

**HI-4422/FP2000/
FP4000/FP5000
Isotropic Electric Field Probe
User's Manual**

Declaration of Conformity

ETS-Lindgren, L.P.
1301 Arrow Point Drive
Cedar Park, TX 78613
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.)**



Isotropic Electric Field Probe
HI-4422/FP2000/FP4000/FP5000

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REVISION RECORD

HI-4422/FP2000/FP4000/FP5000, Manual, Part #600054

Revision	Description	Date
	Initial Release	July, 1993
A	Revised	August, 1994
B	Changed Battery Charger	June, 1997
C	Added CE Label	June, 1997
D	Revised	January, 1998
E	Changed Charger Specs	August, 1999
F	Changed Area Code	February, 2000
G	Revised	July, 2005

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1.0 INTRODUCTION

The HI-4422/FP2000/FP4000/FP5000 is a battery-operated broadband radio frequency (RF) isotropic electric field probe designed for a variety of applications including broadcast facilities, industrial RF source and electro magnetic compliance (EMC) testing.

The HI-4422/FP2000/FP4000/FP5000 probes 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 probe ideally suited for a wide range of field monitoring applications. The HI-4422/FP2000/FP4000/FP5000 probes are excellent tools for electric field mapping, RADHAZ measurements and EMC field monitoring.



**Figure 1: HI-4422/FP2000/FP4000/FP5000
Electric Field Probe**

The basic HI-4422/FP2000/FP4000/FP5000 probes are shipped complete with a 10 meter fiber extension cable, a carrying case, battery charger and connectors for extending the optic cable.

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The HI-4422/FP2000/FP4000/FP5000 probe measures field strength in each of three axes. It performs a vector addition calculation on the readings and sends the result to the receiver via a fiber optic cable. Data from each axis can be viewed individually, or can be combined. Frequency response of the HI-4422/FP2000/FP4000/FP5000 is 10 kHz to 1 GHz; dynamic range is 1 to 300 Volts/meter (V/m).

SPECIFICATIONS

Dynamic Range	1 to 300 Volts/meter (V/m)
Ranges	10, 30, 100, 300 Volts/meter full scale
Frequency Response	10 kHz to 250 MHz \pm 0.5 dB
	250 MHz to 1.0 GHz \pm 1.0 dB
Linearity	\pm 0.5 dB full scale (F.S.): \pm 2 least significant bits (LSBs) of A/D converter
Isotropy	\pm 0.5 dB
Overload Withstand	1000 Volts/meter maximum, all ranges
Environmental Operating Temp	10 °C to 40 °C (+50 °F to +104 °F)
Environmental Humidity	5% to 95% relative humidity, non-condensing
Fiber Optic Cable Connector	Standard FSMA
Battery	3.6 VDC, 1400 mA-h rechargeable Nickel-Cadmium (NiCd)
Battery Charger	115/230 VAC, approximately 1 hour
Probes	64 mm (2.5 in) cube with probe shields on three sides
Probe Mount	1/4 - 20 UNC tapped hole (internal thread) in base of probe
Weight	0.4 Kg (14 oz.)
Optional Equipment	See Table 2

2.0 GETTING STARTED

ACCEPTANCE AND CONTROLS

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 that, which 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 switch, two fiber optic connectors and a battery charger connector are mounted on the HI-4422/FP2000/FP4000/FP5000 probe housing (Figure 3-1).

XMIT/RCV

The fiber optic cable assembly from the receiver is attached to the probe via two connectors. The cable ends are color-coded—white for XMIT, yellow for RCV. Identically colored dots are located on the probe housing adjacent to these connectors. Be sure that each cable is attached to the proper probe connector.

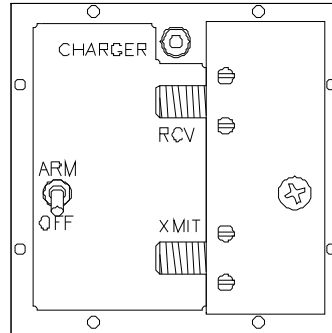


Figure 2: Switch and Connectors

When the cables are not attached, always cover the probe connectors 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.

