491009 Dielectric Tripod is the preferred method for mounting field probes for making unperturbed field measurements. It includes a 1/4–20 UNC threaded stud for mounting any ETS-Lindgren probe with a tripod mount. It is designed with an adjustable center post and a rotating mount.



Tripod

#### H-491269 Probe Stand

The ETS-Lindgren Probe Stand may also be used in testing configurations. The probe stand supports multiple probes with additional probe carriers.



Probe Stand

### About Probe Operation

Field probes are nominally rated for operation within a specific frequency range, but may also respond to signals above and below those frequencies. A probe may exhibit response to frequencies below the lower end of the range, and may also respond to frequencies above the upper end of the range, though not consistently or predictably.



Before using your battery-operated probe, read their respective sections in the Appendices.

To calibrate the probe prior to shipment, ETS-Lindgren also charges the internal battery at the factory. Every effort is made to make sure that the probe arrives ready to use, but you should verify the condition of the battery prior to making any measurements.



For a list and description of communication and information transfer protocols, including command structure and probe commands, see *Appendix D: Operating Protocols*.



For the HI-6053, HI-6006, and HI-6023 products, it is recommended that the battery(ies) be removed when stored for extended periods of time.

## FEATURES

The HI-60XX Series Field Probe is a battery-operated probe that utilizes three orthogonal sensors to provide an isotropic reading of the electric field. When requested, X, Y, Z, and total field data can be reported, making the HI-60XX Series true 3-axis probes.

### HI-6023 Field Probe

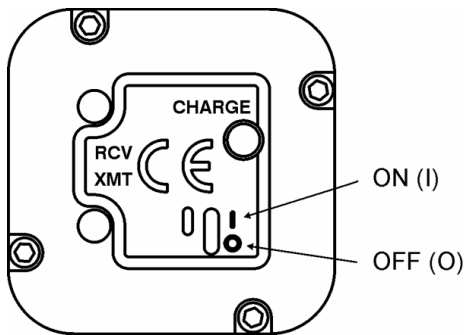
The **ETS-Lindgren HI-6023 Field Probe** provides broadband frequency coverage and wide dynamic range that satisfies the demands of most test requirements.

The frequency response of the HI-6023 is 10 kHz to 1 GHz, and the dynamic range is 2 to 800 Volts per meter (V/m).

The HI-6023 is a true 3-axis probe. When requested, X, Y, Z, and total field data can be reported.



### HI-6023 Power Switch



The power switch activates and deactivates the HI-6023:

**ON (I)**—When the power switch is in the I position, an internal 4.8 VDC Nickel-Metal Hydride (NiMH) battery provides power to the probe, and the power indicator LED blinks.

**OFF (O)**—When the power switch is in the O position, the probe is inactive. To prolong battery life, set the switch to **OFF** when the probe is not in use.

### HI-6006 Field Probe

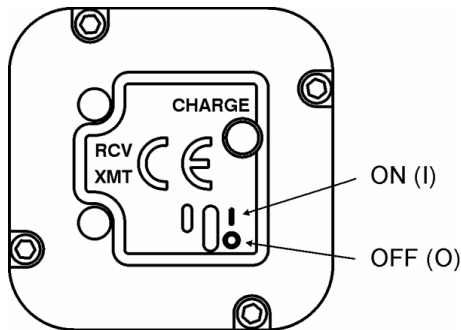
The **ETS-Lindgren HI-6006 Field Probe** is a fully intelligent sensor enabling fast and accurate EMF measurements with industry-leading performance specifications. Optical coupling to a variety of readout options makes this probe ideally suited for a wide range of field monitoring applications.

The HI-6006 is a true 3-axis probe. When requested, X, Y, Z, and total field data can be reported.



### HI-6006 Power Switch

The power switch activates and deactivates the HI-6006:



**ON (I)**—When the power switch is in the I position, an internal 4.8 VDC Nickel-Metal Hydride (NiMH) battery provides power to the probe, and the power indicator LED blinks.

**OFF (O)**—When the power switch is in the O position, the probe is inactive. To prolong battery life, set the switch to **OFF** when the probe is not in use.

### HI-6053 Field Probe

The **ETS-Lindgren HI-6053 Field Probe** provides broadband frequency coverage and wide dynamic range that satisfies the demands of most test requirements.





Before using your battery-operated probe, read their respective sections in the Appendices.

To calibrate the probe prior to shipment, ETS-Lindgren also charges the internal battery at the factory. Every effort is made to make sure that the probe arrives ready to use, but you should verify the condition of the battery prior to making any measurements.



For a list and description of communication and information transfer protocols, including command structure and probe commands, see *Appendix D: Operating Protocols*.



For the HI-6053, HI-6006, and HI-6023 products, it is recommended that the battery(ies) be removed when stored for extended periods of time.

The frequency response of the HI-6053 is 10 MHz to 40 GHz, and the dynamic range is 2 to 800 Volts per meter (V/m).

The HI-6053 assembly consists of a pyramidal casing containing the sensor, which is mounted on one end of a shaft. The other end of the shaft is attached to an extrusion that houses the electronics. The sensor and electronics housing operate and are calibrated as a unit.

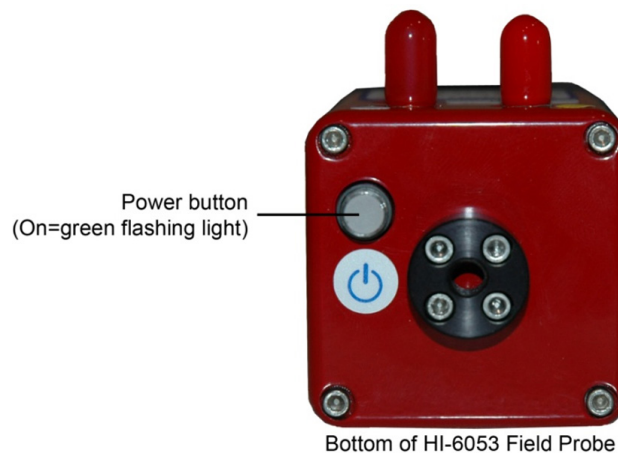


The HI-6053 is a true 3-axis probe. When requested, X, Y, Z, and total field data can be reported.



### HI-6053 Power Switch

The power button that activates and deactivates the HI-6053 is located on the bottom of the electronic housing. A green indicator light in the power button flashes when the probe is on.

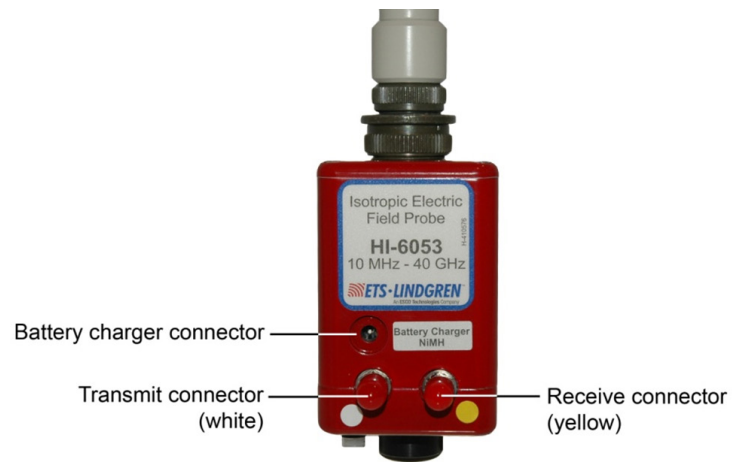


**On**—To turn the HI-6053 on, push in the power button, and then release. The power button flashes a green indicator light when the probe is on, and four AAA Nickel-Metal Hydride (NiMH) batteries supply power.

**Off**—To turn the HI-6053 off, push in the power button, and then release. The green indicator light stops flashing, indicating the probe is off. When not in use, turn the probe off to prolong battery life.

### HI-6053 Controls

Two fiber optic connectors and a battery charger connector are mounted on the HI-6053 housing.





ETS-Lindgren may substitute a similar part or new part number with the same functionality for another part/part number. Contact ETS-Lindgren for questions about part numbers and ordering parts.



Only qualified personnel should operate (or service) this equipment. If you have any questions concerning maintenance, contact ETS-Lindgren Technical Support. Warranty may be voided if housing is opened.

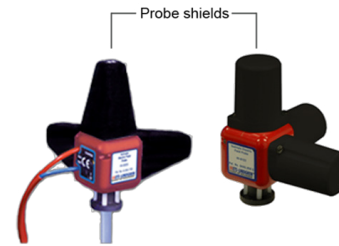
## MAINTENANCE

### Probe Shield Care and Replacement

This section applies only to the following probes; for probe shield part numbers:

- HI-6023
- HI-6006

Over time the probe shields may accumulate foreign materials that could become embedded in the shield surface. Probe shields must be kept clean to maintain proper operation.



If the probe shields need to be replaced, you may order them from ETS-Lindgren. Follow these steps to replace the probe shields:

1. Remove the nylon screws from the probe shield.
2. Lift the shield straight up and away from the housing. Lift the shield high enough to clear the internal antenna assembly, or you may damage the assembly. Never touch the antenna assembly. You may transfer a static charge to the assembly that may distort or disable the measuring capability in that axis.
3. With the probe in a protective, supportive position, carefully replace the probe shield by lowering it straight down onto the housing.
4. Make sure to clear the internal antenna assembly when lowering the shield or you may damage the assembly.
5. Replace the screws snugly without over-tightening them.
6. Over-tightening the screws may damage the screw heads. If you require additional nylon screws, you may order them from ETS-Lindgren or obtain them locally. Non-conductive screws must be used for this application. Never use metal screws.
7. Repeat this procedure for the other shields, if necessary.





To order replacement screws for the HI-6023 / HI-6006 battery hatch, see "Battery Charger, Battery, Battery Hatch Replacement Screws" on page 20



The HI-6006 probe is shown in the following steps; the steps are identical for the HI-6023.

