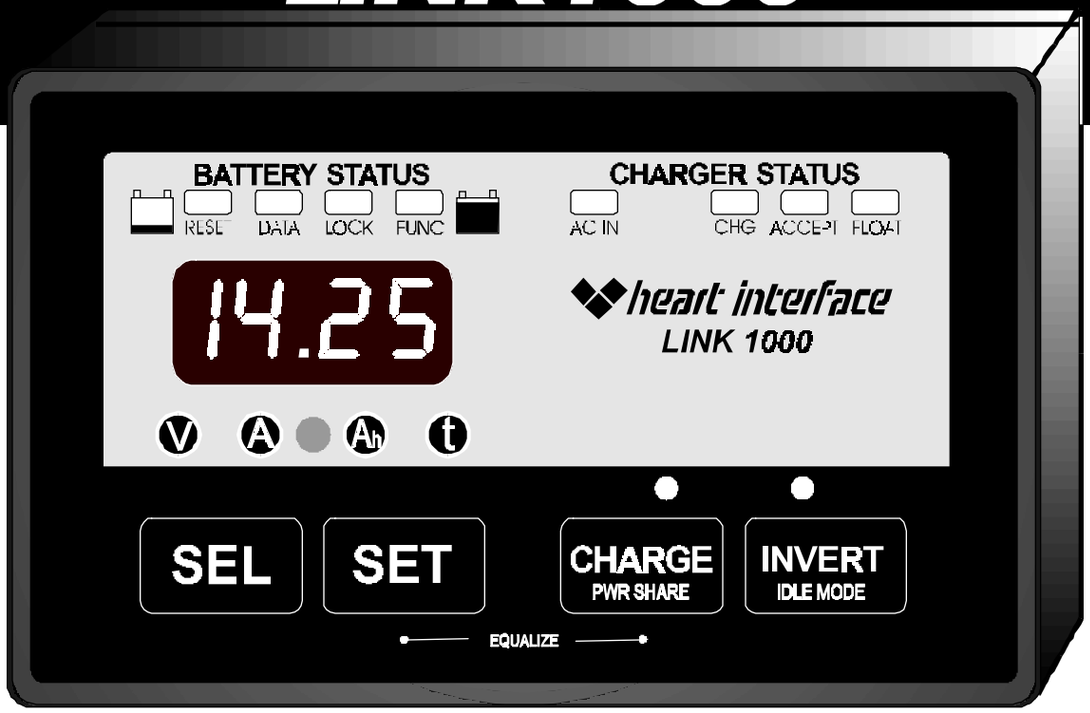
TC2+2 COMPATIBLE

OWNER'S MANUAL
LINK 1000



INSTALLER NOTE: LEAVE THIS MANUAL WITH THE OWNER. IT CONTAINS IMPORTANT OPERATING INFORMATION.

This manual applies to Link 1000 with serial number above 1900.

APPLICATIONS: The ***Link 1000*** is an instrumentation and control panel designed for use with Heart Interface ***Freedom*** series inverter/chargers operated with a single battery bank. For installations with a ***Freedom*** inverter/charger and two battery banks, the ***Link 2000*** is recommended. For instrumentation of a single battery bank (no inverter control) the ***Link 10*** is recommended, while the ***Link 20*** is recommended for instrumention of a two battery bank system (no inverter control).

OPERATION: Instructions how to operate your ***Link 1000*** begin on page 4 of this manual.

INSTALLATION: This manual contains easy to follow installation instructions beginning on Page 37.

WARRANTY ISSUES: Warranty issues should be directed to Heart Interface. Please do not route warranty issues through your dealer. See Page 36.

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LINK 1000 SPECIFICATIONS

Power Supply Voltage	8-40 Volts DC (Not for use with 32V Systems)
Power Consumption	90*mA (Typical) 170 mA (Full display brightness) 25* mA (Sleep mode; light bar only on.) * @12VDC. Values are about half on 24V systems.
Voltage Measurement Range	0.1-50 Volts DC
Voltage Resolution	0.05 Volts DC
Voltage Accuracy	± 0.10 Volts DC at full scale.
Current Measurement Range	± 500 Amps DC
Current Resolution	0.1 Amp DC (From 0 to ± 42.0 Amps) 1 Amp DC (From ± 42 to ± 500)
Current Accuracy	± 0.1 Amp DC at full scale low range ± 1 Amp DC at full scale high range
Current Shunt	± 0.25% Ratio: 50mV @ 500A
Amp Hour Range	± 1,999 Amp Hours
Time Remaining Range	255 Hours maximum
Charger Voltage Regulation	± 0.2 Volts DC
Product overall size:	4.725" x 2.975 x 1.075" deep"
Weight:	Approx. 4.6 oz. (excluding current sensing shunt)

Link1000 INTRODUCTION

Congratulations! You have purchased a powerful instrumentation and control system. In order to understand, use, and install it, PLEASE read this manual!! It is as short as possible and provides important information. Please contact us with suggested improvements. For ***Link 1000*** installation and operation questions please call Heart Interface. For warranty support and repair please call Cruising Equipment.

☞ This symbol is used to point out very important sections of this manual or to indicate items that may need to be changed through Set Up routines. Please take the time to read these sections.

☞ The following warnings must be considered during the installation of the ***Link 1000***. Failure to read and follow these special notes can lead to damage to the ***Link 1000***, the ***Freedom*** inverter, or other electrical equipment.

POWER CONNECTION WARNINGS

1. **Do not** disconnect the negative battery cable to the ***Freedom*** inverter/charger with AC present or with either the inverter or charger functions operating.

2. When installing your ***Link 1000***, make all DC power and shunt connections **BEFORE** plugging in the phone cable to the ***Freedom*** inverter/charger. Similarly, unplug the phone cord to the ***Freedom*** before removing DC and shunt connections.

3. The On/Off switch on the front of the ***Freedom*** unit must be OFF.

IMPORTANT BATTERY FACTS

1. An ***Amp-hour (A hr)*** is 1 Amp of current flowing for one hour, or 2 Amps for 1/2 hour, or 4 Amps for 1/4 hour, etc.

2. Deep cycle battery capacity in Amp-hours is generally stated at the ***20 hour rate***. This means a 12 Volt, 100 A hr battery will sustain 5 amps for 20 hours before its voltage under load drops to 10.5 volts. A 12 Volt lead-acid battery which cannot maintain 10.5 Volts under load is considered "dead" - it's completely discharged.

3. Our ***Mid-Capacity Rule*** says discharging more than 50% of a battery's capacity shortens cycle life. Charging more than 85% takes too long with an engine driven charging system. So, 35% of the battery capacity is all that is normally available. For example, if you regularly need 100 Amp-hours of energy between charging sessions, your battery capacity should be about 300 Amp-hours.

USING YOUR *LINK 1000*

DISPLAY LIGHTS

Press **SEL**

The green light which is on tells you which units are presently displayed.

Ⓥ **Volts** is the electric *potential to do work*. Voltage is useful to assess the approximate state-of-charge and to check for proper charging. Examples: An at rest, fully charged battery will show about 12.8V. A 12 V battery is 100% discharged when it reachs 10.5Volts with a 20 hr. rated load applied. A typical charging voltage would be 14.2V.

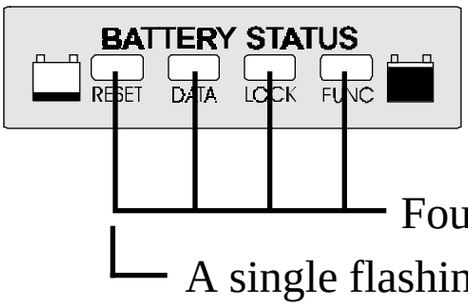
Ⓐ **Amps** is the present *flow* of current in or out of the battery. For example, a refrigerator may draw 6 Amps of current. This is displayed as -6.0 (6 Amps are being *consumed from the battery*). Discharge is shown as a negative number and charging is shown as a positive (unsigned) number.

Ⓐh **Amp-hours** (A hrs) consumed represents the *amount of energy removed from* the battery. If you run a 10 Amp load for one hour, 10 Amp-hours are consumed. Your ***Link 1000*** will show -10 in the Ⓐh display. During charging the ***Link 1000*** compensates for charging efficiency as it counts back up toward 0.

ⓣ **Time** is an ***estimate*** of how long (in hours) the battery will sustain a load before it is completely discharged. It is based on a selectable, time averaged, rate of discharge. Default is the average of the last four minutes of use. During charging the numeric display will read **CCC** , indicating the battery is charging (Amps is a positive number).