ARM/OFF

The ARM/OFF switch activates and deactivates the probe. In the ARM position, its internal 3.6 VDC NiCd battery powers the probe: in the OFF position, the probe is inactive. To prolong battery life, set this switch to OFF when the probe is not in use.

CHARGER

A standard fast charger is supplied with the HI-4422/FP2000/FP4000/FP5000. When charging is complete, the fast charger acts as a trickle charger. Battery performance will not degrade, regardless of how long it is on the trickle charger.

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BATTERY

The NiCd battery provides up to 40 hours of probe operation when fully charged.

BATTERY CHARGING

Each HI-4422/FP2000/FP4000/FP5000 probe contains a rechargeable nickel-cadmium (NiCd) battery. A fully-charged battery (nominal output voltage of 3.6 VDC) provides up to 4m,asghjkl89asghjkl890 hours of operation. When the battery has discharged to 3.3 VDC, the probe is still operational, but its battery needs charging: when the voltage drops below 3.18 VDC, measurement accuracy will be compromised by further operation.

NOTE: ETS-Lindgren charges the internal NiCd battery of the HI-4422/FP2000/FP4000/FP5000 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. To check probe battery voltage, refer to the operation of the BAT keypad in Section 8.0 of the HI-4416 User's Manual.

CHARGING PROCEDURE

- Step 1. Plug the charger into a suitable AC source.
- Step 2. Set the probe switch to OFF. Insert the plug on the charger cable into the probe's CHARGER jack.
- Step 3. The battery is now charging. This may take approximately 1 hour, depending on how deeply the batteries are discharged. When charging is complete, the charger automatically goes into a trickle charge and will continue to do so until the probe is disconnected.

BATTERY TIPS

NiCd 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 NiCd 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-4422/FP2000/FP4000/FP5000 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.

3.0 OPERATION

This section discusses the theory of operation and the functions of the HI-4422/FP2000/FP4000/FP5000 Isotropic Electric Field Probe. A high-level block diagram (Figure 4) is included to aid the discussion. The objective is to provide information that enhances the user's understanding of the design of this probe.

SYSTEM THEORY

The HI-4422/FP2000/FP4000/FP5000 Isotropic Electric Field Probe utilizes a microprocessor for intelligent operation and control. The probe's self-contained power supply employs a 3.6 VDC NiCd battery, which provides up to 40 hours of continuous operation.

For each axis, the probe measures the radio frequency signal level and generates a linearized reading of the measurement. A vector addition is performed on these three readings: the resultant is transmitted to the receiver over glass fiber optic cables. The probe provides data to the readout via either a short form or long form output word. See Appendix B for details on both output word formats.

PROBE OPERATION

Receiver commands to the probe consist of the following:

- ! Send reading
- ! Read battery voltage
- ! Zero
- ! Set sleep timer
- ! Change range
- ! Read temperature
- ! Enable/disable axis

The signal flow within the probe is shown in the block diagram.