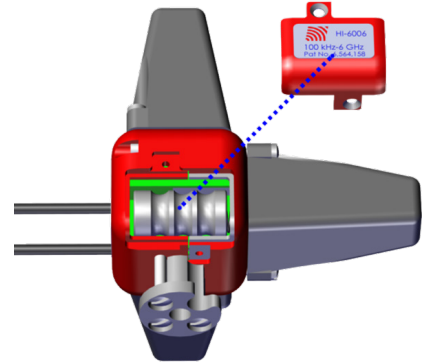
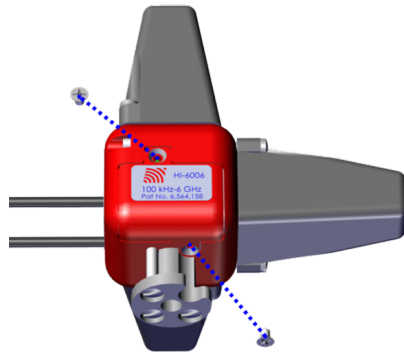


Notice the location of the + (positive) and - (negative) marks on the battery and inside the probe. You will use these marks in step 4 to install the new battery.

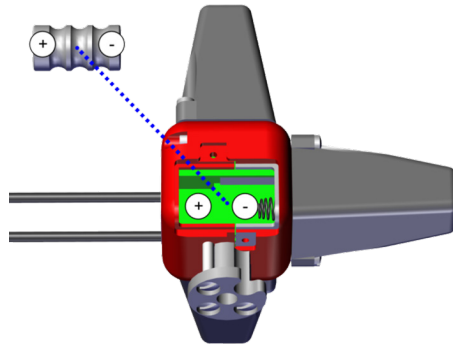
## Battery Replacement

### HI-6023 & HI-6006 Battery Replacement

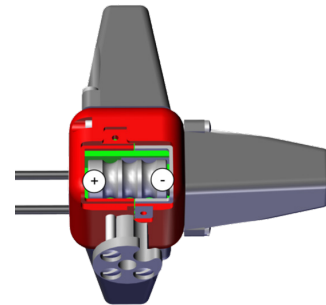
1. Rotate the two hatch screws and remove.
2. Remove the hatch.



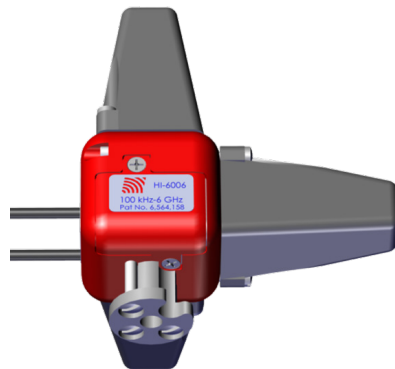
3. Remove the spent battery.



4. Insert the new battery, making sure to align the + (positive) and - (negative) marks on the battery with the mark on the probe.



5. Replace the hatch and the two screws.



6. After replacing the battery, the probe needs to have a CHARGE/DISCHARGE cycle performed to synchronize the electronics and the new battery for accurate battery monitoring. This is done by connecting the probe to the charger and pressing the DISCHARGE button.



If you are not qualified to perform this procedure, please consult ETS-Lindgren Technical Support. ETS-Lindgren is not responsible for damage to the probe as a result of replacing the batteries.



See the *Product Information Bulletin* included with your shipment for information on ETS-Lindgren calibration services.



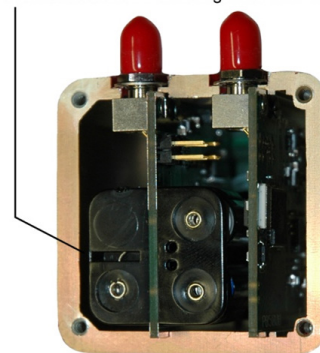
Recycle the used batteries, or dispose of them safely and properly. Many cities collect used batteries for recycling or disposal. You may contact your local waste disposal agency for information on battery recycling and disposal.

## HI-6053 Battery Replacement

During the annual calibration of your HI-6053 at the ETS-Lindgren factory, the batteries are tested to verify continued operability. If required, the batteries are replaced at that time. It is rare that you should need to replace the batteries between calibration checks, but in that event, follow these steps.

1. Turn the HI-6053 off. Verify that the green indicator light is not flashing.
2. Carefully disconnect the fiber optic cables from the **Transmit** and **Receive** connectors.
3. Remove the two nuts; one on each fiber optic connector.
4. Remove the four screws from the bottom of the electronics housing.
5. Lift the bottom away from the housing. Wires from the power button are connected to the internal circuitry, so carefully turn the bottom over and place it to the side, avoiding placing stress on the wires.

Board with four AAA rechargeable NiMH batteries

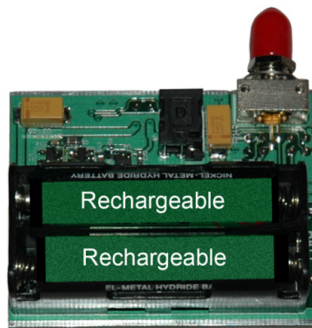


Inside HI-6053 housing  
(Bottom plate with power button wires not shown)

6. A single connector attaches the two boards together. Withdraw the two boards from the housing at the same time. The boards should easily slide out of the tracks.
7. Detach the two boards by carefully separating them at the connector, avoiding damage to the pins.
8. Replace the four AAA rechargeable NiMH batteries, orienting the +/- ends as indicated.



Vertical board  
with four batteries



Horizontal board  
with two batteries showing

## CAUTION

Before performing any maintenance, disconnect the fiber optic cables from the unit and turn off power.

When disconnecting fiber optic cables, apply the included dust caps to the ends to maintain their integrity.

Before connecting fiber optic cables, clean the connector tips and in-line connectors.

Before attaching in-line connectors, clean them with moisture-free compressed air.

Failure to perform these tasks may result in the damage to the fiber optic connectors or cables.



ETS-Lindgren may substitute a similar part or new part number with the same functionality for another part/part number. Contact ETS-Lindgren for questions about part numbers and ordering parts.

9. Reattach the two boards at the connector.
10. Slide the two boards into the correct tracks inside the housing, and carefully push them until they are completely recessed.
11. Replace the bottom of the housing, avoiding damage to the power button wires.
12. Replace and tighten the four screws into the bottom of the housing.
13. Replace the two nuts removed in step 3; one on each fiber optic connector.
14. After replacing the battery, the probe needs to have a CHARGE/DISCHARGE cycle performed to synchronize the electronics and the new battery for accurate battery monitoring. This is done by connecting the probe to the charger and pressing the DISCHARGE button.

### Maintenance of Fiber Optics

Fiber optic connectors and cables can be damaged from airborne particles, humidity and moisture, oils from the human body, and debris from the connectors they plug into. Always handle connectors and cables with care, using the following guidelines.

### Replacement and Optional Parts

Following are the part numbers for ordering replacement or optional parts for the EMC Probes. Not every part can be used with every probe; check **For Probe Model** in each table to verify which part can be used with which probe.

#### Readout Options

For Probe Model	Part Description	Model Number
HI-6023, HI-6006, HI-6053	EMCenter	7000-001 7000-004 7000-010 7000-011
HI-6023, HI-6006, HI-6053	Fiber Optic Modem, RS-232 Interface	HI-4413P
HI-6023, HI-6006, HI-6053	Fiber Optic to USB Converter, USB Interface	HI-4413USB



The probe shield replacement kit includes: Three probe shields (cones), One each X, Y, and Z axis label, and six screws

### Probe Shields

For Probe Model	Part Number
HI-6023	112955
HI-6006	H-651016

### Cables, Connectors, Maintenance/Cleaning Kits

For Probe Model	Part Description	Part Number
HI-6023, HI-6006, HI-6053	Cable, Fiber Optic, Glass	H-491106-xx (xx=length in meters)
	Connector Set, two required (Bulkhead Feedthrough)	H-231205000

### Battery Charger, Battery, Battery Hatch Replacement Screws

Battery Charger	
For Probe Model	Part Number
HI-6023, HI-6006	1738371
HI-6053	1738369

Battery	
For Probe Model	Part Number
HI-6023, HI-6006	122552
HI-6053	400038 (4 required)

Battery Hatch Replacement Screws	
For Probe Model	Part Number
HI-6023, HI-6006	123593 [kit includes (2) screws, (1) screwdriver]

### Carrying Cases

For Probe Model	Part Number
H-6023, HI-6006	H-491260
HI-6053	H-491291

### Tripod, Probe Stand

For Probe Model	Part Description	Part Number
All Probe Models	Tripod, Dielectric	H-491009
	Probe Stand	H-491269
	Probe Carrier for H-491269 Probe Stand	H-491276



ETS-Lindgren may substitute a similar part or new part number with the same functionality for another part/part number. Contact ETS-Lindgren for questions about part numbers and ordering parts.



Only qualified personnel should operate (or service) this equipment. If you have any questions concerning maintenance, contact ETS-Lindgren Technical Support. Warranty may be voided if housing is opened.

## Upgrade Policies

Periodically, probes are upgraded to enhance functionality. Contact ETS-Lindgren Customer Service for the upgrade status of your probe.

## Service Procedures

### Contacting ETS-Lindgren

Please see [ets-lindgren.com](http://ets-lindgren.com) for a list of ETS-Lindgren offices, including phone and email contact information.

### Sending a Component For Service

For the steps to return a system or system component to ETS-Lindgren for service, see the *Product Information Bulletin* included with your shipment.

### Calibration Services and Annual Calibration

See the *Product Information Bulletin* included with your shipment for information on ETS-Lindgren calibration services.



For battery charger specifications, see Appendices, depending on your battery charger model.



ETS-Lindgren may substitute a similar part or new part number with the same functionality for another part/part number. Contact ETS-Lindgren for questions about part numbers and ordering parts.



Only qualified personnel should operate (or service) this equipment. If you have any questions concerning maintenance, contact ETS-Lindgren Technical Support. Warranty may be voided if housing is opened.

