

HI-6005/FP-6001

Electric Field Probe

User's Manual

Declaration of Conformity

ETS-Lindgren, L.P.
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USA



Declares that the HOLADAY product described in this instruction manual is in compliance with: EN EMC Directive 86/336/EEC, EN50082-1, EN55011

ETS-Lindgren, L.P.
(Formerly Holaday Industries, Inc.)



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REVISION RECORD

HI-6005/FP-6001 MANUAL, Part #600089

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1.0 INTRODUCTION

NOTE: Read *Addendum: HI-6005/FP-6001 Battery Service Bulletin* before reading the remainder of this manual or using your HI-6005/FP-6001.

The HI-6005/FP-6001 Electric Field Probes embody the latest innovations in isotropic sensor design and low noise, miniaturized electronics. The HI-6005 and FP-6001 are fully intelligent sensor enabling fast and accurate EMF measurements with industry-leading performance specifications. Optical coupling to a variety of readout options makes this new probe ideally suited for a wide range of field monitoring applications. The HI-6005 and FP-6001 are excellent tools for electric field mapping, RADHAZ measurements and EMC field monitoring.

The basic HI-6005 and FP-6001 are shipped complete with an attached one-meter fiber optic cable, a 10 meter fiber extension cable, a carrying case, battery charger and connectors for extending the optic cable.



Figure 1: Model HI-6005/FP-6001 Electric Field Probe

SPECIFICATIONS

Dynamic Range:	0.5 to 800 V/m	
	Single Range (64 dB)	
Frequency Response:	100 kHz to 5 GHz	
Linearity:	± 0.5 dB full scale (F.S.)	
Isotropy:	± 0.5 dB	
Overload Withstand:	1500 V/m max. Continuous Field	
Environmental:	Operating Temp.	10°C to 40°C (+50°F to +104°F)
	Operating Humidity:	5% to 95% relative humidity, non-condensing
Fiber Optic Cable Connector:	Standard FSMA	
Battery:	4.8 VDC, 45 mA-h rechargeable Nickel- Metal Hydride (NiMH)	
Battery Charger:	115/230 VAC, approximately 2 hrs.	
Dimensions:	32 mm (1.25 in) cube with probe shields on three sides	
Probe Mount:	¼--20 UNC (internal thread)	
Weight:	0.08 Kg (2.6 oz.)	
Optional Equipment:	See Table 2	

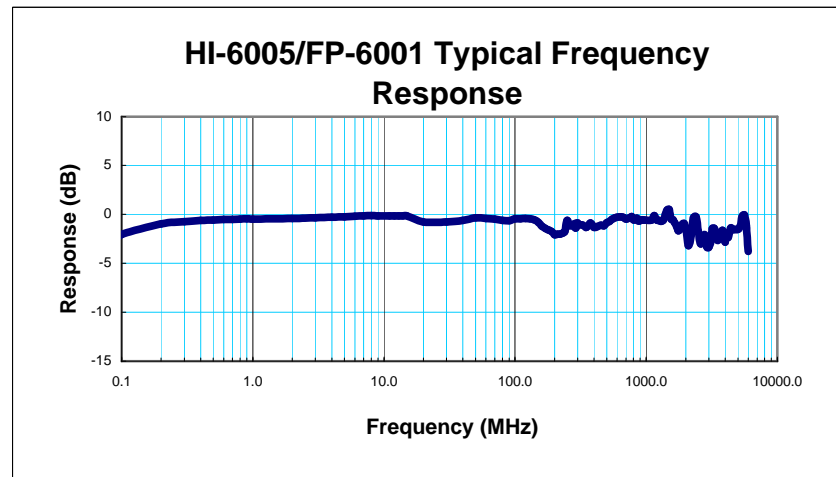


Figure 2: Typical Frequency Response

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2.0 GETTING STARTED

ACCEPTANCE AND CONTROLS

This section contains information on: unpacking and acceptance of the HI-6005/FP-6001 probe; probe controls; probe connectors; the battery, and bench testing the battery charger.

Unpacking and Acceptance

Step 1. Upon delivery of your order, inspect the shipping container(s) for evidence of damage. Record any damage on the delivery receipt before signing. In case of concealed damage or loss, retain the packing materials for inspection by the carrier.

Step 2. Remove the probe from its shipping containers. Save the boxes and any protective packing materials for future use.

Step 3. Check all materials against the packing list to verify that the equipment received matches what was ordered. If you find any discrepancies, note them and call ETS-Lindgren Customer Service for further instructions.

Be sure that you are satisfied with the contents of your order and the condition of your equipment before installing the probe.

Probe

A power switch and a battery charger connector are mounted on the HI-6005/FP-6001 probe housing (Figure 2). Fiber optic cables are fixed inside the probe's housing.

XMIT/RCV

The fiber optic cable assembly from the probe connects to a readout via two connectors. The cable ends are color-coded—white for XMIT, yellow for RCV. Be sure that each cable is attached to the proper readout connector; yellow to yellow, white to white.

When the cables are not attached, always cover the ends with the protective plastic covers supplied with the unit, or with similar material. This prevents dirt and other contaminants from entering the connector, causing communication problems.