☞ For the **TIME** function to operate correctly, you must correctly enter your battery capacity (if different than the default 200 Amp-hours), battery Type, and an appropriate Peukert Exponent through the **SET UP** routines.

READING THE LIGHT BAR

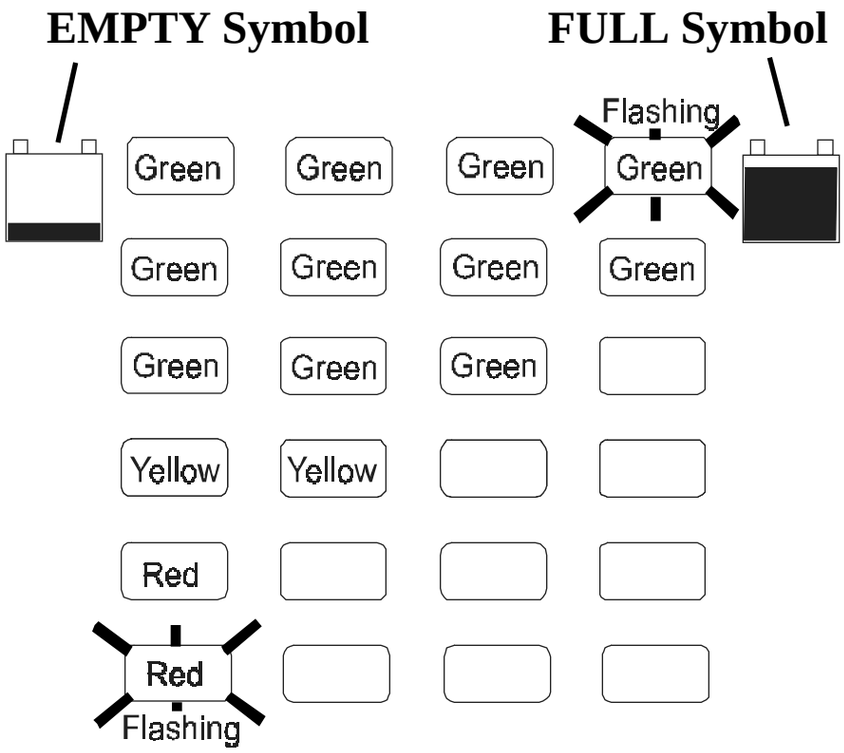


Above the ***Link 1000*** numeric display are four lights. They show you battery state-of-charge at a glance.

Four lights green means a nearly full battery.

A single flashing red light means it's nearly discharged.

The light bar scaling is adjustable. As your ***Link 1000*** comes from the factory, it is set to show a flashing red light whenever your battery is more than 80% discharged (20% charged). The default setting usually indicates enough energy remains with two yellow lights showing to start an engine driven charging source. If desired, you may scale the light bar to show a flashing red light when your battery is more than 40% discharged, however, this is not recommended. To adjust the discharge floor, see Page 22, Function F09.

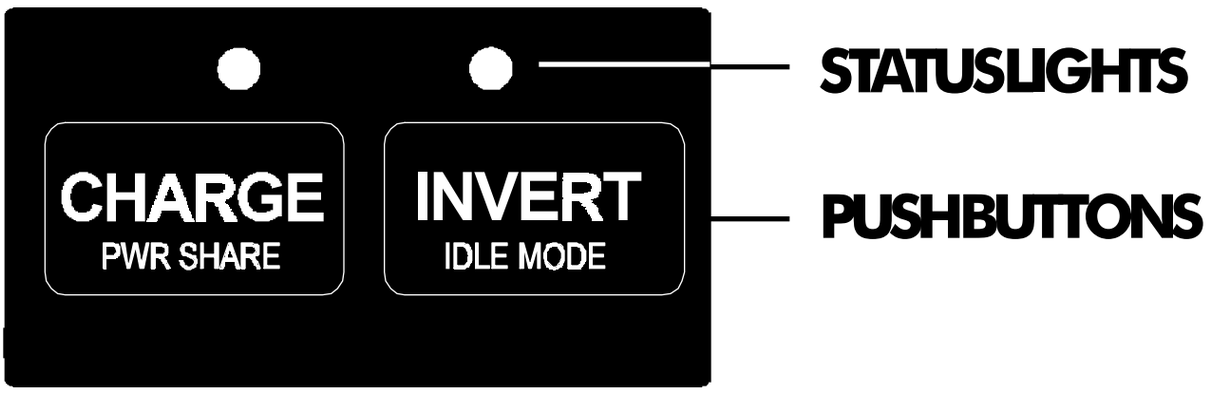


Percent Full	
Default	***Optional***
100%	100%
80-99.9	90-99.9
60-79.9	80-89.9
40-59.9	70-79.9
20-39.9	60-69.9
0-19.9	50-59.9

☞ The Light Bar operates on *rate corrected* Amp-hours. If you have quickly discharged your battery, the light bar may tell you to charge *before* you would normally make that decision based on the Amp-hour display. The light bar is *rate compensated*.

REMEMBER: Charge your battery when the Light Bar tells you to!

INVERTER FUNCTIONS

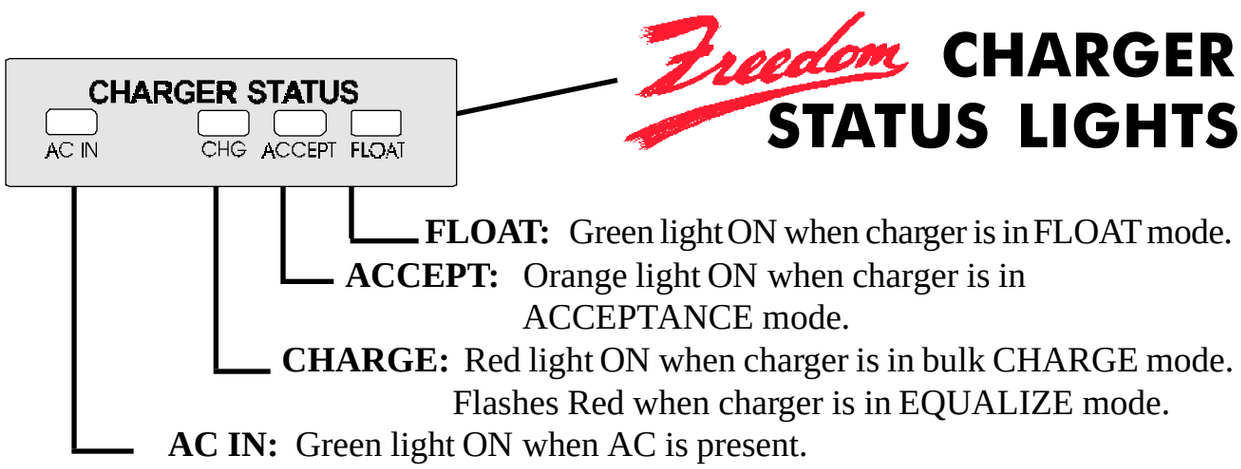


The ***Link 1000*** communicates with the ***Freedom*** inverter/charger via a telephone cable. When the **CHARGE** button is pressed, the ***Link 1000*** sends a "charger **on**" command to the ***Freedom*** inverter/charger. The green light above the button is lit when the "charger on" command is sent. The charge function will only operate when the inverter is connected to a battery and external AC is available. The initial power up condition is with the charger turned ON. On inverters prior to serial number 100,000 charging is enabled when the INVERT button is on.

When the **INVERT** switch is pressed, the inverter is commanded on and the green light above the button is lit. The inverter function will only operate if it is hooked up to the battery and there is no external AC power available. The **INVERT ON** switch does not indicate actual operation, only that the inverter function is enabled. The initial power up condition is with the inverter turned OFF.

MARINE AND RV OPERATING TIP

When external AC power is available, loads normally supplied by the inverter are automatically transferred to external AC power by the ***Freedom's*** internal transfer switch. With no external AC available, inverter loads run on energy stored in the battery. If you have a big load, such as an electric water heater running on a circuit that is automatically transferred, you run the risk of quickly discharging your battery if external power fails. To avoid this, turn the inverter function OFF when leaving the boat or RV unattended. Leaving the charger function ON helps to assure a full battery when you return.



IDLE MODE AND POWER SHARING

PWR SHARE: Power Share automatically reduces the ***Freedom****'s* charger output if the AC load through the automatic transfer switch exceeds a settable current limit. This load management feature helps prevent external source AC supply breakers from tripping when the charger, water heater, and perhaps other loads, all come on at once. The default value is 30Amps (or OFF for ***Freedom 25***).