## SPECIFICATIONS

### HI-6023 Specifications

Dynamic Range:	2.0–800 Volts per meter (V/m)
Ranges:	Single
Typical Frequency Response:	<b>10 kHz–1 GHz</b> <ul style="list-style-type: none"> <li>• 10 kHz–30 kHz: +0.5 dB, -2.5 dB</li> <li>• 30 kHz–1 GHz: ±1 dB</li> </ul>
Typical Frequency Response with Correction:	10 kHz–1 GHz: ±0.9 dB
Linearity:	±0.5 dB
Isotropy:	±0.5 dB @ 400 MHz
Overload Withstand:	> 1,500 V/m CW
Fiber Optic Cable Connector:	Standard FSMA
Probe Mount:	1/4–20 UNC tapped hole (internal thread)
Battery:	Rechargeable Nickel-Metal Hydride (NiMH)
Battery Life:	Up to 8 hours
Battery Charger:	<ul style="list-style-type: none"> <li>• 100–240 VAC universal input</li> <li>• 3-hour charge from full depletion</li> </ul>
<b>Environmental</b>	
Operating Temperature:	10°C to 40°C 50°F to 104°F
Humidity:	5% to 95% relative humidity, non-condensing
<b>Dimensions</b>	
Housing:	32 mm x 32 mm x 32 mm 1.26 in x 1.26 in x 1.26 in
Probe Shields:	36 mm (1.42 in)
Weight:	80 g (2.82 oz)



For battery charger specifications, see Appendices, depending on your battery charger model.



ETS-Lindgren may substitute a similar part or new part number with the same functionality for another part/part number. Contact ETS-Lindgren for questions about part numbers and ordering parts.



Only qualified personnel should operate (or service) this equipment. If you have any questions concerning maintenance, contact ETS-Lindgren Technical Support. Warranty may be voided if housing is opened.

## HI-6006 Specifications

Dynamic Range:	0.5–800 Volts per meter (V/m) Single Range (64 dB)
Ranges:	Single
Typical Frequency Response:	<b>100 kHz–6 GHz</b> <ul style="list-style-type: none"> <li>• 500 kHz–2 GHz: +1 dB, -2.5 dB</li> <li>• 2 GHz–5.5 GHz: +3.5 dB, -4.5 dB</li> <li>• 5.5 GHz–6 GHz: +2 dB, -6 dB</li> </ul>
Typical Frequency Response with Correction:	100 kHz–6 GHz: ±0.9 dB
Linearity:	±0.5 dB (1–800 V/m)
Isotropy:	±0.5 dB @ 400 MHz
Overload Withstand:	1,500 V/m maximum; Continuous field
Fiber Optic Cable Connector:	Standard FSMA
Probe Mount:	1/4–20 UNC (internal thread)
Battery:	Rechargeable Nickel-Metal Hydride (NiMH)
Battery Life:	Up to 8 hours
Battery Charger:	100–240 VAC; Approximately three hours
<b>Environmental</b>	
Operating Temperature:	10°C to 40°C 50°F to 104°F
Humidity:	5% to 95% relative humidity, non-condensing
<b>Dimensions</b>	
Housing:	32 mm x 32 mm x 32 mm 1.26 in x 1.26 in x 1.26 in
Probe Shields:	43 mm (1.69 in)
Weight:	0.08 kg (2.6 oz)



For battery charger specifications, see Appendices, depending on your battery charger model.



ETS-Lindgren may substitute a similar part or new part number with the same functionality for another part/part number. Contact ETS-Lindgren for questions about part numbers and ordering parts.



Only qualified personnel should operate (or service) this equipment. If you have any questions concerning maintenance, contact ETS-Lindgren Technical Support. Warranty may be voided if housing is opened.

## HI-6053 Specifications

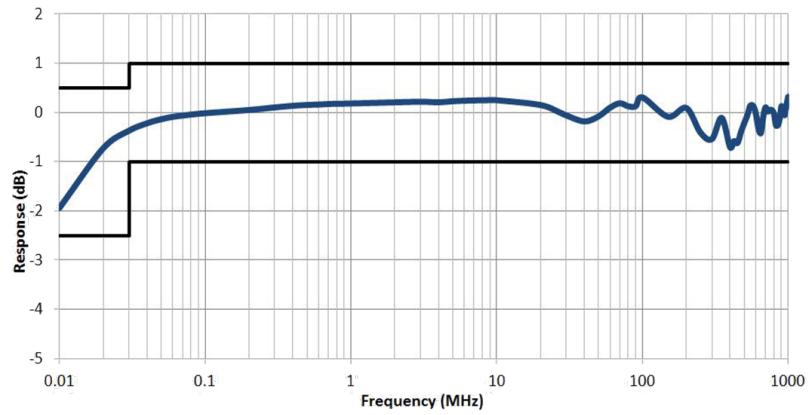
Dynamic Range:	2.0–800 Volts per meter (V/m)
Ranges:	Single
Typical Frequency Response:	<b>10 MHz–40 GHz</b> <ul style="list-style-type: none"> <li>• 10 MHz–100 MHz: +3 dB, -4 dB</li> <li>• 100 MHz–1 GHz: +3 dB, -0.5 dB</li> <li>• 1 GHz–18 GHz: +4 dB, -2 dB</li> <li>• 18 GHz–40 GHz: +3.5 dB, -4.5 dB</li> </ul>
Typical Frequency Response with Correction:	<ul style="list-style-type: none"> <li>• 10 MHz–18 GHz: ±0.9 dB</li> <li>• 18 GHz–40 GHz: ±1.1 dB</li> </ul>
Linearity:	±0.5 dB
Isotropy:	±1.0 dB < 18 GHz
Overload Withstand:	1,500 V/m
Fiber Optic Cable Connector:	Standard FSMA
Probe Mount:	1/4–20 UNC tapped hole (internal thread)
Battery:	Four AAA batteries, rechargeable Nickel-Metal Hydride (NiMH)
Battery Life:	> 30 hours continuous (at full charge)
Battery Charger:	100–240 VAC; Approximately three hours
<b>Environmental</b>	
Operating Temperature:	10°C to 40°C 50°F to 104°F
Humidity:	5% to 95% relative humidity, non-condensing
<b>Dimensions</b>	
Probe Length:	438 mm (17.24 in) (includes electronics housing)
Probe Diameter:	57 mm (2.24 in)
Weight:	0.36 kg (12.64 oz)



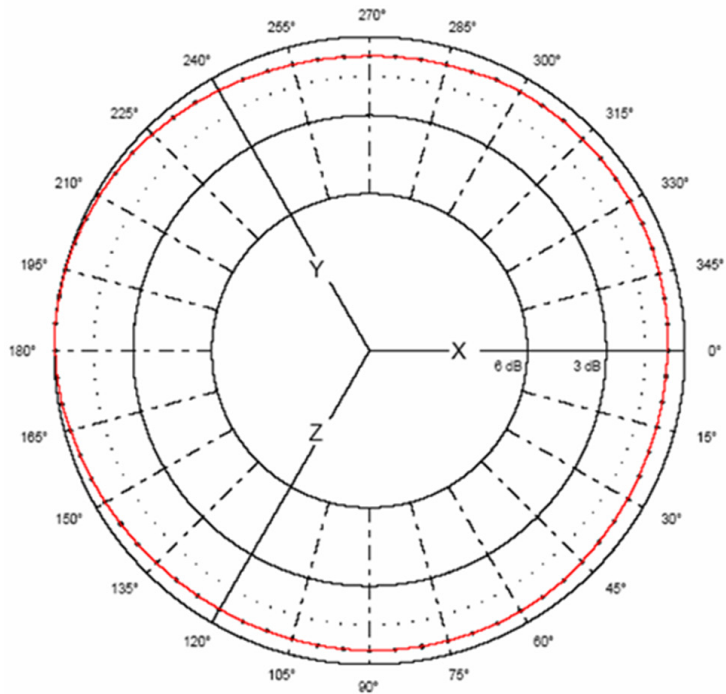
# TYPICAL DATA

## HI-6023 Typical Data

### HI-6023 Typical Frequency Response with Limits



### HI-6023 Typical Isotropic Response



TEM Cell and GTEM! –  
Field Level 20 V/m.



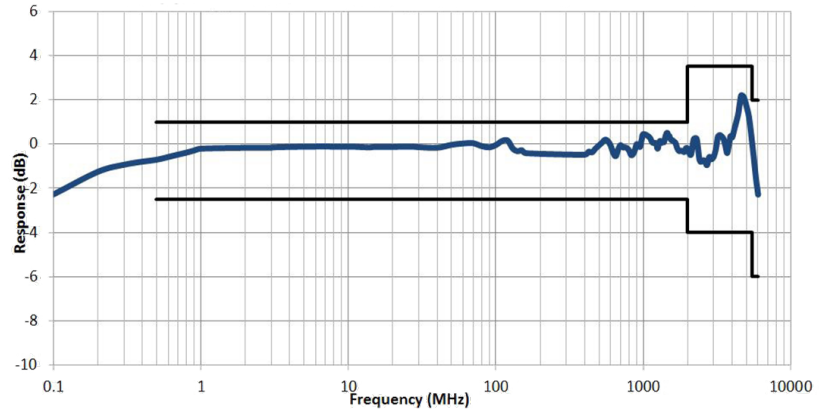
Isotropic response  
measured in a 20 V/m  
field at 400 MHz.



Anechoic room and  
TEM Cell – Field Level  
20 V/m.