POWER

The power switch activates and deactivates the probe. In the ON (1) position, the probe is powered by its internal 4.8 VDC NiMH battery and the power indicator LED will blink; in the OFF position (0), the probe is inactive. To prolong battery life, set this switch to OFF when the probe is not in use.

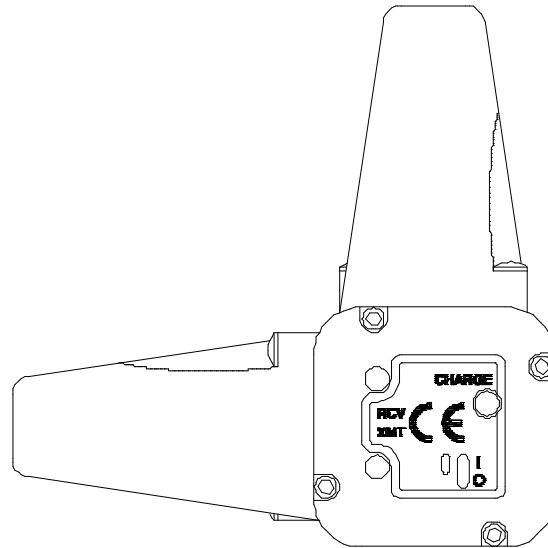


Figure 3: HI-6005/FP-6001 Power Switch and Connectors

CHARGER

A standard fast charger is supplied with the HI-6005/FP-6001. When charging is complete, the fast charger acts as a trickle charger. Battery performance will not degrade, regardless of how long it is connected to the trickle charger.

BATTERY

The NiMH battery provides up to 10 hours of probe operation when fully charged.

3.0 OPERATION

HI-6005/FP-6001 SYSTEM DESCRIPTION

This section describes the operations and functions of the HI-6005/FP-6001 Isotropic Electric Field Instrumentation System. The objective is to provide information that will enhance the user's understanding of the design of this system.

The HI-6005/FP-6001 is a sophisticated and very accurate electric field measuring system which consists of the HI-6005/FP-6001 Isotropic Electric Field Probe and the HI-6005/FP-6001 Isotropic Electric Field Probe Interface Software. The Interface Software is designed to be installed on a "host system". The "host system" could be an ETS-Lindgren system readout or the ETS-Lindgren HI-6005/FP-6001 Isotropic Electric Field Probe Interface Software installed on the user's system.

The HI-6005/FP-6001 Probe is the electric field measurement component which provides "Raw Data" to the Interface Software. The Interface Software processes this data into calibrated field level readings that will be presented to the user through the host system.

The combination of the speed and the processing power of the host system, results in a superior system performance providing the user with calibrated field level readings.

HI-6005/FP-6001 Probe Description

The HI-6005/FP-6001 Isotropic Electric Field Probe utilizes an enhanced RISC micro-controller for intelligent operation and control. The probe's self contained power supply employs a 4.8 VDC NiMH battery, which provides 10 hours of continuous operation.

Three orthogonal mono-pole antennas are used to provide an isotropic reading of the radio frequency electric field. A Schottky diode detector circuit is used to convert the RF electric field signal level present on the antenna to a voltage signal level, which can be measured by the instrumentation circuitry.

Each of the three axes of the probe are instrumented independently and are controlled by the micro-controller. This enables the probe to sample the signal level for each of the three axes at exactly the same instant, no multiplexing. When this data is used by the Interface Software to calculate a composite field reading, the result is the true composite field reading for the instant the signal level sample was taken.

An advantage of the architecture of the HI-6005/FP-6001 is that the data from each of the three axes is read by the micro-controller at the same time that results in faster data collection capabilities.

Additional features of the HI-6005/FP-6001 Probe are temperature sensing with $\frac{1}{2}$ degree Celsius increments, and battery gas gauging which measures the available capacity of the battery pack.

Each HI-6005/FP-6001 Probe contains unique calibration data in non-volatile memory. This memory is also programmed with information such as the serial number of the probe, the software revision of the embedded software within the probe, and the date the probe was last calibrated.

BATTERY

Each HI-6005/FP-6001 probe contains a rechargeable nickel-metal hydride (NiMH) battery. A fully-charged battery (nominal output voltage of 4.8 VDC) provides up to 10 hours of operation. When the battery has discharged to 4.4 VDC, the probe is still operational, but its battery needs charging. When the voltage drops below 4.0 VDC, measurement accuracy will be compromised by further operation.

Battery Charging

Plug the battery charger into a suitable AC power source and insert the charger jack into the connector labeled CHARGE on the HI-6005/FP-6001 (be sure the power switch is in the OFF position). When the charger is first connected, the PENDING LED (amber) will light while the charger qualifies the battery for fast charge. When the voltage is at a safe level the charger will switch to the fast charge mode and the CHARGING LED (amber) will light. When charging is complete, the charger will switch to pulse trickle mode and the COMPLETE LED (green) is turned on.

Battery Discharging

The battery in the HI-6005/FP-6001 may be discharged at any time. Connect the charger to the unit, as described above. Press the Discharge button and the DISCHARGE LED (amber) will light. The battery is now being fully discharged, a process that may take up to 6 hours. When this cycle is complete, it will then be recharged, which will take about two hours. The total discharge time is about 8 hours.