The following Power Sharing ranges apply to inverters with serial #'s greater than 100,000:
Freedom 10 & 20 Range: 5, 15,20, 30A; ***Freedom 25 & 30*** Range: 5, 20, 30A,OFF;
Freedom 10E & 20E Range: 2.5, 7.5, 10, 15A; ***Freedom 25E*** Range: 2.5, 10, 15A, OFF

For ***Freedom*** serial numbers prior to100,000 use this table:

Model	**F10**	**F10**	**F10E**	**F10E**	**F20**	**F20**	**F25**	**F25**
Serial#	**≤70759**	**≥70760**	**≤71746**	**≥71747**	**≤70699**	**≥70700**	**≤70801**	**≥70802**
Display	**Amps**	**Amps**	**Amps**	**Amps**	**Amps**	**Amps**	**Amps**	**Amps**
0	30	30	15	15	30	30	OFF	OFF
1	20	20	10	10	20	20	50	30
2	15	15	7.5	7.5	15	15	30	20
3	10	5	5	2.5	10	5	20	5

TO SET OR CHANGE PWR SHARE

☞ **NOTE:** The **CHARGE** button must be **ON** to set Power Share.

1. Press and hold **SET**. Note SEL appears in the display.
2. Press the **CHARGE/PWR Share** button. The present value will appear.
3. If you press and hold **SET** 3 seconds, the display will scroll through other values.
4. Release the button when the desired value appears.
5. The new value is displayed for 5 seconds.
6. When the display returns to normal, the new value has been stored in memory.

IDLE MODE: Idle mode defines how large an AC load is needed to wake the inverter from its idle (or "standby") mode. The default value is 4 Watts. Setting Idel Mode to 0 Watts forces the inverter **ON** at all times. But when on, the inverter will draw about 0.5 Amp. In Idle mode, current consumption is 0.12 Amps. Available Idle Mode settings are 0W, 4W, 6W, and 15W.

TO SET OR CHANGE IDLE MODE

☞ **NOTE:** The **INVERT** button must be **ON** to set Idle Mode.

1. Press and hold **SET**. Note SEL appears in the display. Release button.
2. Press the **INVERT/Idle Mode** button. The present value will appear.
3. If you press and hold **SET** 3 seconds, the display will scroll through other values.
4. Release the button when the desired value appears.
5. The new value is displayed for 5 seconds.
6. When the display returns to normal, the new value has been stored in memory.

HOW TO USE YOUR *Link 1000*

SIMPLE BATTERY MANAGEMENT RULE:
Recharge When the Battery is 50% Discharged!

The ***Link 1000*** is a guide to the battery's state of charge. Our ***Mid-Capacity Rule*** says you should begin charging when your ***Link 1000*** shows that 50% (or more) of battery capacity has been consumed. In Marine and RV systems, which are trying to minimize charging time with an engine driven alternator, or generator powered charging, the battery is normally charged only to the 85% level. This means only 35% of the battery capacity is actually available for use. The Mid-Capacity rule is a very conservative approach to battery use. Occasionally discharging a battery more deeply is perfectly acceptable. The Mid-Capacity rule is intended as a design and operating guideline, not a law which must be obeyed without exception.

We recommend synchronizing your ***Link 1000*** to the 100% charged level of the battery. You should begin recharging when 50% of the your battery capacity has been consumed. **When recharging from an engine driven source, you do not need to charge until the meter reads 0 Amp-hours consumed.** You may cease charging even though 15% of capacity has not been returned by charging. See example below. When you plug back into AC power, or when a long drive provides power which exceeds demand, the remaining Amp-hours consumed will be replaced. Periodic conditioning or ***Equalizing*** should be used to remove any negative Amp-hours that are not replaced during normal charging.

OVERCHARGE AMP-HOURS

If the battery is 100% charged, and the ***Link 1000*** is in sync with the battery, overcharge A hrs are displayed as a positive Amp-hour number. Some accumulation of overcharge A hrs is normal with systems continuously connected to a charger. For example: A 100 A hr battery at Float voltage, will normally have a little less than 0.1 Amp flowing into it. This means you would expect about 2.4 A hrs of overcharge to accumulate each day. If your battery system is larger, proportionately more current flows and more overcharge A hrs will accumulate.

If the charging system is a constant voltage type set at 14.2 volts, as much as 1 Amp of current may be flowing all the time *after* the battery has reached the charged parameters. Prolonged high voltage applied to a fully charged battery will likely cause gassing. You would expect to see a large A hr overcharge every day. This is a clear indication that you are destroying your battery by overcharging. Check your ***Link 1000*** before turning off a charging source to see that you have not accumulated too many over-charge A hrs. When discharging begins, overcharge A hrs are erased and the ***Link 1000*** resets to zero and begins to report Amp-hours consumed.

If you Equalize your batteries using a Heart Interface ***Freedom*** inverter/charger, you will accumulate some overcharge A hrs during Equalizing. *This is normal* and insures that the ***Link 1000*** stays synchronized with the battery state of charge.

BATTERY CAPACITY TESTING

Your ***Link 1000*** can be used to conduct periodic capacity tests that tell you the actual amount of energy your batteries can store. A capacity test should start with a battery that has been properly charged and equalized. The objective is to find the maximum available capacity.

Deep cycle battery capacity is usually stated as a 20 hour discharge rate. A 100 A hr battery will provide 5 amps for 20 hours. At discharge rates above 5 amps, the battery will not supply 100 A hr. For example: If you are drawing 100 amps out of the battery it will last less than half an hour. Consider the following table:

CAPACITY AT VARIOUS DISCHARGE RATES

(As a percent of 20 hour rate)

Hours to Discharge	Capacity (percent of rating)
20	100%
10	89%
5	78%
3	66%
1	45%

To test battery capacity, charge battery until charge parameters are met. This resets Amp-hours to zero. Positive Amp-hours will be zeroed when you begin to discharge.

Turn on a load that draws approximately 5% of the expected battery capacity. Check the current with the Amps display. The load should be constant, such as incandescent lighting. Now put the ***Link 1000*** in the Volts display mode. When the battery voltage drops to 10.5 volts (or 21 volts if you're testing a 24V system), hopefully about 20 hours later, turn off the load and look at the A hrs display on your ***Link 1000***. The A hrs displayed is your actual battery capacity.

If less than 20 hours passed before the battery voltage fell to 10.5V you can still determine the capacity with some arithmetic. For example: Assume a 12V battery rated at 100 A hr. Apply a 5 amp load. Suppose it only took 10 hours for the voltage to reach 10.50 volts. The ***Link 1000*** would display -50 A hr. This is the 10 hour capacity. Dividing 50 by 89% (10 hour rate) from the table above, you determine that the actual 20 hour capacity is 56 Amp-hours. You could repeat the test at 5% of the tested capacity (2.8A) to verify the actual capacity.

USING YOUR *Freedom* TO TEST BATTERY CAPACITY

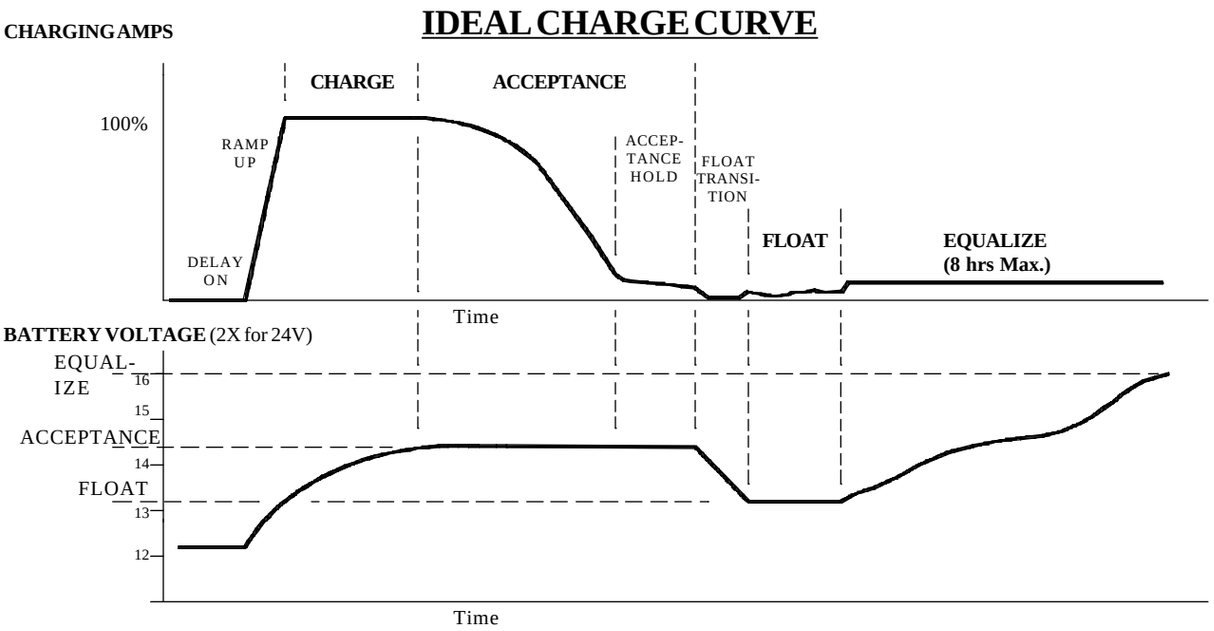
Your ***Freedom*** inverter makes testing the battery capacity easy. First, fully charge (and Equalize if necessary) the battery to be tested. Use a load like incandescent lights running on the inverter whose amperage consumption is 5% or less of the battery capacity. Let the load run until the inverter shuts down on low voltage (about 10.2V). Read the number of Amp-hours that have been consumed from the battery. If it is not close to the expected number use the procedure outlined above to estimate the capacity.