## HI-6006 Typical Data

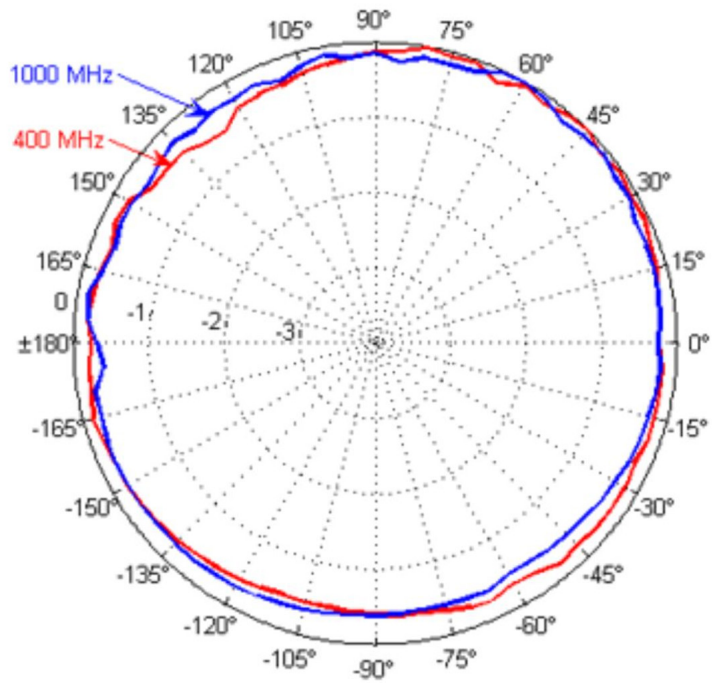
### HI-6006 Typical Frequency Response with Limits



### HI-6006 Typical Isotropic Response



Actual data taken at  
400 MHz, field level  
20 V/m, maximum  
variation 0.54 dB.

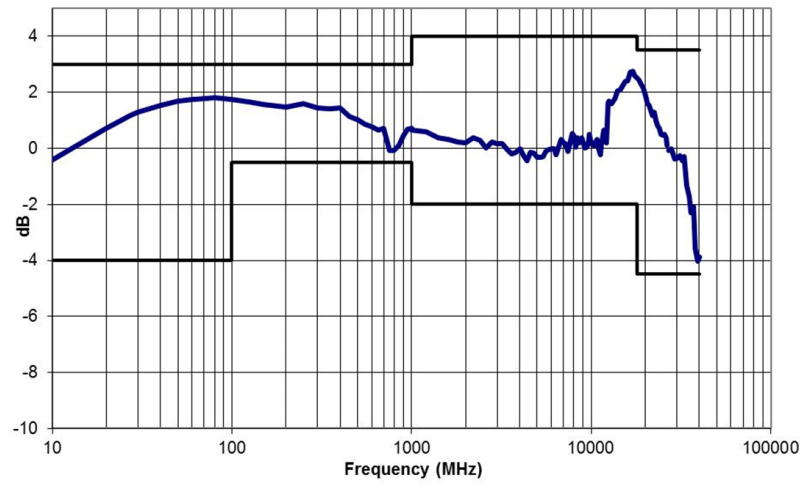




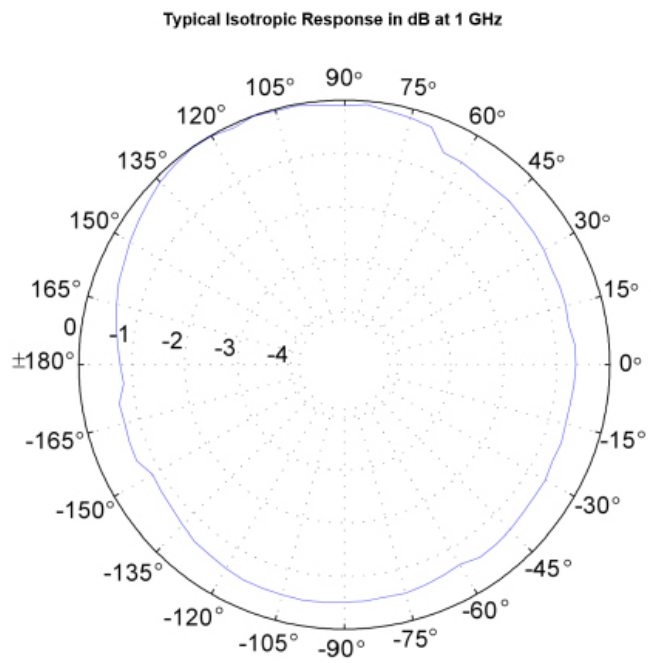
Field Level 20 V/m.

## HI-6053 Typical Data

### HI-6053 Typical Frequency Response



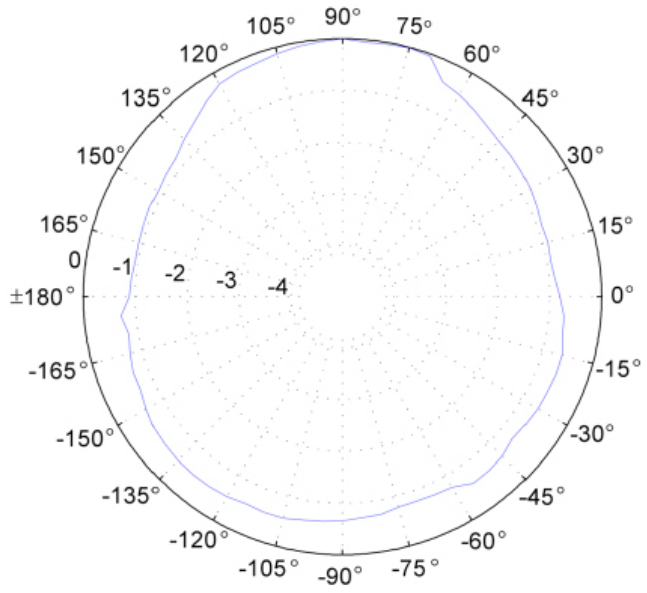
### HI-6053 Typical Isotropic Response



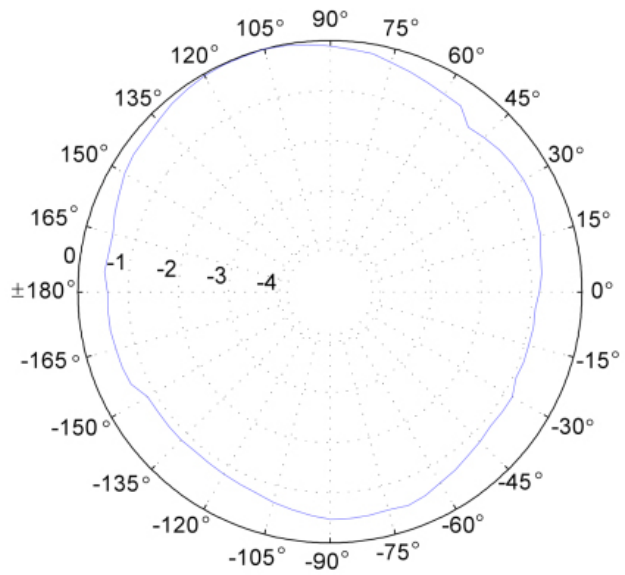


Field Level 20 V/m.

Typical Isotropic Response in dB at 10 GHz



Typical Isotropic Response in dB at 18 GHz





With proper care, the batteries should last two to three years. Follow these recommendations to ensure maximum battery life and optimum testing performance:

- Turn the probe off when the probe is not in use. Leaving the probe on for extended periods of time will damage the batteries. When the batteries are discharged, the flashing power **ON** indicator will not function.
- When possible, leave the probe connected to the battery charger, and the battery charger connected to the mains electrical supply (charger operating). The battery charger status indicators will show **CHARGER ON** and **COMPLETE** when the batteries are on a maintenance charge.
- Operate the probe only within the optimum operating temperature range of +20°C to +30°C (+68°F to +86°F). Although NiMH batteries are rated for operation in temperatures from 20°C to +65°C (4°F to +140°F), operating the probe at temperature extremes reduces the operating time of the batteries.
- Make sure the batteries are fully charged before resuming operation. The batteries do not require periodic deep discharges to reverse the effect caused by repeated shallow discharges, but undercharging can reduce battery capacity.

Fully charged batteries (nominal output voltage of 4.8 VDC) provide up to 30 hours of operation. When the batteries have discharged to 4.4 VDC, the probe will operate, but the batteries need to be charged. When the voltage drops below 4.0 VDC, measurement accuracy may be compromised by continued operation.

When the battery voltage indication is less than 4 volts, a low battery indication is attached to the output data string warning of the problem. ETS-Lindgren software applications provide a warning indication on the display screen of the readout device. It is recommended that custom software packages using data from the probe monitor the data output for this condition.

If the batteries exhibit low terminal voltages during charging, or if they appear unable to acquire or maintain a charge, the batteries may be shorted or damaged. To replace the batteries, see *HI-6053 Battery Replacement*.

## CAUTION

Never attempt to recharge a non-rechargeable battery.

### Charging the Batteries

For maximum battery life, fully charge the batteries before placing the probe into service. Failing to fully charge the batteries may result in reduced battery life and cause premature battery failure.

To charge a battery:

1. Make sure the probe is off or the batteries will not charge.
2. Connect the battery charger to the electrical mains, and then plug the charger output into the battery charger connector on the probe.

## Charging Indicators

The following LEDs are located on the front of the battery charger:

- **POWER ON** (green)—Indicates the battery charger is connected to the AC power source.
- **NO BATTERY** (amber)—Indicates the battery charger does not detect a battery.
- **PENDING** (amber)—Indicates the battery charger detects a battery. Before fast charging can begin, the battery voltage must fall within predetermined acceptable limits. A pulse-trickle charge is provided to bring a depleted battery to a valid charge prior to fast charge.
- **CHARGING** (amber)—Indicates the voltage pre-qualification condition has been met, and fast charge has started. Fast charging continues until termination by a peak voltage detect or a maximum charge time. For peak voltage detect, the fast charge is terminated when the battery voltage is lower than the previously measured values by 24mV. If a peak voltage is not detected, then the fast charge is terminated when the maximum time limit of 180 minutes is reached.
- **COMPLETE** (green)—Indicates a fast charging peak voltage is detected. If the probe is turned on during the fast charge period of the charge cycle, the current surge that the batteries provide to the electronics in the probe will cause a momentary voltage drop on the batteries, causing the charger to terminate the fast charge based on a peak voltage detect condition.