For more complete instructions about charging and discharging your HI-6005/FP-6001, refer to Appendix C for the chargers' manual (ETS-Lindgren #600087).

NOTE: ETS-Lindgren, charges the internal NiMH battery of the HI-6005/FP-6001 at the factory in order to calibrate the probe prior to shipment. While every effort is made to ensure that your probe arrives ready to use, we cannot guarantee that this will be the case. Always check the condition of the probe's battery prior to making any measurements.

Battery Tips

NiMH batteries have several characteristics that can affect both their performance and operating life. The following tips advise you how to take advantage of these characteristics to get the most out of your probe's battery.

- Although NiMH batteries are rated for operation in temperatures from -20 °C to +65 °C (-4 °F to +140 °F), operating the probe in extreme temperatures will reduce operating time significantly. The optimum operating temperature range for these batteries is +20 °C to +30 °C (+68 °F to +86 °F).
- The battery in the HI-6005/FP-6001 does not require periodic "deep discharges" to reverse the capacity-depleting "memory effect" caused by repeated shallow discharges; however, undercharging can reduce battery capacity. Therefore, after the charging procedure is complete, be sure that the battery is fully charged before resuming field operation.
- If the battery exhibits low terminal voltage during charging, or if it appears unable to acquire or maintain an appreciable charge, individual cells in the battery may be shorted or damaged. If, for any reason, your battery needs replacement, contact ETS-Lindgren Customer Service for assistance.

4.0 MAINTENANCE

This section explains which maintenance tasks can be performed by the user. It also provides information regarding replacement and optional parts. If you have any questions concerning probe maintenance, consult ETS-Lindgren Customer Service.

MAINTENANCE RECOMMENDATIONS

Maintenance of the HI-6005/FP-6001 is limited to external components such as cables or connectors.

Any calibration or maintenance task that requires probe disassembly should be performed at the factory. Contact ETS-Lindgren Customer Service before opening the unit to avoid problems with your probe's warranty.

NOTE: Opening the probe enclosure may void your warranty. If your system is under warranty, contact ETS-Lindgren Customer Service before performing any maintenance inside the probe.

Probe Shields

Over time, the probe shields (the black, cone-shaped structures with the axis labels) may accumulate foreign materials, which may become embedded in the shield surface. Shields must be kept clean to maintain proper probe operation.

Probe Shield Replacement

If the probe shields need to be replaced, they may be ordered from ETS-Lindgren. Use the following procedure to replace the probe shields.

Step 1. Remove the two nylon screws from the probe shield.

Step 2. Lift the shield straight up and away from the HI-6005/FP-6001 housing. BE SURE THAT YOU LIFT IT HIGH ENOUGH TO CLEAR THE INTERNAL ANTENNA ASSEMBLY, OR YOU MAY DAMAGE IT. Place the probe in a protected location while performing the next step.

NOTE: 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.

Step 3. CAREFULLY replace the shield by lowering it straight down onto the housing: again, be sure to clear the antenna assembly when doing so.

Step 4. Replace the screws. Snug them up only: DO NOT OVERTIGHTEN THE SCREWS, OR YOU MAY DAMAGE THE HEADS.

NOTE: If you require additional nylon screws, you may order them from ETS-Lindgren or you may obtain them locally. Non-conductive screws must be used for this application. NEVER use metal screws.

The probe is now ready to be put back into operation. Repeat this procedure for the other shields, if necessary.

Upgrade Policies

Periodically, probes are upgraded to enhance functionality. Contact ETS-Lindgren Customer Service to check on the upgrade status of your probe(s).

RETURN PROCEDURES

To return a system or system component, use the following procedure.

Step 1. Contact ETS-Lindgren Customer Service (+1-512-531-6400) to obtain an SRO, Service Request Order.

Step 2. Briefly describe the problem in writing. Give details regarding the observed symptom(s) or error codes, and whether the problem is constant or intermittent in nature. Please include the date(s), the service representative you spoke with, and the nature of the conversation. Include the serial number of the item being returned.

Step 3. Package the system or component carefully. Use the original packing boxes and materials, if possible.

PERIODIC/PREVENTIVE MAINTENANCE

ETS-Lindgren recommends an annual calibration check of the HI-6005/FP-6001 probe to verify that it is performing within specifications. ETS-Lindgren Service Personnel at the factory may perform this calibration check. Return your probe(s), using the original packing materials (if possible), to:

ETS-Lindgren
Attn: Service Department
1301 Arrow Point Drive
Cedar Park, TX 78664
sales@ets-lindgren.com

PARTS INFORMATION

Use the following tables for ordering replacement (Table 1) or optional (Table 2) parts for the HI-6005/FP-6001.