CAUTION! Be sure to completely recharge your battery after a discharge test.

THE IDEAL CHARGE CURVE

The ***Link 1000*** transmits critical battery state of charge information to the ***Freedom*** inverter/charger. This enables the charger to conform to our proven **Ideal Charge Curve** with four basic cycles; **CHARGE, ACCEPTANCE, FLOAT,** and **EQUALIZE**.

The **CHARGE** cycle supplies full charger output current until the battery reaches the Acceptance charging voltage (14.4V typ.). The **ACCEPTANCE** cycle continues until the battery is accepting only a small amount of current. The battery is now full. During the **FLOAT** cycle the voltage is lowered to maintain the batteries, without water consumption, for long life. The **EQUALIZE** cycle allows for periodic "equalizing" of liquid electrolyte batteries for maximum capacity and life. The batteries should be Equalized every 30 days during deep cycling service.



IDEAL CHARGE STATE TABLE

CYCLE	VOLTAGE	BATTERY CURRENT	STATUS LIGHT
CHARGE	**12.0 - 14.4** (Rising)	Maximum ***Freedom*** rating	**RED**
ACCEPTANCE	**14.4** (Constant)	Falling	**YELLOW**
FLOAT	**13.5** (Constant)	Small, less than 2% of Capacity	**GREEN**
EQUALIZE	**13.2 - 16.0** (Rising)	Constant until 16V	**SLOW FLASH RED**

Link 1000 FACTORY DEFAULT VALUES:

Battery capacity = 200 Ahrs
Acceptance Voltage = 14.4 Volts for 12 Volt systems
= 28.8 Volts for 24 Volt systems
Charged Current % = 2% (of battery capacity)
Float Voltage: 0.9V below the Acceptance Voltage for Liquid electrolyte batteries.
0.6V below the Acceptance Voltage for Gelled electrolyte batteries.
Ambient Temp. = 70^0F (See Temperature Compensation Table, Page 20)

SYNCHRONIZING TO YOUR BATTERY

A charged battery has zero A hrs removed. Synchronizing your ***Link 1000*** to read zero when the battery is charged insures that you always know the net number of A hrs removed.

There are two ways to synchronize your ***Link 1000***:

1) Install the ***Link 1000*** on a fully charged battery and it will be in sync.

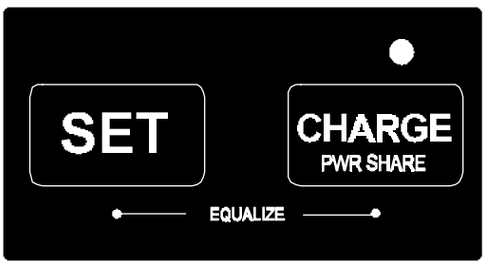
2) If the ***Link 1000*** is installed on a partially charged battery, simply charge with your ***Freedom*** inverter/charger until the charged parameters are met. The ***Link 1000*** will begin counting up and will display overcharging A hrs as a positive number. When the battery is fully charged, turn off the charging source. When discharging begins the ***Link 1000*** resets Amp-hours to zero, starts counting down, and is in sync.

If the ***Link 1000*** should ever get out of sync with the battery state-of-charge it must be resynchronized. The best way is to discharge the battery at least 10% of the declared battery capacity and then recharged until the charged parameters are met and the meter resets the Amp-hours display to 0. Overcharge Amp-hours will be displayed as a positive (unsigned) number. When the next discharge cycle begins, any overcharge Amp-hours will reset to zero.

Remember occasional controlled overcharging insures that the ***Link 1000*** remains in sync with the battery's state-of-charge.

EQUALIZING

Equalizing is controlled overcharging of a lead-acid battery (or battery bank) to remove lead sulfate that is not removed during normal charging. The ***Link 1000*** can invoke the equalizing cycle available in ***Freedom*** series inverter/chargers. Liquid batteries should be equalized every 30 days when in cycling service or every 30 deep cycles.



CAUTION:

TURN OFF ALL DC LOADS!!!
Equalizing requires voltages which can damage sensitive equipment.

To start the **EQUALIZE** Cycle, insure the Charger is **ON** and the batteries are fully charged. Press and hold the **SET** button until **SEL** is displayed. Release button. Now, press **both** the **SET** and **CHARGE** buttons simultaneously. "**00E**" will be displayed. Continue to hold both buttons for five seconds, until the red **CHARGE** ***Freedom*** status light begins to flash and the "**00E**" goes out.

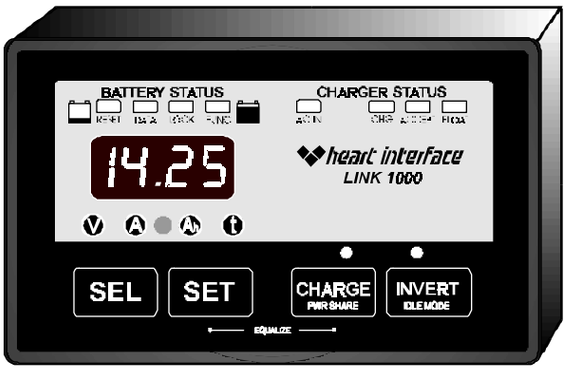
To end equalizing, repeat same procedure. The red **CHARGE** light goes out and the ***Freedom*** inverter/charger is forced to **FLOAT** when equalizing ends. If you don't manually end equalizing, the cycle automatically ends after eight hours, or if external AC power is interrupted. To terminate **EQUALIZE** early on ***Freedoms*** prior to serial #100,000, you must turn off *both* the **CHARGE** and **INVERT** buttons on the ***Link 1000***.

☞ Equalizing causes your battery to gas. You should check your battery electrolyte ("water") level before and after Equalizing. Do not overfill before equalization as the electrolyte may expand and overflow. You should always be present during equalizing. Make sure there is plenty of ventilation. Leave the filler caps loosely on or cover opened cell tops with a folded paper towel.

EQUALIZING GEL BATTERIES

Gelled batteries are not normally equalized. However, if they have been severely discharged, it may be the only way to get them to begin to accept a charge. The voltage is limited to the **ACCEPTANCE** charging level but the cycle lasts for 8 hours.
Be sure that the battery TYPE # is set to #2 before using this cycle on gelled batteries.

SETUP PROCEDURES



Your ***Link 1000*** comes with default values chosen to work with most systems. Normally the only values that may need to be changed are: The battery capacity, battery type (liquid or gelled), temperature, and high discharge rate compensation (Peukert) exponent. Please be sure you understand each function before changing the factory default values.

Holding the **SET** button until the numeric display reports **SEL** accesses the *Set Up* and *Advanced Functions* modes. If you press **SEL** once, you will display the first Set Up variable: Charged Voltage. Pressing **SEL** repeatedly will step through more variables: Charged Current, battery Amp-hour capacity, and Time Remaining averaging. Corresponding status lights come on for each. If you change any settings, please note them in the spaces provided on Page 35.

If you continue pressing **SEL**, you will step through *the functions* named in small text below each of the lights on the Light Bar. Some *functions* have multiple displays. **RESET**, **DATA**, and **LOCK***ing* of your meter are described on Pages 25-27, while *Advanced* **FUNC***tions being on Page 19.*

When a desired *variable* or *function* is displayed, pressing the **SET** button will display the present value of the function. Pressing **SET** again will display the next choice. If you *hold* the **SET** button for 3 seconds, the display will begin scrolling. When the desired value appears, release the button. If the button is held down longer, the display will increment to the end of its range, then roll over to its minimum value and continue to scroll.