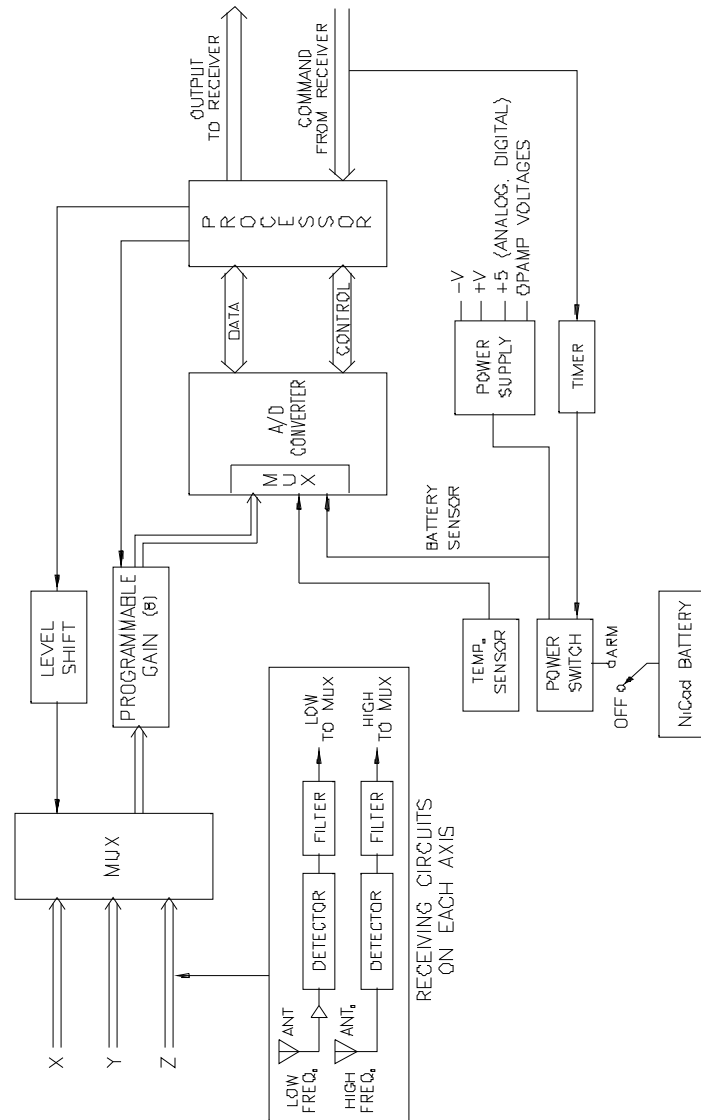


Figure 4: Probe Block Diagram

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To measure field strength, three sets of mutually orthogonal monopole antennas are used to provide an isotropic response to the ambient field. The probe uses two antennas per axis—one each for high and low frequencies—to receive RF signals. The signals are fed to a Schottky diode detector (low frequency signals are pre-amplified first). After filtering and amplification, the high and low frequency signals generated by each axis (a total of six signals) are fed into the multiplexer.

The microprocessor instructs the multiplexer to look at each of the six axis signals sequentially. A time-division output signal from the multiplexer is fed into the programmable gain stage.

The programmable gain stage provides the required amplification factors for the high and low frequency signals on each range. The system uses four ranges (10, 30, 100, and 300 V/m): each range requires both a high and low frequency gain setting—eight amplification factors in all.

For example, assume the probe is making measurements using the 100 V/m range. When the multiplexer selects the low frequency X axis signal, the microprocessor directs the programmable gain stage to use the appropriate amplification factor for this signal. This process is repeated for the next signal sample (X high) as well as for the four remaining axis signals. The output of the gain stage feeds the multiplexed front end of the analog-to-digital (A/D) converter.

After stepping through all six axis signals, the microprocessor commands the multiplexed A/D front end to read the battery voltage and temperature sensing lines. An entire A/D cycle, therefore, consists of eight readings.

The eight readings from the A/D converter are input to the microprocessor, which performs a vector sum calculation on the X, Y and Z channels. This data is transmitted to the receiver.

PROBE POWER SUPPLY

A sealed rechargeable 3.6 VDC NiCd battery, which drives both the analog and digital power supplies, powers the probe; the HI-4422/FP2000/FP4000/FP5000 employs separate power sources to provide isolation between the analog and digital circuitry. With the probe switch in the ARM position, voltage from the battery is applied to the power switch. This switch routes the battery voltage to the power supply, enabling the microprocessor. A timer circuit controls the power switch. The timer monitors the fiber optic connector input line to determine whether the probe has received a command during a specified period (several seconds). If no command is received during this period, the timer signals the power switch to disable the power supply and the microprocessor. In essence, the probe goes dormant to conserve battery power: only the fiber optic input circuitry remains active in order to detect new commands. When the next command from the receiver reaches the probe, power is reapplied automatically and the processor is reactivated, "waking up" the probe.

NOTE: The probe uses volatile random access memory (RAM). If, for any reason, power to the probe is lost, the probe must be re-zeroed.

ZEROING

When the receiver sends a zero command, the probe must be in a zero field environment. This is because the zero command causes the multiplexer (via the processor) to perform a normal read cycle on all axis signals. This procedure is executed for all 24 ranges (four ranges, three axes per range, two antennas per axis). When the processor receives all the zero-field signal values, it stores them in a special register; these values are subtracted from all subsequent measurements. Therefore, a probe that is zeroed while it is not in a zero field environment will give erroneous readings.