Part Description (Replacement Parts)	Part Number
Carry Case	491207
Battery Charger	491198-48
Cone Replacement Kit	H-651016
	Includes: Three (3) shield, six (6) screws and one (1) each X, Y and Z labels
HI-6005/FP-6001 User's Manual	600089

Table 1: Replacement Parts List

Part Description (Optional Parts)	Part Number
Cable, Fiber Optic, Glass, 10 Meter	491106-10
Conn. Set, (Bulkhead Feedthru) (two)	231205000
Tripod, Dielectric, HI- 6005/FP-6001	491000
Collapsible Probe Handle Assembly	491206
Fiber Optic / RS232 Interface	HI-4413P
Graphical Readout	HI-4460

Table 2: Optional Parts List

5.0 WARRANTY POLICY FOR ELECTROMAGNETIC ISOTROPIC FIELD MONITORING COMPONENTS

SCOPE AND DURATION OF WARRANTIES

Seller warrants to Buyer that the ETS-Lindgren Brand Products to be delivered hereunder will be (1) free from defects in material, manufacturing workmanship, and title, and (2) conform to the Seller's applicable product descriptions and specifications, if any, contained in or attached to Seller's quotation. If no product descriptions or specifications are contained in or attached to the quotation, Seller's applicable product descriptions and specifications in effect on the date of shipment shall apply. The criteria for all testing shall be Seller's applicable product specifications utilizing factory-specified calibration and test procedures and instruments.

All product warranties, except the warranty of title, and all remedies for warranty failures are limited in time as shown in the table below.

<u>Product Warranted</u>	<u>Duration of Warranty</u> <u>Period</u>
FM5004	3 Years
HI-6005	3 Years
FP-6001	3 Years
HI-4450	3 Years
FP-4080	3 Years
FP-5000	3 Years
FP-2080	3 Years
HI-4453	3 Years
FP-4083	3 Years
FP-5083	3 Years
FP-2083	3 Years
FP-5080	3 Years
FP-4000	3 Years
FP-2000	3 Years
HI-4422	3 Years

Any product or part furnished to Buyer during the warranty period to correct a warranty failure shall be warranted to the extent of the unexpired term of the warranty applicable to the repaired or replaced product.

The warranty period shall commence on the date the product is delivered to Buyer; however, if Seller assembles the product, or provides technical direction of such assembly, the warranty period for such product shall

commence on the date the assembly of the product is complete. Notwithstanding the foregoing, in the event that the assembly is delayed for a total of thirty (30) days or more from the date of delivery for any reason or reasons for which Seller is not responsible, the warranty period for such product may, at Seller's options, commence on the thirtieth (30th) day from the date such product is delivered to Buyer. Buyer shall promptly inspect all products upon delivery. No claims for shortages will be allowed unless shortages are reported to Seller in writing within ten (10) days after delivery. No other claims against Seller will be allowed unless asserted in writing within thirty (30) days after delivery (or assembly if the products are to be assembled by Seller) or, in the case of alleged breach of warranty, within the applicable warranty period.

WARRANTY EXCLUSIONS

Except as set forth in any applicable patent indemnity, the foregoing warranties are exclusive and in lieu of all other warranties, whether written, oral, express, implied, or statutory. EXCEPT AS EXPRESSLY STATED ABOVE, SELLER MAKES NO WARRANTY, EXPRESS OR IMPLIED, BY STATUTE OR OTHERWISE, WHETHER OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE OR USE OR OTHERWISE ON THE PRODUCTS, OR ON ANY PARTS OR LABOR FURNISHED DURING THE SALE, DELIVERY OR SERVICING OF THE PRODUCTS. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF.

Warranty coverage does not include any defect or performance deficiency (including failure to conform to product descriptions or specifications) which results, in whole or in part, from (1) negligent storage or handling of the product by Buyer, its employees, agents, or contractors, (2) failure of Buyer to prepare the site or provide an operating environmental condition in compliance with any applicable instructions or recommendations of Seller, (3) absence of any product, component, or accessory recommended by Seller but omitted at Buyer's direction, (4) any design, specification, or instruction furnished by Buyer, its employees, agents or contractors, (5) any alteration of the product by persons other than Seller, (6) combining Seller's product with any product furnished by others, (7) combining incompatible products of Seller, (8) interference with the radio frequency fields due to conditions or causes outside the product as furnished by Seller, (9) improper or extraordinary use of the product, or failure to comply with any applicable instructions or recommendations of

Seller, or (10) acts of God, acts of civil or military authority, fires, floods, strikes or other labor disturbances, war, riot, or any other causes beyond the reasonable control of Seller. This warranty does not cover batteries or any item that is designed to be consumable. Seller does not warranty products of others, which are not included in Seller's published price lists.

BUYER'S REMEDIES

If Seller determines that any product fails to meet any warranty during the applicable warranty period, Seller shall correct any such failure by either, at its option, repairing, adjusting, or replacing without charge to Buyer any defective or nonconforming product, or part or parts of the product. Seller shall have the option to furnish either new or exchange replacement parts or assemblies.

Warranty service during the applicable warranty period will be performed without charge to Buyer within the contiguous 48 United States during Seller's normal business hours. After the warranty period, service will be performed at Seller's prevailing service rates. Subject to the availability of personnel, after-hours service is available upon request at an additional charge. For service outside the contiguous 48 United States, travel and per diem expenses, when required, shall be the responsibility of the Buyer, or End User, whichever is applicable.

The remedies set forth herein are conditioned upon Buyer promptly notifying Seller within the applicable warranty period of any defect or nonconformance and making the product available for correction.