The battery charger switches to top-off charge mode that provides a charge current one-eighth of the fast charge rate. This charge continues from the time when a peak voltage detect terminates the fast charge, until the maximum time of 180 minutes is reached. If the probe is disconnected from the charger at this point in the charge cycle, the batteries will operate properly.

Following the maximum time of 180 minutes, a pulse-trickle charge mode is used to compensate for the self-discharge of the batteries while idle in the charger.

The fast charge current is low enough that there is not always enough heating of the battery cells to cause the voltage to drop. With no voltage drop there is no peak voltage detection, and the fast charge will terminate after the maximum time of 180 minutes is reached.

## Synchronizing The Battery Charge Indicator

The probe has internal circuitry to track the charge condition of the batteries. NiMH batteries have a sharp discharge-curve knee, which means there is little indication that the batteries are nearly discharged prior to a low battery condition. The internal circuitry tracks the charging and discharging currents of the batteries and displays the calculated battery condition.

It is possible that the battery charge indication may lose synchronization with the actual battery condition. A loss of synchronization may be indicated by a low battery charge alert after the batteries were recently fully charged. Loss of synchronization may also be indicated by short battery life and premature low battery alert.

To synchronize the battery charge indicator:

1. Make sure the probe is off or the batteries will not charge.
2. Connect the battery charger to the electrical mains, and then plug the charger output into the battery charger connector on the probe.
3. Press the **DISCHARGE** button on the battery charger. The batteries will fully discharge, and then fully recharge. The total time required to discharge and recharge is approximately seven hours.
4. For best results, repeat the process once. However, it may be necessary to repeat the process three times for proper synchronization. The synchronization process may take up to 12 hours.

When completely charged, the battery indicator for the probe should indicate a charge level of more than 90%.

## Discharging a Battery

To discharge the batteries:

1. Make sure the probe is off or the batteries will not charge.
2. Connect the battery charger to the electrical mains, and then plug the charger output into the battery charger connector on the probe.
3. Press the **DISCHARGE** button on the battery charger. The batteries will fully discharge, and then fully recharge. The total time required to discharge and recharge is approximately seven hours.



## Battery Charger Specifications

The battery charger may be powered by standard line voltage (110–240 VAC, 50–60 Hz) or by an optional automobile cigarette lighter plug (12.5 VDC).

NiMH Battery:	4.8 volt 4 cell NiMH Battery, 25 mAH (rapid charge cells, 1.2 volts/cell) ETS-Lindgren Part #122552
<b>Power</b>	
Main:	18 VDC power input from AC/DC Adapter item number 1719573
<b>Output</b>	
Open Circuit Voltage:	18 VDC
Fast Charge Pending Current:	2.0 mA
Fast Charge Current:	25 mA
Pulsed Trickle Charge Current:	2.0 mA
Output Voltage (During Fast Charge):	4–8 VDC
<b>Environmental</b>	
Operating Temperature:	10°C to 40°C 50°F to 104°F
Humidity:	5% to 95% relative humidity, non condensing



Only qualified personnel should operate (or service) this equipment. If you have any questions concerning maintenance, contact ETS-Lindgren Technical Support. Warranty may be voided if procedures are not followed correctly.

## Maintenance Recommendations

- Operate the battery charger with care.
- There are no user serviceable parts inside the battery charger. Opening the battery charger housing may void your warranty.



The HI-6053 Field Probe contains four AAA Nickel-Metal Hydride (NiMH) batteries, and uses the Series 1517910 Battery Charger.

## CAUTION

Before operating the Series 1738369 Battery Charger, see *Safety Information*.

# APPENDIX B: SERIES 1738369 BATTERY CHARGER FOR NiMH BATTERIES

## Introduction

The **1738369 Nickel-Metal Hydride (NiMH) Battery Charger** charges 4.8 volt 220 mA NiMH batteries and is powered by a 18VDC wall mount power supply. The 1517910 Battery Charger uses a  $-(dV)/(dT)$  negative delta V technique to determine when the battery is fully charged, which is typically two hours. With this technique, the charge state of the battery has no effect other than shortening the charge time.



The top face of the battery charger displays LEDs that provide the operating status. The battery charger connects to the device being charged through a short cord terminated with a power jack. An integrated circuit within the battery charger monitors the battery voltage and controls the charging functions according to the charge state of the battery.

## Battery Life

The NiMH batteries powering the battery-operated probe have high energy density for maximum operating time between charges, but also have a significant self-discharge characteristic. When the probe is stored for longer than a week or two, the batteries will discharge even though not in use. Leaving the batteries in a discharged condition for long periods of time may result in reduced battery life. For optimum testing time, charge the batteries before use.

The battery charger is microprocessor controlled to charge the batteries in the fastest possible manner. When the charger senses that the batteries are fully charged, the charging current drops to a maintenance level. This level is sufficient to maintain the battery in a fully charged state. It is acceptable to leave the probe connected to the battery charger for up to fourteen days. If the probe will be in storage for an extended period of time it is best practice to remove the battery. Please note that when the battery is reinserted the probe will require a discharge-charge cycle to synchronize the battery and probe electronics.

When possible, leave the probe connected to the battery charger, and the battery charger connected to the mains electrical supply (charger operating). The battery charger status indicators will show CHARGER ON and COMPLETE when the battery is on a maintenance charge. It is acceptable to leave the probe and charger in this state for up to fourteen days. If the probe will be in storage for an extended period of time, it is best practice to remove the battery. Please note that when the battery is reinserted the probe will require a discharge-charge cycle to synchronize the battery and probe electronics.

With proper care, the batteries should last two to three years. Follow these recommendations to ensure maximum battery life and optimum testing performance:

- Turn the probe off when the probe is not in use. Leaving the probe on for extended periods of time will damage the batteries. When the batteries are discharged, the flashing power **ON** indicator will not function.
- When possible, leave the probe connected to the battery charger, and the battery charger connected to the mains electrical supply (charger operating). The battery charger status indicators will show **CHARGER ON** and **COMPLETE** when the batteries are on a maintenance charge.
- Operate the probe only within the optimum operating temperature range of +20°C to +30°C (+68°F to +86°F). Although NiMH batteries are rated for operation in temperatures from 20°C to +65°C (4°F to +140°F), operating the probe at temperature extremes reduces the operating time of the batteries.
- Make sure the batteries are fully charged before resuming operation. The batteries do not require periodic deep discharges to reverse the effect caused by repeated shallow discharges, but undercharging can reduce battery capacity.

Fully charged batteries (nominal output voltage of 4.8 VDC) provide up to 30 hours of operation. When the batteries have discharged to 4.4 VDC, the probe will operate, but the batteries need to be charged. When the voltage drops below 4.0 VDC, measurement accuracy may be compromised by continued operation.

When the battery voltage indication is less than 4 volts, a low battery indication is attached to the output data string warning of the problem. ETS-Lindgren software applications provide a warning indication on the display screen of the readout device. It is recommended that custom software packages using data from the probe monitor the data output for this condition.

If the batteries exhibit low terminal voltages during charging, or if they appear unable to acquire or maintain a charge, the batteries may be shorted or damaged. To replace the batteries, see *HI-6053 Battery Replacement*.

### Charging the Batteries

For maximum battery life, fully charge the batteries before placing the probe into service. Failing to fully charge the batteries may result in reduced battery life and cause premature battery failure.

To charge a battery:

1. Make sure the probe is off or the batteries will not charge.
2. Connect the battery charger to the electrical mains, and then plug the charger output into the battery charger connector on the probe.

## CAUTION

Never attempt to recharge a non-rechargeable battery.

## Charging Indicators

The following LEDs are located on the front of the battery charger:

- **POWER ON** (green)—Indicates the battery charger is connected to the AC power source.
- **NO BATTERY** (amber)—Indicates the battery charger does not detect a battery.
- **PENDING** (amber)—Indicates the battery charger detects a battery. Before fast charging can begin, the battery voltage must fall within predetermined acceptable limits. A pulse-trickle charge is provided to bring a depleted battery to a valid charge prior to fast charge.
- **CHARGING** (amber)—Indicates the voltage pre-qualification condition has been met, and fast charge has started. Fast charging continues until termination by a peak voltage detect or a maximum charge time. For peak voltage detect, the fast charge is terminated when the battery voltage is lower than the previously measured values by 24mV. If a peak voltage is not detected, then the fast charge is terminated when the maximum time limit of 180 minutes is reached.
- **COMPLETE** (green)—Indicates a fast charging peak voltage is detected. If the probe is turned on during the fast charge period of the charge cycle, the current surge that the batteries provide to the electronics in the probe will cause a momentary voltage drop on the batteries, causing the charger to terminate the fast charge based on a peak voltage detect condition.

The battery charger switches to top-off charge mode that provides a charge current one-eighth of the fast charge rate. This charge continues from the time when a peak voltage detect terminates the fast charge, until the maximum time of 180 minutes is reached. If the probe is disconnected from the charger at this point in the charge cycle, the batteries will operate properly.

Following the maximum time of 180 minutes, a pulse-trickle charge mode is used to compensate for the self-discharge of the batteries while idle in the charger.

The fast charge current is low enough that there is not always enough heating of the battery cells to cause the voltage to drop. With no voltage drop there is no peak voltage detection, and the fast charge will terminate after the maximum time of 180 minutes is reached.

## Synchronizing The Battery Charge Indicator

The probe has internal circuitry to track the charge condition of the batteries. NiMH batteries have a sharp discharge-curve knee, which means there is little indication that the batteries are nearly discharged prior to a low battery condition. The internal circuitry tracks the charging and discharging currents of the batteries and displays the calculated battery condition.

It is possible that the battery charge indication may lose synchronization with the actual battery condition. A loss of synchronization may be indicated by a low battery charge alert after the batteries were recently fully charged. Loss of synchronization may also be indicated by short battery life and premature low battery alert.

To synchronize the battery charge indicator:

1. Make sure the probe is off or the batteries will not charge.
2. Connect the battery charger to the electrical mains, and then plug the charger output into the battery charger connector on the probe.
3. Press the **DISCHARGE** button on the battery charger. The batteries will fully discharge, and then fully recharge. The total time required to discharge and recharge is approximately seven hours.
4. For best results, repeat the process once. However, it may be necessary to repeat the process three times for proper synchronization. The synchronization process may take up to 12 hours.