APPLICATION CONSIDERATIONS

OUT-OF-BAND CONSIDERATIONS

Although the specified operating range of the HI-4422/FP2000/FP4000/FP5000 is from 10 kHz to 1 GHz, it responds to signals both above and below these frequencies. Such responses must be taken into account when performing certain operations, such as zeroing.

On the low frequency end, the HI-4422/FP2000/FP4000/FP5000 is specified to operate down to 10 kHz; however, the probe can exhibit some response to frequencies as low as 50/60 Hz. Such an out-of-band response poses a problem when zeroing the unit, since this operation obviously assumes a zero field condition. Therefore, when zeroing, the user must compensate accordingly for any low frequency out-of-band response.

At the upper end, similar problems can occur. The specified upper operating limit is 1 GHz. Above this frequency, the dimensions of the probe body itself become appreciable in relation to wavelength: this makes the behavior of the HI-4422/FP2000/FP4000/FP5000 unpredictable above 1 GHz. Responses to frequencies up to 6 GHz must be compensated for when zeroing the probe.

RESOLUTION LIMITATIONS

Limitations in system resolution may result in a non-zero reading when the receiver is zeroed. If this occurs, it does not necessarily mean either that there is a problem with the receiver or that your readings are inaccurate. Probe linearity is specified as ± 0.5 dB full scale; in addition, the variance of the probe's A/D converter is ± 2 least significant bits. When using the most sensitive range (10 V/m), these specifications create the possibility that, under zero field conditions, the receiver may display a non-zero value.

PROBE SUPPORT STRUCTURES

It is very important to keep conductive objects away from the HI-4422/FP2000/FP4000/FP5000. Any such objects in the proximity of the probe may distort the near field and compromise measurement accuracy. If your application requires measurements from a fixed position, always mount the probe on a non-metallic platform, using non-metallic screws.

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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-4422/FP2000/FP4000/FP5000 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. Check with ETS-Lindgren Customer Service (+1-512-531-6400) 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 white, cone-shaped structures with the axis labels) accumulate foreign materials; in particular, bits of dirt or metal may become embedded in the shield surface. Shields must be kept clean to maintain proper probe operation.

NOTE: NEVER attempt to clean the shields while they are mounted on the probe housing.

To clean the shields, use the following procedure:

Step 1. Remove the four nylon screws from the faceplate of the probe shield.

Step 2. Lift the faceplate straight up and away from the HI-4422/FP2000/FP4000/FP5000 housing. BE SURE THAT YOU LIFT THE FACEPLATE 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. Clean the shield's exterior surface using a mild soap and water solution. Rubbing alcohol is also effective, provided care is taken to keep it away from the axis label. Wait for exterior surface to dry completely. DO NOT clean the interior surface of the shield.

Step 4. CAREFULLY replace the faceplate by lowering it straight down onto the housing: again, be sure to clear the antenna assembly when doing so.

Step 5. Replace the screws holding the faceplate. Snug them up only: DO NOT OVERTIGHTEN THE SCREWS, OR YOU MAY DAMAGE THE HEADS.

NOTE: If you require additional nylon faceplate 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).

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RETURN PROCEDURES

To return a probe to ETS-Lindgren, use the following procedure:

Step 1. Briefly describe the problem in writing. Give details regarding the observed symptom(s), and whether the problem is constant or intermittent in nature. If you have talked previously to ETS-Lindgren Customer Service about the problem, provide the date(s), the name of the service representative you spoke with, and the nature of the conversation. Include the serial number of the item being returned.

Step 2. Package the probe carefully. Use the original boxes and packing materials, if possible. If not, use the Parts List in Table 1 to order new boxes and foam packing from ETS-Lindgren.

If the probe is still under warranty, refer to the Limited Warranty at the front of this manual for additional information about your return.

PERIODIC/PREVENTIVE MAINTENANCE

ETS-Lindgren recommends an annual calibration check of the HI-4422/FP2000/FP4000/FP5000 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
1301 Arrow Point Drive
Cedar Park, TX, USA 78613
Tel: +1 512-531-6400
Fax: +1 512-531-6500

PARTS INFORMATION

Use the following tables for ordering replacement (Table 1) or optional (Table 2) parts for the HI-4422/FP2000/FP4000/FP5000.