The preceding paragraphs set forth Buyer's exclusive remedies and Seller's sole liability for claims based on failure of the products to meet any warranty, whether the claim is in contract, warranty, tort (including negligence and strict liability) or otherwise, and however instituted, and, upon the expiration of the applicable warranty period, all such liability shall terminate. IN NO EVENT SHALL SELLER BE LIABLE TO BUYER FOR ANY SPECIAL INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND ARISING OUT OF, OR AS A RESULT OF, THE SALE, DELIVERY, NON-DELIVERY, SERVICING, ASSEMBLING, USE OR LOSS OF USE OF THE PRODUCTS OR ANY PART THEREOF, OR FOR ANY CHARGES OR EXPENSES OF ANY NATURE INCURRED WITHOUT SELLER'S WRITTEN CONSENT DESPITE ANY NEGLIGENCE ON BEHALF OF THE SELLER. IN NO EVENT SHALL SELLER'S LIABILITIES UNDER ANY CLAIM MADE BY BUYER EXCEED THE PURCHASE PRICE OF THE PRODUCT IN

RESPECT OF WHICH DAMAGES ARE CLAIMED. This agreement shall be construed in accordance with laws of the State of Illinois. In the event that any provision hereof shall violate any applicable statute, ordinance, or rule of law, such provision shall be ineffective to the extent of such violation without invalidating any other provision hereof.

Any controversy or claim arising out of or relating to the sale, delivery, nondelivery, servicing, assembling, use or loss of use of the products or any part thereof or for any charges or expenses in connection therewith shall be settled in Austin, Texas by arbitration in accordance with the Rules of the American Arbitration Association, and judgment upon the award rendered by the Arbitrator may be entered in either the Federal District Court for the Western District of Texas or the State District Court in Austin, Texas, all of the parties hereto consenting to personal jurisdiction of the venue of such court and hereby waive the right to demand a jury trial under any of these actions

6.0 APPENDIX A: ERROR CODES

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 (e.g., overflow).
E2	Buffer full error. Too many characters contained between the Start Character/Carriage Return sequence.
E3	The received command is not valid.
E4	The received parameter is not valid.
E5	Hardware error (e.g., EEPROM failure).
E6	Parity error.
E9	Commands are locked.

7.0 APPENDIX B: HI-6005/FP-6001 OPERATING PROTOCOLS

The information in this appendix assumes that you have purchased the optional HI-4413P Fiber Optic/RS232 Interface, and are capable of communicating directly with the HI-6005/FP-6001 probe.

COMMUNICATION PROTOCOL

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

INFORMATION TRANSFER PROTOCOL

The HI-6005/FP-6001 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 HI-6005/FP-6001. When the HI-6005/FP-6001 completes the command, it responds with a string consisting of:

- 1) A start character (":")
- 2) The command letter, followed by
- 3) Data, if required, and terminated with
- 4) 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 HI-6005/FP-6001 responds with an error code, as detailed in Appendix A.

COMMANDS

Command	Description
B<CR>	Read battery voltage.
	Probe Response:
	:Bxx.xx<CR>
	Where
	:B04.80=100% of charge = 4.8 volts
	:B04.00=0% of charge = 4.0 volts
	<CR> = carriage return
BP	Read battery capacity in percentage.
	Probe Response:
	:Bxx<N or F><CR>
	Where
	:B64N=100% of charge = 4.8volts
	:B00F=0% of charge = 4.0 volts
	N = safe operating level
	F = Fail level
D3	Read probe data.
	Probe Response:
	:Dx.xxyy.yyzz.zB<CR>
	Where
	xxxx, yyyy, zzzz are 4 digit axis values with a floating decimal point
	B is the battery flag (N or F)
D5	Read probe data.
	Probe Response:
	:Dx.xxyy.yyzz.zcccc.B<CR>
	Where
	xxxx, yyyy, zzzz, are 4 digit axis values with a floating decimal point
	cccc is the composite field value with a floating decimal point
	B is the battery flag (N or F)

Command	Description
I	Identification command.
	Probe Response:
	:I6005<sr><sn><cd>B<CR>
	Where
	sr = 10 character software revision
	sn = 8 character serial number
	cd = 8 character calibration date
	B = battery flag (N or F)
TC	Read Temperature in Centigrade.
	Probe Response: :Txxxx.<CR>
TF	Read Temperature in Fahrenheit.
	Probe Response: :Txxxx.<CR>
<Null><CR>	Send the ASCII null character.
	Probe Response: :N<CR>
	This is a special command that can be used as the initial command to the probe after it is turned on.

8.0 APPENDIX C: SERIES 491198-48 BATTERY FAST CHARGER MANUAL

Series 491198-48

NiMH Battery Fast Charger

Manual



1. General Safety Considerations



This symbol alerts the user that important literature concerning the operation and maintenance of this unit has been included. Therefore, it should be read carefully in order to avoid any problems.



Warning

This is a Safety Class I product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor, inside or outside the instrument, is likely to make the instrument dangerous. Intentional interruption is prohibited. DO NOT defeat the earth-grounding protection by using an extension cable, power cable, or autotransformer without a protective ground conductor.

This instrument is to be used with a three-wire power cord set which meets or exceeds the requirements of EN60799. The power cord set used must be rated for a minimum of 250V/10A. When connected to an appropriate power line outlet, this cable grounds the instrument cabinet.