If this sounds complicated, relax! It's not. Once you go through it a few times, it will become second nature. On the next page, we'll go through this again step-by-step.

FACTORY DEFAULT VALUES

Invert/Charge Controls:

CHARGE	= ON
INVERT	= OFF
Idle Mode	= 4 Watts
Power Sharing	= 30 Amps (***Off*** for ***Freedom 25*** units)

Monitoring Functions:

Charged Voltage	= 13.2 Volts for 12 Volt systems
	= 26.4 Volts for 24 Volt systems
Charged Current	= 2% (of battery capacity, 4 Amps @ 200 A hrs)
Battery Capacity	= 200 A hrs
CEF	= 95% (***C***harge ***E***fficiency ***F***actor)
Ambient Temp.	= 70°F
Battery Type	= #0 (Liquid cells)
Peukert Exponent	= 1.25

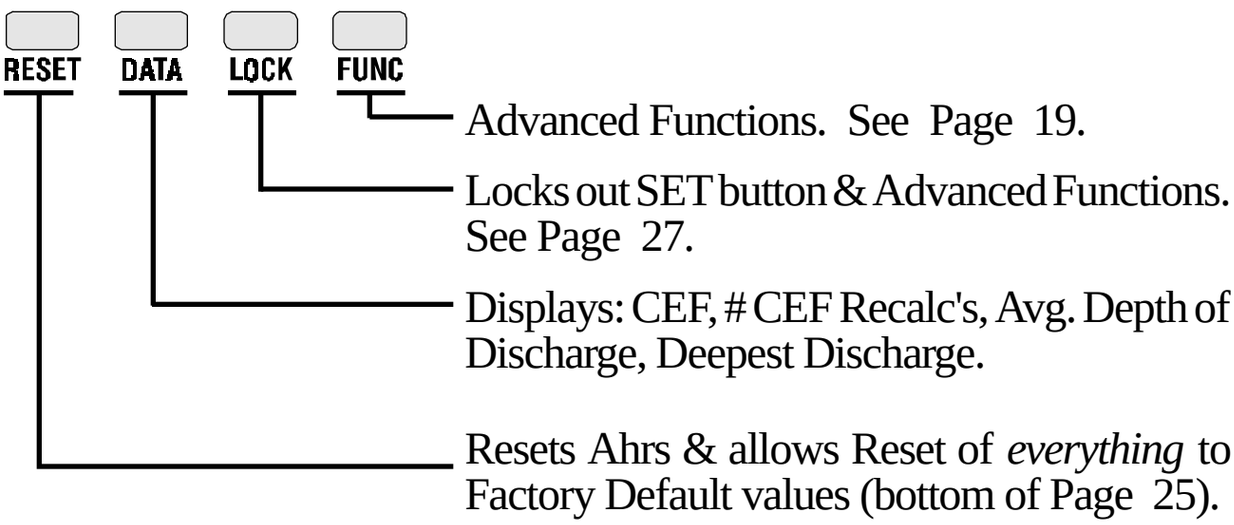
USING SET AND SEL BUTTONS

Press and hold the **SET** button until SEL is displayed to access the **Set Up** and Advanced Functions modes. With **SEL** displayed, press the **SEL** button to choose the function you want to **SEL**ect.

Pressing **SEL** chooses a *variable* or *function*. The Set Up mode always begins at the Ⓥ (Volts) function. Each press of the **SEL** button scrolls to the next item. When a variable or function is selected, its corresponding light and present value is displayed. To change a variable, press the **SET** button until the value appears that you wish. The order displayed and brief descriptions are below.

LIGHT	DESCRIPTION
Ⓥ	Charged Voltage (The Voltage above which the battery must remain when charging in order to be considered "full".)
Ⓐ	Charged Current % (Charging current [*in Amps*] must be below this percentage of the battery capacity [*in Amp-hours*] to be considered full).
Ⓐh	Battery Capacity in Amp-hours
ⓣ	Time interval over which current is averaged for time remaining function.

Pressing **SEL** *in the Set Up mode steps through the following:*



☞ **Now let's SET UP your system! We'll explain Charged Voltage, Charged Current Percentage, Battery Capacity, Time of Operation Remaining averaging, and set an appropriate rate compensation (Peukert) exponent.**

WHEN TO SET UP Ⓥ AND Ⓐ

The ***Link 1000*** depends on correctly set Charged Parameters to stay in sync with battery state-of-charge, to automatically reset to zero, and to automatically calculate the Charging Efficiency Factor (***CEF***) of your battery. The two numbers which define Charged Parameters are: Charged Voltage and Charged Current Percent.

What these Charged Parameters mean is simply this: If you charge a battery above a given charging voltage and hold it there until the charging current drops below a few percent of battery capacity, the battery is effectively FULL. Although you could continue charging, once voltage is held high and charging current drops to a few percent, any additional energy going into the battery will be turned into heat or hydrogen and oxygen gas.

Based on extensive studies, we have selected a default Charged Voltage of 13.2 volts for "12 Volt " systems (26.4V on "24 Volt" systems) and a Charged Current of 2% of declared battery capacity. This means a 200 Amp-hour liquid cell battery held over 13.2 volts until charging current drops below 4 amps, is effectively full. (4 amps is 2% of 200 Amp-hours.) Once your system is able to fully recharge your battery, we can then calculate battery efficiency when five conditions are met:

CONDITIONS TO RESET AMP-HOURS TO ZERO

1. Discharge 10% of declared battery capacity to trigger algorithm.
2. Recharge until kWhrs becomes a positive number.
3. The voltage must be above the Charged Voltage Parameter.
4. The current must be below the Charge Current Parameter.
5. Conditions 3 & 4 must be met for 5 minutes (1 min. for AE [**F05**] mode).

☞ If your battery voltage is **other than 12 or 24 Volts,** you *must* set up an appropriate Charged Voltage. 2.2 volts/cell is appropriate at normal temperatures for liquid cell batteries.

☞ If the charged parameters are not set correctly, the ***Link 1000*** may never recalculate the ***CEF***! If you accumulate negative A hrs, check your charged parameters.

Please consider changing only the battery capacity unless your system falls into one of the following categories:

1) Battery chemistry other than lead acid.
12 Volt NiCad (and NiFe) systems would normally use 15.5 to 15.7 as the Charged Voltage. See your battery specifications for guidance. The Charged Current % can probably stay at 2% of declared battery capacity.

2) Charging normally ends before current drops below 2%.
If the charging system is normally shut down before charging current drops below 2%, the Charged Current % will have to be changed.

3) Your system operates at extremes of temperature.

HOW TO SET Ⓥ (Charged Voltage)

Your ***Link 1000*** automatically selects an appropriate Charged Voltage for 12 or 24 Volt liquid cells on power up. If you have **gel cells**, see Page 20 to set Battery Type. An appropriate Charged Voltage for gel cells will be selected. If extremes of temperature are involved, or you have exotic batteries, here's how to change Charged Voltage:

1. Press **SET** for 5 seconds. — *SEL* will appear in the numeric display.
2. Press **SEL** once. — The Ⓥ light will come on and 13.2 [or 26.4*] will appear in the numeric display.
3. Press and hold **SET**. — The numeric display will move up in 0.1 Volt steps until *50.0* volts is displayed. The display will then "wrap around" and start counting up from *8.5* Volts. Stop at the desired voltage.
4. After 10 seconds, the displayed setting is stored in memory and normal operation resumes.

HOW TO SET Ⓐ (Charged Current)

The ***Link 1000*** is factory set to use 2% of battery capacity as its Charging Current Percentage. If you normally end charging before 2% is reached, or use a very large battery bank, such as might be encountered in an alternative energy installation, a different value may be appropriate. Here's how to change it:

1. Press **SET** for 5 seconds. — *SEL* will appear in the numeric display.
2. Press **SEL** twice. — The Ⓐ light will come on and 2 will appear in the numeric display.
3. Press and hold **SET**. — The numeric display will move up in 1 percent steps until 7 percent is displayed. The display will then "wrap around" and start counting up from *1* percent.
4. After 10 seconds, the displayed setting is stored in memory and normal operation resumes.

HOW TO SET Ⓐh (BATTERY CAPACITY)

The first time you apply power to a ***Link 1000***, it assumes you have 200 Amp-hours of battery capacity. 200 Amp-hours is the factory default capacity. If your battery capacity is different (and it probably is) you must change the declared battery capacity. Before you try to set battery capacity, you'll need to know what your battery (or battery bank) should deliver.