When completely charged, the battery indicator for the probe should indicate a charge level of more than 90%.

## Discharging a Battery

To discharge the batteries:

1. Make sure the probe is off or the batteries will not charge.
2. Connect the battery charger to the electrical mains, and then plug the charger output into the battery charger connector on the probe.
3. Press the **DISCHARGE** button on the battery charger. The batteries will fully discharge, and then fully recharge. The total time required to discharge and recharge is approximately seven hours.

## Battery Charger Specifications

The battery charger may be powered by standard line voltage (110–240 VAC, 50–60 Hz) or by an optional automobile cigarette lighter plug (12.5 VDC).

NiMH Battery:	<ul style="list-style-type: none"> <li>• 4 AAA batteries, rechargeable NiMH (rapid charge cells, 1.2 volts/cell)</li> <li>• ETS-Lindgren Part #400038 (quantity required = 4)</li> </ul>
<b>Power</b>	
Main:	18 VDC power input from AC/DC Adapter item number 1719573
<b>Output</b>	
Open Circuit Voltage:	18 VDC
Fast Charge Pending Current:	2.0 mA
Fast Charge Current:	220 mA
Pulsed Trickle Charge Current:	2.0 mA
Output Voltage (During Fast Charge):	4–8 VDC
<b>Environmental</b>	
Operating Temperature:	10°C to 40°C 50°F to 104°F
Humidity:	5% to 95% relative humidity, non condensing



Only qualified personnel should operate (or service) this equipment. If you have any questions concerning maintenance, contact ETS-Lindgren Technical Support. Warranty may be voided if procedures are not followed correctly.

## Maintenance Recommendations

- Operate the battery charger with care.
- There are no user serviceable parts inside the battery charger. Opening the battery charger housing may void your warranty.

## APPENDIX C: OPERATING PROTOCOLS



The information in this section is subject to change, and is included for reference only. ETS-Lindgren recommends that you use the commands and information provided in the *ETS-Probe DLL User Guide*.

The following information assumes that the HI-6113 Laser Data Interface (LDI), HI-4413P Fiber Optic Modem, or HI-4413USB Fiber Optic to USB Converter was purchased and is communicating directly with the probe.

### Communication Protocol

#### HI-60XX Series Battery-Operated Field Probes

Data Type:	RS-232 Serial
Data Mode:	Asynchronous
Word Length:	7bit
Parity:	Odd
Stop Bits:	1
Data Rate:	9600 baud

### Information Transfer Protocol

The probe responds to commands from another device; it transmits no data without first receiving instructions to do so.

#### Command Structure

See the following pages for detailed information regarding the command structure to the probe. When the probe completes the command, it responds with a string consisting of:

- A start character (":")
- The command letter
- Data (if required)
- <CR> (a carriage return)

If the command does not require the probe to return any data, the probe simply responds with the start character (":") then the command letter and a carriage return. If an error occurs, the probe responds with an error code.

## Probe Commands

All probe commands return :E7 when the probe is turned off.

### HI-60XX Series Field Probes

Probe Command	Description	Probe Response
B<CR>	Read battery voltage	:Bxx.xx<CR> <ul style="list-style-type: none"> <li>• :B04.80 =100% of charge =4.8 volts</li> <li>• :B04.00 =0% of charge =4.0 volts</li> </ul>
BP	Read battery capacity in percentage	Bxx<N or F><CR> <ul style="list-style-type: none"> <li>• :B64N =100% of charge =4.8 volts</li> <li>• :B00F =0% of charge =4.0 volts</li> <li>• N=safe operating level</li> <li>• F=fail level</li> </ul> Percentage reported in hexadecimal, 0% to 64%
D3	Read probe data	:Dx.xxyy.yyzz.zB<CR> <ul style="list-style-type: none"> <li>• xxxx, yyyy, zzzz= 4-digit axis values with floating decimal point</li> <li>• B=battery flag, N or F</li> </ul>



The BP command is provided for backward compatibility and should not be used to monitor the converter voltage, which always responds with :B64N<CR>.





<Null><CR> is a special command that can be used as the initial command to the probe after it is turned on.

Probe Command	Description	Probe Response
D5	Read probe data	<ul style="list-style-type: none"><li>• :Dx.xxyy.yzzz.zcccc. B&lt;CR&gt;</li><li>• xxxx, yyyy, zzzz= 4-digit axis values with floating decimal point</li><li>• cccc=composite field value with floating decimal point</li><li>• B=battery flag, N or F</li></ul>
I	Identification command	:I60XX<sr><sn><cd>B<CR> <ul style="list-style-type: none"><li>• XX=specific probe model</li><li>• sr=10-character software revision</li><li>• sn=8-character serial number</li><li>• cd=8-character calibration date</li><li>• B=battery flag, N or F</li></ul>
TC	Read temperature in Centigrade	:Txxx.<CR>
TF	Read temperature in Fahrenheit	:Txxx.<CR>
<Null><CR>	Send the ASCII null character	:N<CR>

## Probe Error Output

If an error occurs, the probe will respond with one of the following strings. These strings begin with a colon and end with a carriage return.

E1	Communication error (for example, overflow)
E2	Buffer full error; too many characters contained between the start character and carriage return sequence
E3	Received command is invalid
E4	Received parameter is invalid
E5	Hardware error (for example, EEPROM failure)
E6	Parity error
E7	Probe commands are not available unless the probe is powered on. To power on the probe, send the Laser ON command, r.
E9	Received command is invalid

## APPENDIX D: ETSPROBE DLL USER GUIDE

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The **ETS-Lindgren ETSProbe DLL** allows users to communicate with one or more supported ETS-Lindgren field probes. The main deliverable consists of a Microsoft® Windows® Dynamic Link Library (DLL) that can be called by a wide variety of programming languages.

ETSProbe DLL is intended for users who want to integrate ETS-Lindgren probes into their own software system.

### About Redistribution

Redistribution and use in source and binary forms, with or without modification, are permitted provided the following conditions are met:

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### Getting Started

1. Download ETSProbe DLL from [ets-lindgren.com](http://ets-lindgren.com).
2. Install ETSProbe DLL using the included automatic installer.  
During installation (provided the installation path is not altered), an assortment of example programs in various languages will be copied to C:\Program Files\ETS-Lindgren\ETSProbe DLL\examples.
3. Create your new program or adapt your existing program to interface with ETSProbe DLL.

### DLL Function Calling Conventions

1. The function call stack/style is the WinAPI style. This allows the widest variety of users to be able to call these functions.
2. The functions take and return only basic types of arguments (32 bit integer, floating point values, and simple c-style zero terminated strings).
3. All outbound string parameters are allocated by the caller and are followed in the argument list by a maximum string length integer parameter.
4. For the same reason, the functions do not take in or send out any object style parameters.
5. All functions have an integer return value such that 0 will signify successful completion. All other values that can be returned are function-specific.

## Supported Probes and Communications Protocols

Probe families HI-Any and FP-Any are probe-type detectors. These detector-probe types can be used in most cases without specifying the exact probe family. There are a few other families that offer higher data sample rates. By default all probes are put into auto range. The following table lists the probe families that can be used with each probe model.

Model	Family Strings
FP1000	FP-Any HI-44xx MS
FP2000	FP-Any
FP2031	FP-Any
FP2033	FP-Any
FP2036	FP-Any
FP2080	FP-Any
FP2083	FP-Any
FP2103	FP-Any
FP2130	FP-Any
FP3000A	
FP3001	
FP3080A	
FP3083	
FP4000	FP-Any HI-44xx MS
FP4031	FP-Any HI-44xx MS
FP4033	FP-Any HI-44xx MS
FP4080	FP-Any HI-44xx MS
FP4083	FP-Any HI-44xx MS
FP4240	FP-Any HI-44xx MS
FP5000	FP-Any HI-44xx MS
FP5033	FP-Any HI-44xx MS
FP5034	FP-Any HI-44xx MS
FP5036	FP-Any HI-44xx MS
FP5080	FP-Any HI-44xx MS

Model	Family Strings
FP5083	FP-Any HI-44xx MS
FP5240	FP-Any HI-44xx MS
FP6001	FP-Any HI-44xx MS
HI-2200 C300	
HI-2200 C310	
HI-2200 E100	
HI-2200 H200	
HI-2200 H210	
HI-3603	
HI-3604	
HI-3638	HI-Any HI-44xx MS
HI-3702	HI-Any HI-44xx MS
HI-4417	
HI-4421	HI-Any HI-44xx MS
HI-4421G	HI-Any HI-44xx MS
HI-4422	HI-Any HI-44xx MS
HI-4431 HCH	HI-Any HI-44xx MS
HI-4431 HSE	HI-Any HI-44xx MS
HI-4431 MSE	HI-Any HI-44xx MS
HI-4431 STE	HI-Any HI-44xx MS
HI-4433 CH	HI-Any HI-44xx MS
HI-4433 GRE	HI-Any HI-44xx MS

Model	Family Strings
HI-4433 HCH	HI-Any HI-44xx MS
HI-4433 HSE	HI-Any HI-44xx MS
HI-4433 LFH	HI-Any HI-44xx MS
HI-4433 STE	HI-Any HI-44xx MS
HI-4450	HI-Any HI-44xx MS
HI-4451	HI-Any HI-44xx MS
HI-6005	HI-Any HI-6005 MS HI-6005 HS HI-6005
HI-6006	HI-Any HI-6005 MS HI-6005 HS HI-6005
HI-6022	HI-Any HI-6005 MS HI-6005 HS HI-6005
HI-6023	HI-Any HI-6005 MS HI-6005 HS HI-6005
HI-6053	HI-Any HI-6005 MS HI-6005 HS HI-6005
HI-6153	HI-Any Laser HS Laser



Baud rates are at 9600 and 115.2 K for the laser models.



Use this type to initialize all FP-series probes.