Warning

No operator serviceable parts exist inside the device. Refer servicing to qualified personnel. To prevent electrical shock, do not remove cover.



Warning

If this instrument is used in a manner not specified by ETS-Lindgren, the protection provided by the instrument may be impaired.



Warning

This battery charger incorporates parts, such as a switch and relay that potentially could produce sparks or arcs.



Warning

For indoor use only, do not expose to rain.

2. Description

The 491198-48 NiMH Battery Fast Charger is a dual power source battery charger. It charges 4.8 volt 25 mA NiMH batteries and is powered by 85 - 264 Vac line power or 12.5 Vdc. The 491198-48 uses a $-(dV)/(dT)$ (negative delta V) technique to determine when the battery is fully charged, typically two hours. With this technique, the charge state of the battery has no effect other than shortening the charge time.

Housed in a rugged enclosure, power enters the battery charger through a power entry module, which contains the fuses, or an optional cigarette lighter plug adapter. LEDs and the label on the front face of the unit provide 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 charger monitors the battery voltage and controls the charging functions according to the charge state of the battery.

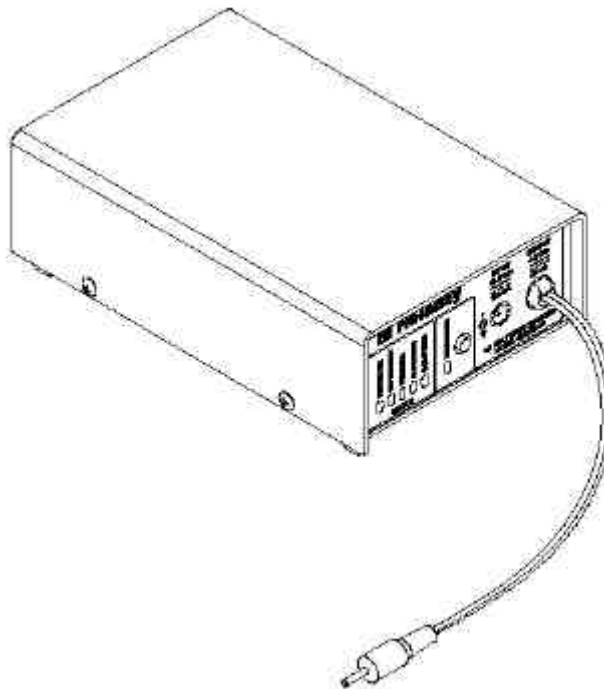


Figure 1: 4.8V Battery Charger

3. UNPACKING AND ACCEPTANCE

This section contains information on unpacking and acceptance of the 491198-48 NiMH Battery Fast Charger.

Step 1. Upon delivery of your order, inspect the shipping container(s) for evidence of damage. Record any damage on the delivery receipt before signing. In case of concealed damage or loss, retain the packing materials for inspection by the carrier.

Step 2. Remove the product from its shipping container. Save boxes and any protective packing materials for future use.

Step 3. Check all materials against the packing list to verify that the equipment received matches what was ordered. If you find any discrepancies, note them and call ETS-Lindgren Customer Service for further instructions.

Be sure that you are satisfied with the contents of your order and the condition of your equipment before using it.

4. SPECIFICATIONS

Power

Main: IEC filtered AC power input module
110 - 240 Vac, 500 mA MAX., 50 - 100 Hz
Alternate: Automobile cigarette lighter to 2mm power plug adapter
cord., 12.5 Vdc, 100 mA
Fuses: 250 Volt, 1.0 Amp, Type T (5 mm x 20 mm)

Output

Open Circuit Voltage: 12 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

NiMH Battery:

4.8 Volt 4 Cell NiMH Battery, 25 mAH (Rapid charge cells, 1.2 volts/cell);
ETS-Lindgren Part #491193

Environmental

Operating temperature 10 to 40° C
Humidity: 5% to 95% relative humidity, non-condensing

Power Cable

This charger is shipped with a three-wire power cable. When this cable is connected to an appropriate AC power source, it connects the chassis to earth ground. The type of power cable shipped with each battery charger depends on the country of destination.

Power Cable Set Information

ETS-Lindgren Part No.	Manufacturer, Part No. and Information
2217500	Volex #17500
	Type SVT, Foil shielded, PVC Jacketed, 60°C
	Molded PVC Grounding Plug NEMA 5-15P UC-004
	Molded PVC Receptacle IEC320/C13 UC-005
	18 Ga. 3 Cond. 10A-125V
2217506C	Volex #17506
	Type SVT, Foil shielded, PVC Jacketed, 60°C
	Molded PVC Grounding Plug NEMA 5-15P UC-004
	Molded PVC Right-Angle Receptacle
	IEC320/C13 UC-006
	18 Ga. 3 Cond. 10A-125V
221100	Countries: Canada, Japan, Puerto Rico, Taiwan, Venezuela, Hong Kong, United States
	Kobiconn #173-7001
	Type H05VV-F, PVC Jacketed, 70°C
	Molded PVC Right-Angle Grounding Plug CEE 7/7 UC-814
	Molded PVC Receptacle IEC320/C13 UC-051
	1.0mm ² 3 Cond. 10A-250V
222600	Countries: Argentina, Austria, Brazil, Finland, France, Germany, Israel, Italy, Holland, Korea, Netherlands, Norway, Sweden, Turkey
	QualTek #370001-E01
	Type H05VV-F, PVC Jacketed, 70°C, Harmonized
	Molded PVC Grounding Plug BS 1363, Fused UC-851
	Molded PVC Receptacle IEC320/C13 UC-852
	1.0mm ² 3 Cond. 10A-250V