The surest way is to ask for the manufacturer's 20 hour rating. If that's missing, remember that for 12 Volt ***liquid*** cells, a Group 24 battery has about 85 Amp-hours, a Group 27 size has about 100 Amp-hours, a Group 30 has about 130 Amp-hours, while 4D's hold about 160 Amp-hours and the heavier 8D is generally about 220 Amp-hours. ***Gel*** cells generally hold about 15% fewer Amp-hours for a given size. A Group 27 case gel cell stores about 85 Amp-hours.

If you use two batteries in parallel, as a single bank, use twice the Amp-hour capacity of a single battery. For three batteries in parallel, use three times the Amp-hour capacity. If you parallel batteries, use the same size and same age batteries. If you use two batteries in series, such as two 6 Volt golf cart batteries, use the Amp-hour capacity of one battery. For example, if you have three 12 Volt Group 27 batteries in *parallel*, you would use (100 A hrs x 3) 300 Ahrs for your battery capacity. Two Trojan T-105 6 Volt golf cart batteries in *series* would use the factory default 200 Amp-hours for capacity.

If you need to change the default setting, here's how you do it:

1.	Press **SET** for 5 seconds.	SEL will appear in the numeric display.
2.	Release. Press **SEL** 3 times.	The Ⓐh light will come on and 200 (default) will appear in the numeric display.
3.	Press and hold **SET**. (Release at desired value)	The display will move in 20 Amp-hour steps over 100 Amp-hours of capacity. 1 Amp-hour increments are shown from 20-40 Amp-hours of capacity, 5 Amp-hour steps from 40-100 Amp-hours capacity. If you continue to hold **SET**, after 4 increments the display scrolls faster. When the value you want appears, release the **SET** button. If you overshoot your capacity you will have to scroll all the way to 1980 Ahrs after which the display will roll over and begin scrolling up starting from 20 Amp-hours.
4.	After 10 seconds, the displayed setting is stored to memory and normal operation resumes.	

HOW TO SET ⓣ

There are four different ways the ***Link 1000*** can calculate the time of operation remaining. You may select present consumption level, a four minute rolling average, a sixteen minute, or a 32 minute rolling average. Which method is best for you depends on your installation. Most installations will find the four minute average appropriate.

1. Press **SET** for 5 seconds. — SEL will appear in the numeric display.

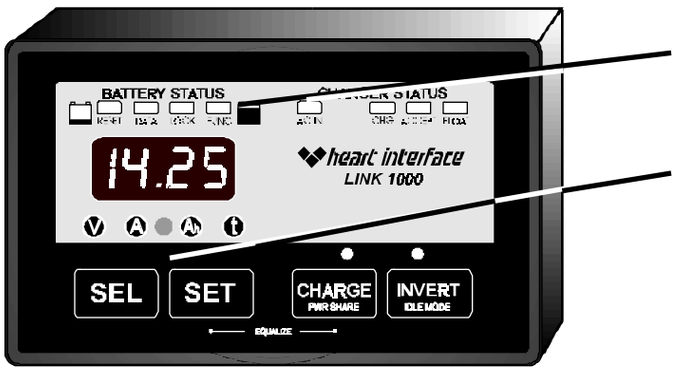
2. Press **SEL** four times. — The ⓣ light will come on and 001 will appear in the ***Link 1000*** numeric display.

3. Press and hold **SET**. — The numeric display will move up in 1 unit steps with choices of:

Instant:	Display:	000
4 Minute Avg:	Display:	00I
16 Minute Avg:	Display:	002
32 Minute Avg:	Display:	003

4. After 10 seconds, the displayed setting is stored in memory and normal operation resumes.

HOW TO SET UP FUNCTIONS



When the **FUNC** light is on, you can access Advanced Functions of the ***Link 1000***. The values for each function are changed using the **SET** and **SEL** keys.

1) Hold down the **SET** button until the numeric display says *SEL*.

2) Now press the **SEL** button 11 times until **F0i** appears in the display. You are now at F01 in the **FUNC**tion mode.

3) Press **SEL** again until the function you wish to set up appears.

4) Press the **SET** button to show the current value of the function you have selected.

5) To change the function value, press **SET.** The display will scroll through the range of available values. Stop scrolling when the value you wish appears in the display.

6) If you are only changing one function, simply leave the unit alone and in 3 seconds, the display will return to normal and the choice you have made for the function selected will be stored in memory.

7) If you wish to set up other functions, press the **SEL** button right away after making your selection in Step 5. You'll now scroll on to the next function, which can be changed the same way. When you have made all the changes desired, simply leave the unit alone for 3 seconds and the values will be memorized and the display returned to normal operation.

FUNCTIONS TABLE

The above section gave you the general approach to changing an Advanced Function setting. Now, we'll go through each of the Advanced Functions and explain what each does and how you may wish to use it. If you ever get "lost" and want to restore all factory default settings, simply follow the RESET procedure on Page 25!

F01 - AUTO DISPLAY SCANNING

DEFAULT = OFF RANGE: OFF, ON

Automatically scans through the major displays: Volts, Amps, Amp-hours, and Time of Operation remaining. Each value is displayed for 4 seconds.

If second battery voltage sensing (**F11**) is ON, 2 voltages are shown: The flashing Volts status light indicates the voltage displayed is that of the second battery bank.

F02 - DISPLAY SLEEP

DEFAULT: ON RANGE: ON, OFF

Turns off all lights on the front panel except for the light bar, AC indicator, charging status lights, and invert and charge status lights.

F03 - SET OR DISPLAY AMBIENT BATTERY TEMPERATURE

THIS FUNCTION DEPENDS ON THE SETTING OF F16, PAGE 23.

IF F16 IS ON, F03 DISPLAYS PRESENT BATTERY TEMP. (^{O}F.)

This function is only available if your *Freedom* inverter/charger is equipped with a Heart Interface ***TC2+2*** temperature sensing unit. Turn off scanning (F01) to see the reported temperature continously.

After time out, the time indicator light (t) will blink during this continous display.

IF F16 IS OFF, F03 DISPLAYS DECLARED BATTERY TEMP. (^{O}F.)

DEFAULT = 70F RANGE = 30-120F STEP = 10F

The ***Link 1000*** default ambient temperature setting is 70^{0}F. The ambient temperature of the battery may be set up to select the appropriate Charge and Float Voltages for the ***Freedom*** inverter/charger. The temperature may be set in 10^{0}F increments.

Setting up a different value should only be done if the battery operates at a temperature significantly different from 70^{0}F **when they are being charged from the *Freedom* Inverter/Charger**. If the batteries are located in a hot engine room, but are not normally charged from the ***Freedom*** charger when the engine is running, do not adjust the temperature to the engine room level. You may need to adjust engine alternator output voltage. **Remember:** Temperatures above 100^{0}F are damaging to batteries. Relocate them or supply forced fresh air ventilation. Charge hot batteries at a lower voltage.

CAUTIONS!

1)Do not adjust to extremes unless the battery is normally at that temperature. Destructive over or under charging may occur.
2)Multiply values by 2 for 24 Volt systems.
3)Voltages are typical, charger regulation ± 0.2 Volts DC.

NOTE

At temperatures of 120 degrees F or above , either reported by the Heart Freedom TC2+2 or if manually set, the Freedom Charger will go to a high temperature, voltage limited charge mode to protect the battery.