Baud rate at 9600. Sample rates exceed 30 samples/second.

### Probe Family HI-Any (Auto Probe Detector)

Automatically detects most ETS-Lindgren Holaday probes, as listed in the following:

- FP5000 Series
- FP4000 Series
- HI-6000 Series
- HI-4433 Series
- HI-4450 Series

### Probe Family FP-Any (Auto Probe Detector FP)

Automatically detects most ETS-Lindgren Holaday probes, as listed in the following:

- FP2000 Series
- FP4000 Series
- FP5000 Series
- FP6001

### Probe Family Virtual

This simulated probe type is for testing and software development purposes. Varying field values are generated using a sin function.

### Probe Family HI-44xx MS

Use this type to obtain higher sample rates on 3-axis probes. This type does not return individual field readings for each axis.

FP5080	HI-4450	FP4080
FP5000	FP5240	FP4083
FP5033	HI-4451	FP4240
FP5034	HI-4453	HI-4422
FP5036	HI-4455	HI-4433-GRE
FP5055	HI-4456	HI-4433-HSE
FP5083	HI-4457	HI-4433-MSE
FP4031	FP4000	HI-4433-STE

### Probe Family HI-6005 MS (Medium Speed)

- FP6001
- HI-6005, HI-6006, HI-6023
- HI-6053



Baud rate at 19200.

Sample rates exceed 50 samples/second.

### Probe Family HI-6005 HS (High Speed)

- FP6001
- HI-6005, HI-6006, HI-6023
- HI-6053

### Probe Types Not Supported

- HI-3603
- HI-3604
- HI-2200

## Quick Start Function Reference

### ETS\_CREATEPROBE()

```
int ETS_CreateProbe(const char *name, int &Handle, const char *CommSettings, const char *Family);
```

#### Purpose:

Creates a probe object and establishes communications to a specified probe.

- Makes an object of the correct type.
- Verifies that the communications to the probe can be established.
- Does a probe identify and an initialization of the probe.

#### Return Value:

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

#### Input Parameters:

Case sensitive strings must be used.

#### char **CommSettings**

ASRL1::INSTR /Comm Port 1

Com1

Com2

etc.

#### char **Family**

HI-Any

FP-Any

HI-44xx MS

HI-6005 MS

HI-6005 HS

Virtual

In most cases HI-Any and FP-Any will communicate with both HI-and FP-models. The exception is that HI-Any must be used to communicate with laser probe models and FP-Any must be used with the FP2000-Series probe models.

Use HS types High Speed for higher sample rates. The HI-44xx HS family does not return individual data from each axis, but does increase the sample rate.

char **name**

Any user specified name

myProbe

Etc.

#### **Output Parameters:**

int \* Handle

Special value used to refer to this probe for subsequent function calls after it is created.

#### **Returns:**

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

#### **ETS\_READFIELDSYNCHRONOUS()**

```
int ETS_ReadFieldSynchronous(int Handle, float &XField, float &YField, float &ZField, float &XYZField);
```

#### **Purpose:**

Takes a single field reading of all axes. The function does not return until all data is captured and processed. Ranging is handled automatically provided **ETS\_Range** has not been set.

#### **Return Value:**

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

#### **Input Parameters:**

int probeHandle

As returned from **ETS\_CreateProbe** function.

#### **Output Parameters:**

Pass-by-reference float: The field values for the X, Y, Z, and combined axes.



## **ETS\_REMOVEPROBE()**

```
int ETS_RemoveProbe(const int probeHandle);
```

### **Purpose:**

Closes the communications port and releases memory back to the system.

The **ETS\_RemoveProbe** function needs to be called whenever a probe is changed or physically removed.

### **Return Value:**

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

### **Input Parameters:**

```
int probeHandle
```

As returned from **ETS\_CreateProbe** function.

### **Output Parameters:**

None.

## **Advanced Function Reference**

## **ETS\_BATTERY()**

```
int ETS_Battery(const int probeHandle, int &Batt);
```

### **Purpose:**

To obtain the battery status as a percentage of full charge. The **ETS\_InitiateReadBattery** function must be called prior to this call. This function returns a fresh battery reading after each

**ETS\_InitiateReadBattery** command.

### **Return Value:**

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

### **Input Parameters:**

```
int probeHandle
```

As returned from **ETS\_CreateProbe** function.

### **Output Parameters:**

Pass-by-reference integer: The battery value as a percentage of full charge.

### **ETS\_CALIBRATIONDATE()**

```
int ETS_CalibrationDate(const int probeHandle, char
*calibrationDate, const int arraySize);
```

#### **Purpose:**

- Returns the last calibration date for the probe.
- Not available on older probes.

#### **Return Value:**

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

#### **Input Parameters:**

```
int probeHandle
```

As returned from **ETS\_CreateProbe** function.

#### **Output Parameters:**

Pass-by-reference string:

calibrationDate specifying the length of string.

### **ETS\_COMBINEDFIELD()**

```
int ETS_CombinedField(const int probeHandle, float &XYZField);
```

#### **Purpose:**

Returns the total combined field of the X, Y, and Z axes.

#### **Return Value:**

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

#### **Input Parameters:**

```
int probeHandle
```

As returned from **ETS\_CreateProbe** function.

#### **Output Parameters:**

Pass-by-reference float: The combined fields of X, Y, and Z axes.

## **ETS\_FIELD()**

```
int ETS_Field(const int probeHandle, float &xField, float &yField,  
float &zField, float &combinedField);
```

### **Purpose:**

To read the field values from the X-axis, Y-axis, Z-axis, and the combined field. This function must follow an **ETS\_InitiateReadField** command. You can poll **ETS\_IsOperationComplete** to determine when **ETS\_InitiateReadField** is finished.

### **Return Value:**

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

### **Input Parameters:**

```
int probeHandle
```

### **Output Parameters:**

Pass-by-reference float: Returns the X, Y, Z, and combined field data.

## **ETS\_FIRMWARE()**

```
int ETS_Firmware(const int probeHandle, char *firmware, const int  
arraySize);
```

### **Purpose:**

To obtain the firmware version for the probe.

### **Return Value:**

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

### **Input Parameters:**

```
int probeHandle
```

As returned from **ETS\_CreateProbe** function.

### **Output Parameters:**

Pass-by-reference character string: Specifying the length of string.

### **ETS\_GETERRORDESCRIPTION()**

```
void ETS_GetErrorDescription(int errorNumber, char *ErrorStr,  
const int arraySize);
```

#### **Purpose:**

To obtain a written description of an error that has occurred.

#### **Return Value:**

None.

#### **Input Parameters:**

```
int probeHandle
```

As returned from **ETS\_CreateProbe** function.

```
int arraySize
```

#### **Output Parameters:**

Pass-by-reference character string: Specifying the length of string.

### **ETS\_GETUNITSSTRING()**

```
int ETS_GetUnitsString(const int probeHandle, char *UnitsStr,  
const int arraySize);
```

#### **Purpose:**

To obtain the current field units setting for the probe.

#### **Return Value:**

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

#### **Input Parameters:**

```
int probeHandle
```

As returned from **ETS\_CreateProbe** function.

```
int arraySize
```

#### **Output Parameters:**

Pass-by-reference character string:

UnitsStr specifying the length of string.

## ETS\_INITIATEREADBATTERY()

```
int ETS_InitiateReadBattery(const int probeHandle);
```

### Purpose:

Initiates a reading of the battery as a percentage of full charge. The function returns immediately without waiting for the operation finish.

To determine when the command is finished, use **ETS\_IsOperationComplete**. When the reading is complete, use **ETS\_Battery** to obtain the value.

### Return Value:

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

### Input Parameters:

```
int probeHandle
```

As returned from **ETS\_CreateProbe** function.

### Output Parameters:

None.

## ETS\_INITIATEREADFIELD()

```
int ETS_InitiateReadField(const int probeHandle);
```

### Purpose:

Initiates a field reading from the probe. The function returns immediately without waiting for the operation finish.

To determine when the operation is finished, use **ETS\_IsOperationComplete**. When the reading is completed use **ETS\_Field** or **ETS\_CombinedField** to obtain the field values.

The default field units are V/m or A/m.

### Return Value:

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

### Input Parameters:

```
int probeHandle
```

As returned from **ETS\_CreateProbe** function.

### Output Parameters:

None.

## ETS\_INITIATEREADTEMPERATURE()

```
int ETS_InitiateReadTemperature(const int probeHandle);
```

### Purpose:

Initiates a reading of the internal temperature of the probe. The function returns immediately without waiting for the operation finish.

To determine when the operation is finished, use **ETS\_IsOperationComplete**. When the reading is completed use **ETS\_TemperatureC** to obtain the value.

### Return Value:

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

### Input Parameters:

```
int probeHandle
```

As returned from **ETS\_CreateProbe** function.

### Output Parameters:

None.

## ETS\_ISOPERATIONCOMPLETE()

```
int ETS_IsOperationComplete(const int probeHandle);
```

### Purpose:

Used with commands that start with the word **Initiate** to determine when an operation is finished.

### Return Value:

Returns an integer status code. The numeric value **0** indicates successful completion. See **Status Codes** for error code description.

### Input Parameters:

```
int probeHandle
```

As returned from **ETS\_CreateProbe** function.

### Output Parameters:

None.

### **ETS\_MODEL()**

```
int ETS_Model(const int probeHandle, char *model, const int  
arraySize);
```

#### **Purpose:**

Returns the probe model identification information.

#### **Return Value:**

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

#### **Input Parameters:**

```
int probeHandle
```

As returned from **ETS\_CreateProbe** function.

#### **Output Parameters:**

The model name is placed in the user allocated string buffer.

### **ETS\_PROBENAME()**

```
int ETS_ProbeName(const int probeHandle, char *name, const int  
arraySize);
```

#### **Purpose:**

Allows the user to read the user-assigned-name.

#### **Return Value:**

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

#### **Input Parameters:**

```
int probeHandle
```

As returned from **ETS\_CreateProbe** function.