Part Description (Replacement Parts)	Part Number
Battery Pack, 3.6 VDC, Rechargeable	H-491038
Box, Foam Insert, 4422/FP2000/FP4000/FP5000 Body	H-470442
Box, Foam Insert, 4422/FP2000/FP4000/FP5000	H-470450
Box, Shipping, 4422/FP2000/FP4000/FP5000	H-390053
Standard Fast Charger (115/230 Volt)	H-491198-36
Element Cover Kit	H-651021
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Table 1. Replacement Parts List

Part Description (Optional Parts)	Part Number
Cable, Fiber Optic, Glass, 10 Meter	H-490994-10
Probe Support, HI-4422/FP2000/FP4000/FP5000	H-490984
Tripod, Dielectric, HI-4422/FP2000/FP4000/FP5000	H-491000
Probe Stand	H-491269
Graphical EMF Readout	HI-4460
Numeric EMF Readout	HI-4416
Field Monitor	FM5004
Fiber Optic / RS232 Interface	HI-4413P

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 Holaday 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 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

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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.

Code	Explanation
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

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7.0 APPENDIX B: 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-4422/FP4000/FP5000 probe.

NOTE: The FP2000 is excluded from this section. The FP2000 Firmware is designed to operate with the FM2000 and FM5000 only. The following protocol information does not apply to this product. If further information is required, please contact ETS-Lindgren Customer Service at +1.512.531.6400.

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-4422/FP4000/FP5000 responds to commands from another device; it transmits no data without first receiving instructions to do so.

COMMAND STRUCTURE

A command to an HI-4422/FP4000/FP5000 probe consists of 1) a command letter, followed by 2) possible parameters, 3) terminated with a carriage return. When it completes the command, the HI-4422/FP4000/FP5000 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 command letter and a carriage return. If an error occurs, the probe responds with an error code, as detailed in Appendix A.

Command	Description
Axxx	Axis enable/disable. x = "E" means enable, x = "D" means disable, xxx order is X axis, Y axis, Z axis
B	Read battery voltage.
Cx	Set baud rate.
	x = 1 sets rate to 2400 baud
	x = 2 sets rate to 9600 baud
Note: The baud rate does not change until the HI-4422/FP4000/FP5000 has been powered down (turned off), let sit for at least 10 seconds, and then powered up (turned on) again.	
Dx	Read probe data.
	x = 1 enables short form output
	x = 2 enables long form output
Rx	Set range. x = 1, 2, 3, 4 or N (next range)
Sx	Sleep timer. x = number of seconds to wait for a command before putting the probe into the sleep mode. In the sleep mode, the HI-4422/FP4000/FP5000 changes to a low power mode that increases battery life. In the sleep mode, the probe can only recognize the receipt of a command; it cannot recognize a command. The first command sent when the probe could be in a sleep mode may be an ASCII null character or any command. Following the receipt of this "wakeup" character, a command can be sent to which the probe will respond.

Isotropic Electric Field Probe
 HI-4422/FP2000/FP4000/FP5000

Command	Description
Tx	Read Temperature. x = C or F
Ux	Set unit type. x = 1, 2, 3, or N (next unit)
	1 = V/m
	2 = mW/cm ²
	3 = [V/m] ²
Z	Zero.
Null	Send the ASCII null character. This is a special command that can be used as the initial command to the probe after it is turned on. The probe responds with "N".
<p>NOTE: When remotely operating the probe using commands manually entered from a computer keyboard, the HI-4422/FP4000/FP5000 may "go to sleep" between commands. This may be noted when the Sleep Timer is set to a short interval such as one or two seconds. When this happens, the probe may seem to be unresponsive to commands or may seem to skip commands. If this condition is observed, send an S0 command and keep sending the command as fast as possible until the probe responds (:S) and the sleep timer is turned off. Now the probe will respond in the proper manner.</p>	

PROBE OUTPUT

Command	HI-4422/FP4000/FP5000/ Response
B	Bxx.xx , where xx.xx is the battery voltage.
D1	Dxx.xxuuu , the short form output.
	xx.xx is the reading. The position of the decimal point depends upon the range setting of the HI-4422/FP4000/FP5000.
	uuu = units
	V = V/m, mW2 = mW/cm ² , _V2 = [V/m] ²
	(underscore indicates a space character).
D2	Dxx.xxuuurrobaaat , the long form output
	xx.xx = the reading, as described for D1.
	uuu = units, as describe for D1.
	rrr = recorder out value (A 3-digit ASCII number from 0 to 255).
	o = over range indicator ("N" = ok, "O" = over range).