TEMPERATURE COMPENSATION TABLE

TEMP		TYPE 0 Liquid		TYPE 1 Gel 1 (Std)		TYPE 2 Gel 2 (Fast)		TYPE 3 AGM	
^{0}F	^{0}C	ACCEPT	FLOAT	ACCEPT	FLOAT	ACCEPT	FLOAT	ACCEPT	FLOAT
120	49	12.5	12.5	13.0	13.0	13.0	13.0	12.9	12.9
110	43	13.6	12.7	13.5	13.0	14.0	13.4	13.9	12.9
100	38	13.8	12.9	13.7	13.2	14.1	13.5	14.0	13.0
90	32	14.0	13.1	13.8	13.3	14.2	13.6	14.1	13.1
80	27	14.2	13.3	14.0	13.5	14.3	13.7	14.2	13.2
70	21	14.4	13.5	14.1	13.6	14.4	13.8	14.3	13.3
60	16	14.6	13.7	14.3	13.8	14.5	13.9	14.4	13.4
50	10	14.8	13.9	14.4	13.9	14.6	14.0	14.5	13.5
40	5	15.0	14.1	14.6	14.1	14.7	14.1	14.6	13.6
30	-1	15.2	14.3	14.7	14.2	14.8	14.2	14.7	13.7

Freedom units produced prior to serial #100,000 have temperature compensation only for warm or cool environments. The temperature setup sets the voltages as per below:

TEMP	TYPE0 (Liquid)			TYPE1(Gel 1)		
	Accept	Float	Equalize	Accept	Float	Equalize
Above 80^{0}F	13.9	13.3	15.8	14.1	13.8	14.1
Below 80^{0}F	14.4	13.5	16.3	14.4	13.8	14.4

F04 - TOGGLE DISPLAY BETWEEN A HR AND KWHR

DEFAULT OFF = A HR DISPLAY MODE

ON = KWHR DISPLAY MODE

When this function is selected the **A hr** display is changed to a kilowatt-hour display. Kilowatt-hours are used by your ***Link 1000*** to determine if 100% of the energy consumed from the battery has been returned. A recalculation of the CEF is not permitted unless this counter is greater than 0.00 kWhr. This counter counts down during discharge and the kWhrs consumed are displayed with a negative number. During charging it counts back up with 100% efficiency. CEF recalculation is prevented until a positive number is in the kWhr counter. This prevents premature CEF recalculation and Ahr reset. Kilowatt-hours are a very precise measurement of energy removed from or returned to your battery bank.

F05 - ALTERNATIVE ENERGY MODE

DEFAULT: OFF

ON = USE ALTERNATIVE ENERGY DEFAULTS

Turn this mode on if your ***Link 1000*** is used in Alternative Energy Systems. This function reduces the time necessary to satisfy the charged parameters from 5 minutes to 1 minute. If you're using a semi-mechanical photovoltaic controller, we strongly suggest you also consider changing Charged Current to 4%. (See *How to Set* Ⓐ *on page 16.*)

F06 - MANUALLY SET *CEF* (Not Recommended)

DEFAULT OFF = AUTO RECALCULATION OF CEF

DISPLAY = A95

RANGE = 65-99 STEP = 1

Allows manual set up of *CEF* (Charge Efficiency Factor). Default display *A95* indicates automatic CEF recalculation feature. Returning to *A95* from a user delcared CEF turns the automatic CEF feature back on. If a user set up CEF has been selected it will appear as a *Uxx* in the **DATA** mode.

F07 - SET TEMPERATURE COEFFICIENT

DEFAULT = 0.5 RANGE = 0.1 - 1.5 STEP = 0.1

This factor compensates for capacity change with temperature. Typical value 0.5% Capacity/^{0}C. This coefficient must be supplied by the battery manufacturer. The default value is typical for lead acid liquid or gelled batteries. Normally this value is not changed.

F08 - SET PEUKERT'S EXPONENT

DEFAULT = 1.25* RANGE = 1.0 - 1.50 STEP = 0.01

Sets the exponent for Peukert's equation. A setting of 1.0 defeats Peukert's calculation. Properly setting Peukert's exponent insures an accurate display of time remaining. See Page 29 for a discussion of Peukert's equation and typical values for various batteries. * Default for liquid electrolyte batteries (F10 set to Type 0). When F10 is set to gelled or AGM batteries (F10 set to Type 1, 2 or 3), a default exponent of 1.11 is used.

F09 - LOW BATTERY DISCHARGE FLOOR

DEFAULT =100% RANGE: 50% - 100% STEP: 5%

Your ***Link 1000*** allows you to declare the discharge floor used for meter calculations. As supplied by the factory, the discharge floor is 100% of Amp-hour capacity, corrected for high discharge rates. If you set the discharge floor to 100%, the **TIME** remaining display essentially reports **TIME** to "dead battery". The factory default discharge floor is 100%, essentially the **TIME** "till the battery is 100% discharged. Charging should begin when two yellow battery status lights are on in order to conform to our ***"Mid Capacity Rule***".

CAUTIONS: If you discharge below the discharge floor, partially charge, but remain below the discharge floor, the **TIME** remaining display will continue to read zero. The **TIME** display will not show meaningful readings until you have recharged above the discharge floor you have set. Also, remember that the light bar and **TIME** remaining displays are run on *rate compensated* (Peukert equation corrected) Amp-hours.

F10 - BATTERY TYPE

0 = LIQUID CELL (DEFAULT) **1 = GEL CELL (STANDARD)**
2 = GEL CELL (FAST CHARGE) **3= AGM (Absorbed Glass Mat)**

This function (Default:Type #0, standard liquid cells) sets the appropriate charge and float voltages for the **FREEDOM** charger (see table below) and sets an appropriate Peukert exponent. Gel cell owners may use Type 1 or Type 2, but should consult with the battery manufacturer prior to using the more aggressive charging regimen described by Type 2. Type 3 sets Acceptance and Float voltages suited to AGM type batteries.

F11 - SECOND BATTERY VOLTAGE SENSE

DEFAULT =OFF **RANGE: ON, OFF**

When ON, this function displays two voltages in the VOLTS display. When the Ⓥ indicator is on at all times (solid), you are seeing the voltage of the monitored battery. If battery Ⓥ indicator is flashing, the second (starting) battery voltage is being displayed.

F12 - # OF OVERLOAD CONDITIONS EXPERIENCED

The number of inverter shutdowns counted since last high level meter reset. This is a troubleshooting tool.

F13 - NUMBER OF INVERTER LOW BATTERY SHUTDOWNS.

The number of inverter low battery shutdowns since last high level meter reset. This is primarily a troubleshooting tool.

F14 - DISPLAY TEST

DEFAULT: OFF **RANGE: ON while SET button is depressed when this function is active.**
OFF when SET is released.

This function confirms proper operation of the ***Link 1000*** front panel display. When the SET button is pressed in the F14 mode, the two top left lights on the battery light bar will be an orange/yellow color. All other lights will display their normal color and the numeric display will read -188.8. The display will return to normal when the SET button is released. Operation of the two right (green) lights on the battery light bar is confirmed when power is initially applied to your ***Link 1000***.

F15 - DISPLAY SOFTWARE REVISION NUMBER

Function F15 selects display of the software revision number. This number is used internally by Heart Interface to keep track of which version of software is installed in your ***Link 1000***. This number should be written down in the Set Up table contained in this manual on Page 35 for your future reference.

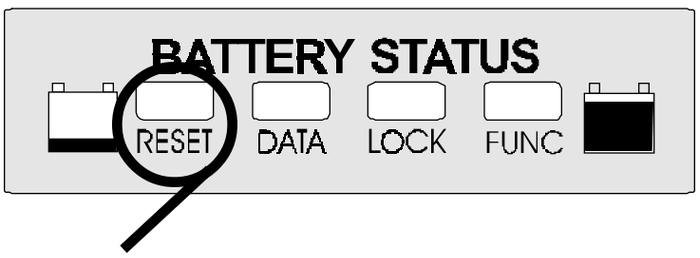
F16 - ACTIVE TEMPERATURE COMPENSATION ON, OFF

DEFAULT: OFF RANGE: OFF, ON

When this function is turned on, the Link 1000 utilizes the actual battery temperature reported to the *Freedom* inverter/charger by a Heart ***TC2+2*** unit.

It is recommended that this function not be turned ON if the Heart Inverter with TC2+2 and temperature probe is not connected.

HOW TO RESET YOUR UNIT



RESET: Two types of **RESET** are provided: Resetting of Amp-hours to zero or a complete reset of all parameters to factory default settings.

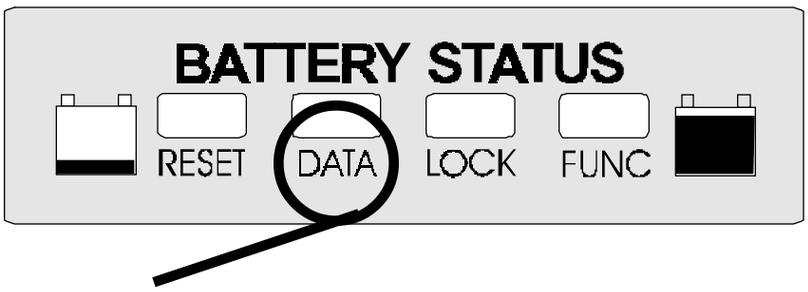
To access the RESET functions:

1) Hold down the **SET** button until **SEL** appears in the numeric display..
2) Press the **SEL** button five times until the red light above the word RESET appears.
3) **AH** is shown in the numeric display.
4) If you wish to reset Amp-hours, simply press and hold the SET button for 5 seconds. When Amp-hours are reset, the word **ALL** is displayed, warning that you are about to reset **ALL** settings to the factory defaults.
5) If you continue to hold **SET** for 5 more seconds, all factory default settings will be restored.