#### **Output Parameters:**

The probe name is placed in the user allocated string buffer.

### **ETS\_READBATTERYSYNCHRONOUS()**

```
int ETS_ReadBatterySynchronous(int Handle, int &battery);
```

#### **Purpose:**

Reads the battery status of the probe and returns only after the probe has responded or a timeout has occurred.

#### **Return Value:**

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

#### **Input Parameters:**

```
int probeHandle
```

#### **Output Parameters:**

**Int battery:** The battery status as the percentage of full charge.

### **ETS\_READTEMPERATURESYNCHRONOUS()**

```
int ETS_ReadTemperatureSynchronous(int Handle, int &temperature);
```

#### **Purpose:**

Reads the internal temperature of the probe and returns only after the probe has responded or a timeout has occurred.

#### **Return Value:**

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

#### **Input Parameters:**

```
int probeHandle
```

#### **Output Parameters:**

**Int temperature:** The probe internal temperature in degrees Celsius.



## **ETS\_SERIALNUMBER()**

```
int ETS_SerialNumber(const int probeHandle, char *serialNumber,  
const int arraySize);
```

### **Purpose:**

Returns the serial number of the probe.

### **Return Value:**

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

### **Input Parameters:**

```
int probeHandle
```

### **Output Parameters:**

Pass-by-reference character string `serialNumber`: Specify the length of string.

## **ETS\_SETRANGE()**

```
int ETS_SetRange(const int probeHandle, int range);
```

### **Purpose:**

SETS-the range for the probe. The default value is 0, which is in Auto Range. The number of ranges is probe-dependent.

### **Return Value:**

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

### **Input Parameters:**

```
int probeHandle
```

**Int range:** Accepts values 0–5.

### **Output Parameters:**

None.

### **ETS\_SETUNITS()**

```
int ETS_SetUnits(const int probeHandle, int Unit);
```

#### **Purpose:**

Switches the field units for the probe. The available units are probe-dependent. Consult the probe user manual for more information.

#### **Return Value:**

Returns an integer status code. The numeric value **0** indicates successful completion. See **Status Codes** for error code description.

#### **Input Parameters:**

```
int probeHandle
```

**Int unit:** Accepts values 1–3.

#### **Output Parameters:**

None.

### **ETS\_TEMPERATUREC()**

```
int ETS_TemperatureC(const int probeHandle, int &TempC);
```

#### **Purpose:**

Reads the internal temperature of the probe. **ETS\_InitiateReadTemperature** must be called prior to this function call. Use the **ETS\_IsOperationComplete** to check for operation completion.

#### **Return Value:**

Returns an integer status code. The numeric value **0** indicates successful completion. See **Status Codes** for error code description.

#### **Input Parameters:**

```
int probeHandle
```

#### **Output Parameters:**

Pass-by-reference integer that is the temperature of the probe in degrees Celsius.

### **ETS\_LASERCURRENT()**

```
int ETS_LaserCurrent(int Handle, float &current);
```

#### **Purpose:**

Reads the laser current of the probe. **ETS\_ReadBattery** must be called to refresh this value.

#### **Return Value:**

Returns an integer status code. The numeric value **0** indicates successful completion. See **Status Codes** for error code description.

#### **Input Parameters:**

```
int probeHandle
```

#### **Output Parameters:**

The laser current of the probe in amps.

### **ETS\_VERSION()**

```
int ETS_Version(char *version, const int arraySize);
```

#### **Purpose:**

Identifies the version of ETSProbe DLL.

#### **Return Value:**

Returns an integer status code. The numeric value **0** indicates successful completion. See **Status Codes** for error code description.

#### **Input Parameters:**

None.

#### **Output Parameters:**

A character string that represents the version of ETSProbe DLL.

### **ETS\_SUPPLYVOLTAGE()**

```
int ETS_SupplyVoltage(int Handle, float &voltage);
```

#### **Purpose:**

Monitors the converter voltage of the laser. In addition the battery voltage of the probe is accessible through this function. **ETS\_ReadBattery** function must be called to refresh this value.

#### **Return Value:**

Returns an integer status code. The numeric value **0** indicates successful completion. See **Status Codes** for error code description.

#### **Input Parameters:**

```
int probeHandle
```

#### **Output Parameters:**

The converter voltage or battery voltage.

### **ETS\_LASERTEMPERATURE()**

```
int ETS_LaserTemperature(int Handle, float &degreesC);
```

#### **Purpose:**

Monitors the laser temperature. **ETS\_ReadTemperature** must be called to refresh this value.

#### **Return Value:**

Returns an integer status code. The numeric value **0** indicates successful completion. See **Status Codes** for error code description.

#### **Input Parameters:**

```
int probeHandle
```

#### **Output Parameters:**

Outputs the temperature of the laser in degrees Celsius.

### **ETS\_ZEROPROBE()**

```
int ETS_ZeroProbe(int Handle);
```

#### **Purpose:**

Zeros older style probes; has no effect on the HI-6000 Series probes.

#### **Return Value:**

Returns an integer status code. The numeric value **0** indicates successful completion. See **Status Codes** for error code description.

#### **Input Parameters:**

```
int probeHandle
```

#### **Output Parameters:**

None.

## Status Codes

A description of the status code can be returned by calling the function **ETS\_GetErrorDescription**. See **Advanced Function Reference** for the description of the function call.

Codes	Description
0	OK
1	Probe handle does not exist
2	Probe family does exist
3	Unable to open communication port
4	Probe not connected
5	Probe response incorrect
6	Operation timeout
7	Busy
8	Probe object does not exist
9	Probe did not respond
10	Probe out of range
11	Invalid input parameter
12	Probes internal gain setting incorrect (cycle power)
13	Error in closing the COMM port
14	Unable to purge COMM port
15	COMM port error
16	Error in writing to COMM port
17	Error in reading from COMM port
18	Laser current too high
19	Internal thread error
20	Bad connection string
21	Value cannot be set
22	Probe model not supported
23	Unable to open file
24	Coefficients do not match
25	Coefficients file error
26	Probe over range
27	Probe under range
28	Function not available
29	Battery fail
30	Battery warning
31	Correction not loaded
32	Out of correction range
33	Correction not supported



Baud rates are at 9600 and 115.2 K for the laser models.



Use this type to initialize all FP-series probes.



Baud rate at 9600. Sample rates exceed 30 samples/second.

### Probe Family HI-Any (Auto Probe Detector)

Automatically detects most ETS-Lindgren Holaday probes, as listed in the following:

- FP5000 Series
- FP4000 Series
- HI-6000 Series
- HI-4433 Series
- HI-4450 Series

### Probe Family FP-Any (Auto Probe Detector FP)

Automatically detects most ETS-Lindgren Holaday probes, as listed in the following:

- FP2000 Series
- FP4000 Series
- FP5000 Series
- FP6001

### Probe Family Virtual

This simulated probe type is for testing and software development purposes. Varying field values are generated using a sin function.

### Probe Family HI-44xx MS

Use this type to obtain higher sample rates on 3-axis probes. This type does not return individual field readings for each axis.

FP5080	HI-4450	FP4080
FP5000	FP5240	FP4083
FP5033	HI-4451	FP4240
FP5034	HI-4453	HI-4422
FP5036	HI-4455	HI-4433-GRE
FP5055	HI-4456	HI-4433-HSE
FP5083	HI-4457	HI-4433-MSE
FP4031	FP4000	HI-4433-STE

### Probe Family HI-6005 MS (Medium Speed)

- FP6001
- HI-6005, HI-6006, HI-6023
- HI-6053



Baud rate at 19200.

Sample rates exceed 50 samples/second.

### Probe Family HI-6005 HS (High Speed)

- FP6001
- HI-6005, HI-6006, HI-6023
- HI-6053

### Probe Types Not Supported

- HI-3603
- HI-3604
- HI-2200

## Quick Start Function Reference

### ETS\_CREATEPROBE()

```
int ETS_CreateProbe(const char *name, int &Handle, const char *CommSettings, const char *Family);
```

#### Purpose:

Creates a probe object and establishes communications to a specified probe.

- Makes an object of the correct type.
- Verifies that the communications to the probe can be established.
- Does a probe identify and an initialization of the probe.

#### Return Value:

Returns an integer status code. The numeric value 0 indicates successful completion. See **Status Codes** for error code description.

#### Input Parameters:

Case sensitive strings must be used.

#### char **CommSettings**

ASRL1::INSTR /Comm Port 1

Com1

Com2

etc.

#### char **Family**

HI-Any

FP-Any

HI-44xx MS

HI-6005 MS

HI-6005 HS

Virtual

## APPENDIX E: EC DECLARATION OF CONFORMITY

- HI-6023 Field Probe
- HI-6006 Field Probe
- HI-6053 Field Probe

Factory	Issued by
ETS-Lindgren, Inc.  1301 Arrow Point Drive, Cedar Park, TX, USA 78613	ETS-Lindgren, Inc.  1301 Arrow Point Drive, Cedar Park, TX, USA 78613

We hereby declare under our sole responsibility that the apparatus complies with the essential requirements of the following directives:

- Electromagnetic Compatibility (EMC) Directive 2014/30/EU, Electromagnetic Compatibility Regulations 2016
- Low Voltage Directive 2014/35, Electrical Equipment (Safety) Regulations 2016
- RoHS Directive (EU) 2015/863 amending Annex II to Directive 2011/65/EU

### Applicable Requirements

Standard	Criteria
EN 55011	• EN 55011:2009/A1:2010 (CISPR 11:2009/A1:2010), Group 1, Class A Immunity
EN 61010-1	• Safety requirements for electrical equipment for measurement, control and laboratory use

### RoHS EIP Category: Electronic Measuring Instrument Products

Substance	
X	Lead
	Mercury
	Cadmium
	Chromium VI
X	PBB Biphenyls
X	PBDE Biphenyl Ethers
	DEHP (2-ethylhexyl) Phthalate
	BBP Butyl Benzl Phthalate
	DBP Dibutyl Phthalate
	DIBP Diisobutyl Phthalate

### Applicable Product Markings