ETS-Lindgren Part No.	Manufacturer, Part No. and Information
221600	Countries: England, Ireland, Malaysia, Scotland, Singapore, South Africa, Wales
	Leeds Electronic Components #FFBS-1310
	Type SAA, Ordinary Duty, PVC Jacketed, 75°C
	Molded Grounding Plug AS3112 UC-822
	Molded PVC Receptacle IEC320/C13 UC-051
	1.0mm ² 3 Cond. 10A-250V
221500	Countries: Australia, China
	Volex #2102H-C3-10
	Type H05VV-F, PVC Jacketed, 70°C
	Molded PVC Grounding Plug SEV 1011 UC-841
	Molded PVC Receptacle IEC320/C13 UC-051
	1.0mm ² 3 Cond. 10A-250V
	Country: Switzerland

5. OPERATING INSTRUCTIONS

The 491198-48 battery charger is intended to charge the 4.8 volt NiMH batteries within the HI-6005/FP-6001, either in the lab or in the field.

Input Power Requirements

The 491198-48 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), see Specifications. The AC power entry module contains a fuse.

Fuse Replacement

If a fuse has blown, it must be replaced with the same type and value or an unsafe condition may result. Refer to Figure 2 for fuse replacement.

The fuse is contained in the fuse drawer in the power input module. To access the fuse, use a screwdriver to pry the drawer open and remove it from the module. The drawer holds two fuses; the fuse towards the outside of the drawer is a spare.

After the fuse has been replaced, slide the fuse drawer back into the module. Make sure that it snaps securely into its locked position.



CAUTION!

NEVER attempt to change the fuse with the battery charger plugged in.

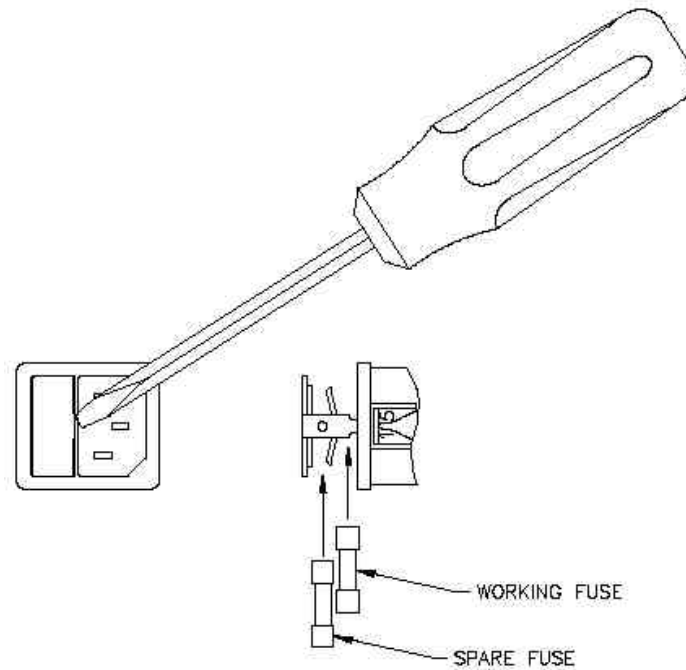


Figure 2: Fuse Replacement

Charging a Battery

After connecting the battery charger to a proper power source, the battery charger simply plugs into the charger jack on the HI-6005/FP-6001. The HI-6005/FP-6001 must be turned off or the battery will not charge.



CAUTION!

NEVER attempt to recharge a non-rechargeable battery.

Charging Indicators

The fast chargers for the HI-6005/FP-6001 are intelligent chargers. Six LEDs located on the front of the charger provide operating information to the user.

The “POWER ON” LED (green) will remain illuminated as long as the charger is plugged into the AC power source.

If the charger does not detect a battery, the “NO BATTERY” LED (amber) light will illuminate.

When the charger does detect the HI-6005/FP-6001's battery, the “PENDING” LED (amber) light illuminates. 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.

Once the voltage pre-qualification condition has been met, fast charge begins and the “CHARGING” LED (amber) will illuminate. 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.

If the probe is turned on during the fast charge period of the charge cycle, the current surge that the battery provides to the electronics in the probe will cause a momentary voltage drop on the battery, causing the charger to terminate the fast charge based on a peak voltage detect condition. When a fast charging peak voltage is detected, the charger “COMPLETE” LED (green) will illuminate.

The 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 battery will still operate properly.

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

The batteries are quite small, and the fast charge current is very low. 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.

The chargers will not damage the battery even when left connected for long periods of time.

Discharging a Battery

Connect the charger to the unit, as described above. Press the Discharge button and the "DISCHARGE" LED (amber) will illuminate. You may press the Discharge button at any time. The battery is now being fully discharged, a process that may take up to 5 hours. When this cycle is complete, it will then be recharged, which typically takes 2 hours, but may take up to 3 hours. The total discharge/recharge cycle time is approximately 7 hours.