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Command	HI-4422/FP4000/FP5000/ Response
D2 (cont'd)	b = battery status ("N"= safe operating level, "W"= warning level, "F" = fail level).
	aaa = axis enable ("E" = enabled, "D" = disabled). Axis order is X, Y, Z.
	t = terminating carriage return.
Rx	Rx, where x is the range.
	x = "" returns the range currently in use
	x = 1, 2, 3, 4 enables the selected range
	x = N sets the probe to the next (higher) range.
TF	Txxx, where xxx is temperature in E Fahrenheit.
TC	Txxx, where xxx is temperature in E Centigrade.

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HI-4422/FP2000/FP4000/FP5000

8.0 APPENDIX C: BATTERY CHARGER MANUAL

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Series 491198-36

NiCd Battery Fast Charger

User's Manual

Declaration of Conformity

ETS-Lindgren, L.P.
1301 Arrow Point Drive
Cedar Park, TX 78613
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.)



Isotropic Electric Field Probe
HI-4422/FP2000/FP4000/FP5000

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HI-4422/FP2000/FP4000/FP5000

Revision Record

Manual #600086, Series 491198-36 NiCd Battery Fast Charger

Revision	Description	Date
	Release	4/99
A	Changed Area Code	2/00
B	Updates	12/04

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.

WARNING

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 491198-36 NiCd Battery Fast Charger is a dual power source battery charger. It charges 3.6 volt 1400 mAh NiCd batteries and is powered by 120-240 Vac line power or 12.5 Vdc. The 491198-36 uses a $-(dV)/(dT)$ (negative delta V) technique to determine when the battery is fully charged, typically one hour. 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.

Isotropic Electric Field Probe
HI-4422/FP2000/FP4000/FP5000

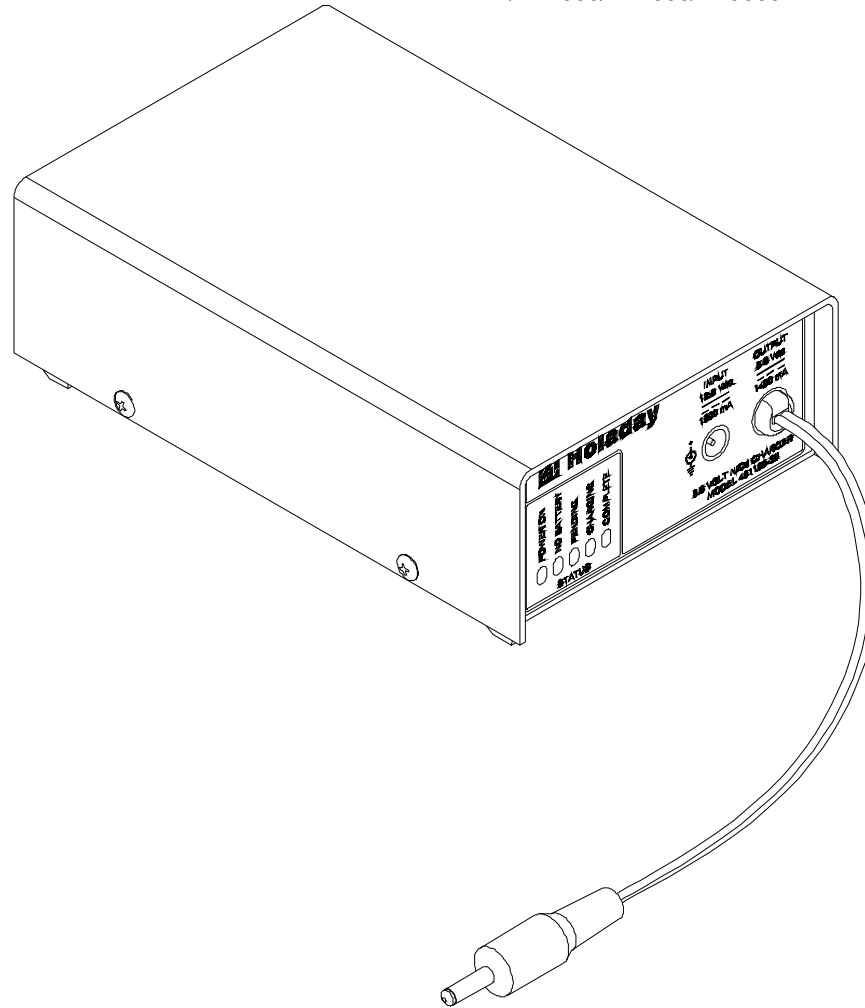


Figure 1: 3.6V Battery Charger

3. Unpacking and Acceptance

Introduction

This section contains information on unpacking and acceptance of the 491198-36 NiCd 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 that which 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: 15 Vdc
Fast Charge Pending Current: 60 mA
Fast Charge Current: 1400 mA
Pulsed Trickle Charge Current: 50 mA
Output Voltage (During Fast Charge): 3 - 6 Vdc

NiCd Battery:

3.6 Volt 3 Cell NiCd Battery, 1400 mAH (Rapid charge cells, 1.2 volts/cell); ETS-Lindgren Part #491038

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 Countries: Canada, Japan, Puerto Rico, Taiwan, Venezuela, Hong Kong, United States
221100	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 Countries: Argentina, Austria, Brazil, Finland, France, Germany, Israel, Italy, Holland, Korea, Netherlands, Norway, Sweden, Turkey
222600	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 Countries: England, Ireland, Malaysia, Scotland, Singapore, South Africa, Wales
221600	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 Countries: Australia, China

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ETS-Lindgren Part No.	Manufacturer, Part No. and Information
221500	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 491198-36 battery charger is intended to charge the 3.6 volt NiCd batteries, either in the lab or in the field.

Input Power Requirements

The 491198-36 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.

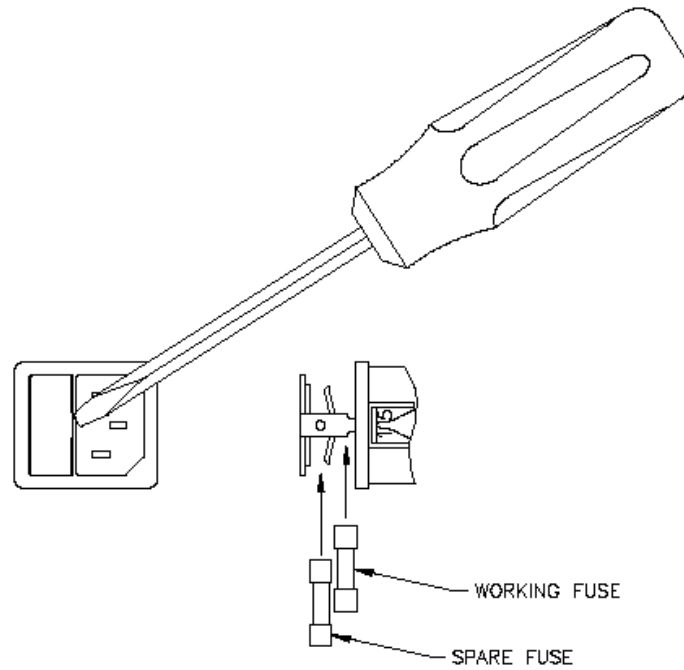


Figure 2: Fuse Replacement

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. The HI-6005 must be turned off or the battery will not charge.

CAUTION

NEVER attempt to recharge a non-rechargeable battery.

Charging Indicators

There are five LEDs located on the front of the charger that 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 unit's battery, the "PENDING" LED (amber) light illuminates while the charger qualifies the battery for fast charge. If the voltage is below the safe fast charge level, the battery is charged in the pulse trickle mode.

When the voltage is at a safe level the charger will switch to the fast charge mode and the "CHARGING" LED (amber) light illuminates.

When charging is complete, the charger switches back to the pulse trickle mode and the "COMPLETE" LED (green) light will illuminate. The device can be left on the charger in this maintenance mode indefinitely.

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.