6. MAINTENANCE

Electronic instruments are delicate. Operate the battery charger with care.

User serviceable parts do not exist inside the battery charger. Warranty may be void if the battery charger housing is opened.

If the battery charger fails to operate, check for a blown fuse inside the power entry module (refer to figure 2).

CAUTION!



NEVER attempt to change the fuse with the battery charger plugged in.

If a fuse is blown it must be replaced. Be sure to use only 250 Volt, 1.0 Amp, Type T (5 mm x 20 mm).

If the battery charger still fails to operate, or if you have any questions concerning charging your products, contact ETS-Lindgren Customer Service.

9.0 ADDENDUM: HI-6005/FP-6001 BATTERY SERVICE BULLETIN

Charge the Battery First

For maximum battery life it is important that you fully charge the battery of your HI-6005/FP-6001 Electric Field Probe before using it. Be sure the probe power switch is set to the OFF Position. Connect the charger to the electrical mains and connect the charger output to the HI-6005/FP-6001. Refer to the user manual for full details.

Failing to fully charge the battery may result in reduced battery life and cause premature battery failure.

Battery Life

The NiMH (nickel – metal hydride) battery powering the HI-6005/FP-6001 Electric Field Probe has high energy density for maximum operating time between charges but also has a significant self-discharge characteristic. When the probe is stored for longer than a week or two, the battery will discharge even when not in use. Leaving the battery in a 'discharged' condition for long periods of time may result in reduced battery life. For optimum testing time, it is advised to charge the battery before use.

The battery charger provided with the HI-6005/FP-6001 is microprocessor controlled to charge the battery in the fastest possible manner. When the charger senses that the battery is fully charged, the charging current drops to a 'maintenance' level. This level is sufficient to maintain the battery fully charged without causing battery damage. It is acceptable to leave the probe connected to the charger for extended periods of time.

Useful Information to Maximize the HI-6005/FP-6001 Battery Life

Following these procedures will assure maximum battery life and optimum testing performance:

1. Be certain the HI-6005/FP-6001 Power Switch is set to the off position when the probe is not in use. The off position of the switch is the 'down' or '0' position. It is easy to overlook the switch position and, when the battery is discharged, the flashing power ON indicator will no longer function. Leaving the Power Switch 'ON' for extended periods of time will damage the battery.
2. When possible, leave the HI-6005/FP-6001 connected to its charger and the charger connected to the mains electrical supply (charger operating). The charger status indicators will show CHARGER ON and COMPLETE when the battery is on a maintenance charge.

With proper care, the HI-6005/FP-6001 battery should last from two to three years. A fully charged battery (nominal output voltage of 4.8 VDC) provides up to 10 hours of operation. When the battery has discharged to 4.4 VDC, the probe is still operational, but the battery needs charging. 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. Software packages from ETS-Lindgren provide a warning indication on the display screen of the readout device. It is recommended that custom software packages using data from the HI-6005/FP-6001 Electric Field Probe monitor the data output for this condition.

Although NiMH batteries are rated for operation in temperatures from -20°C to $+65^{\circ}\text{C}$ (-4°F to $+140^{\circ}\text{F}$), operating the probe at temperature extremes will reduce operating time. The optimum operating temperature range for these batteries is $+20^{\circ}\text{C}$ to $+30^{\circ}\text{C}$ ($+68^{\circ}\text{F}$ to $+86^{\circ}\text{F}$).

The battery in the HI-6005/FP-6001 does not require periodic "deep discharges" to reverse the capacity depleting "memory effect" caused by repeated shallow discharges; however, undercharging can reduce battery capacity. Therefore, after the charging procedure is complete, be sure that the battery is fully charged before resuming field operation.

If the battery exhibits low terminal voltages during charging, or if it appears unable to acquire or maintain an appreciable charge, individual cells in the battery may be shorted or damaged. If, for any reason, your battery needs replacement, contact ETS-Lindgren Customer Service for assistance.

Synchronizing the Battery Charge Indicator

The HI-6005/FP-6001 Electric Field Probe has internal circuitry to track the charge condition of the battery. NiMH batteries have a sharp discharge-curve knee, which means that there is very little indication that the battery is nearly discharged prior to a "LOW BATTERY" condition. The internal circuitry tracks the charging and discharging currents of the battery and displays the calculated battery condition.

It is possible that this battery charge indication may lose its synchronization with the actual battery condition. This may be indicated by a low battery charge indication when the battery has been recently fully charged. It may also be indicated by short battery life and premature LOW BATTERY indication.

To synchronize the battery charge indicator, connect the battery charger to the electrical power mains and to the HI-6005/FP-6001 as described in the user manual. Be sure the power switch of the HI-6005/FP-6001 is in the OFF position. Press the DISCHARGE button on the battery charger. The battery will now be fully discharged and then fully recharged. For best results repeat this process at least once more (total of two times). It may be necessary to repeat the process a total of three times for proper synchronization. The complete discharge/charge process may take up to 12 hours.

When completely charged, the HI-6005/FP-6001 battery indicator should indicate a charge level of more than 90%.