Resetting Amp-hours to zero does not eliminate historical battery data.

However, if you reset ALL, you will remove any battery historical data you have accumulated. You generally use the reset ALL function when you change out a battery or battery bank.

DATA: YOUR BATTERY HISTORY



DATA: The **DATA** mode is used to recall key historical information about the battery.

To access the DATA displays:

1) Hold down the **SET** button until **SEL** appears in the numeric display..
2) Press the **SEL** button six times until the red light above the word DATA appears.
3) The first number displayed will be Charging Efficiency Factor.
4) Press **SEL** again. The number of CEF Recalculations is displayed.
5) Press **SEL** again. The deepest depth of discharge is displayed.
6) Press **SEL** again. The average depth of discharge is displayed.
7) Press **SEL** again. The next light on the Light Bar, the one over the word **LOCK** will come on. The **LOCK** function is described on the next page.

What the Historical Information Means:

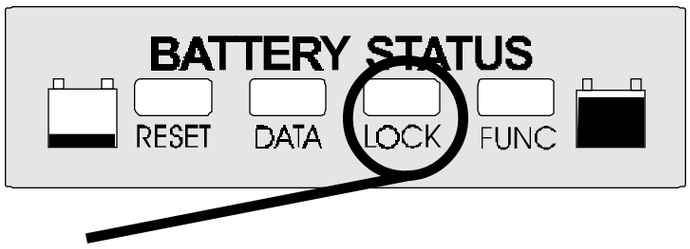
***CEF* (Displayed as *E99*):** The Charging Efficiency Factor (CEF) is the rate at which Amp-hours are counted back up during charging. The Amp-hour CEF, not kilowatt-hour CEF, is displayed. A display of *E99* indicates a 99% CEF based on Amp-hours. The Default setting is 95%. **NOTE:** If the CEF display has a *"U"* in front of it, this means the CEF has been selected by the user. See *Advanced Function* F06 on Page 21 for details.

#CEF Recalculations (Displayed as *+1999*): This is the number of times that the battery has been discharged more than 10% and then completely recharged (meaning charged until the Charged Parameters have been met). Consider this to be the number of charge/ discharge cycles the meter has recorded since its last **RESET** to factory defaults. A discharge of less than 10% of battery capacity is not counted as a "cycle".

Deepest Discharge (Displayed as *-1999*): Shows the deepest discharge in Amp-hours recorded by the meter since its last **RESET** to factory defaults. Think of this as the "worst thing you've ever done to your battery".

Average Discharge (Displayed as *1999*): The running average of all discharges as an Amp-hour value since last **RESET** to factory defaults. For best battery life, you should not routinely discharge more than 50-65% of your battery's capacity. If you do, you shorten its life. An average discharge of 500 Amp-hours on a 900 Amp-hour battery is demanding but not unreasonable. An average discharge of 180 Amp-hours from a 200 Amp-hour battery is almost a sure way to make a battery salesman happy!

LOCK: KID PROOFING



LOCK: The **LOCK** mode is used to keep kids (or others) from changing your ***Link 1000*** Set Up.

To access the LOCK:

1) Hold down the **SET** button until **SEL** appears in the numeric display.
2) Press the **SEL** button 10 times until the red light above the word **LOCK** appears.
3) Press **SET** again. The word ON or OFF will appear in the numeric display.
5) Press **SET** again to change **LOCK** status.

SETTING PEUKERT EXPONENT

Think of the Peukert exponent as the "shrink rate" of your battery bank. As you discharge your batteries more rapidly, their effective size shrinks. A battery which can supply 200 Amp-hours when slowly discharged over 20 hours may provide only 95 Amp-hours if discharged rapidly in one hour. The technical description of this "shrink factor" defined by the Peukert exponent, varies among battery designs.

For your convenience, we've included some common Peukert exponents on Pages 31 and 32 and a technical description including a "do it yourself" method to calculate the Peukert exponent on Pages 29-30.

When you select Battery Type (See Function F02 on Page 20), your ***Link 1000*** automatically sets a Peukert exponent which is generally correct. However, your batteries may have different characteristics than "average" and you may wish to change the exponent so your Time Remaining and Light Bar displays will be as accurate as possible. To change the Peukert exponent, proceed as follows:

A. Press and hold the **SET** button for 3 seconds to enter Set Up mode. **SEL** appears in the display. Press **SEL** and notice that the green Ⓥ LED is on.

B. Continue to press the **SEL** button until the letters **F08** appear in the display. (This will require eighteen presses of the **SEL** button.) The right most green light bar indicator with the legend **FUNC** under it will be lit.

C. Now press and hold the **SET** button. If Battery Type is set to #1, the default value of 1.25 (or the previously programmed value) will appear in the display. If Battery Type #2 is selected, the default value of 1.11 (or the previously programmed value) will be displayed. The range of values is from 1.0 to 1.50.

Holding down the **SET** button will cause the display to increment in 0.01 steps, after 4 increments the display scrolls faster. When the value you want appears, release the **SET** button. If you overshoot your capacity you will have to scroll all the way to 1.50 after which the display will roll over to 1.00 and continue incrementing up.

D. After 10 seconds, if no keys are pressed, the ***Link 1000*** exits the Set Up mode and the selected value is stored as the new Peukert's exponent and the display returns to Ⓥ (Volts).

HIGH DISCHARGE RATES & PEUKERT'S EQUATION

Peukert's Equation describes the effect of different discharge rates on battery capacity. As the discharge rate increases the available battery capacity decreases. The tables on pages 30, 31 & 32 have typical values of "*n*" for common batteries. Page 30 is a look-up table, pages 31 & 32 have "*n*" values for common batteries, and page 32 has the formula for calculating "*n*" for other batteries.

The ***Link 1000*** uses Peukert's equation only for calculating the Time Remaining function and for the light bar display. The Amp hours display is always the actual number of A hrs consumed. This means that if you heavily discharge a battery, your time remaining display may show zero hours remaining before the expected number of A hrs of battery capacity is consumed.

Making two discharge tests, one at a high discharge rate ($\mathbf{I}_1$ and $\mathbf{t}_1$) and one at a low rate ($\mathbf{I}_2$ and $\mathbf{t}_2$) , that bracket your normal range of operation, allows you to calculate an "*n*" which will describe this varying effect. The ***Link 1000*** uses a default value of *"n"* equal to 1.25 which is typical for many liquid cell batteries. Setting Battery Type 1, 2, (gel cell) or 3 (AGM) changes the Peukert exponent to 1.11, a common exponent for these type cells.

At some low to moderate discharge rate, typically a battery's 20 hour rate, the logarithmic effect of Peukert's Equation is greatly reduced. The effect of discharge rates smaller than this is nearly linear. Battery manufacturer specifications of battery capacity in Amp-hours is typically given at the 20 hour rate. If a battery is discharged at, or slower than, the 20 hour rate, you should be able to remove the rated capacity if the battery is healthy.

The equation for Peukert's Capacity (C_p) is:

$$C_p = I^n t \quad \text{where} \quad n = \frac{\log t_2 - \log t_1}{\log I_1 - \log I_2}$$

By doing two discharge tests and knowing I_1 & I_2 (discharge current in Amps of the two tests), and t_1 & t_2 (time in hours for the two tests) you can calculate *n* (the Peukert exponent). You will need a calculator with a log function to solve the equation above.

Instead of doing two discharge tests yourself, you may use the 20 hour discharge rate and the number of reserve minutes as the two discharges to solve Peukert's equation. After you solve for your Peukert's exponent you may enter it using Advanced Function F08.

TABLE OF PEUKERT'S EXPONENT FOR VARIOUS BATTERY RATINGS

DIRECTIONS: FIND THE 20 HR RATING OF YOUR BATTERY ON THE HORIZONTAL AXIS. FIND THE RESERVE CAPACITY RATING ON THE VERTICAL AXIS. THE INTERSECTION IN THE TABLE GIVES THE "*N*" VALUE.

20 Hr rating	60	70	85	86	90	95	105	108	112	120	130	150	170	180	208	210	216	221	225
Reserve Minutes																			
60	1.41																		
90	1.22	1.32	1.46	1.47															
120	1.09	1.17	1.30	1.31	1.34	1.39	1.48	1.50											
130	1.05	1.13	1.25	1.26	1.30	1.34	1.42	1.45	1.49										
150		1.06	1.17	1.18	1.21	1.25	1.33	1.36	1.39	1.46									
160		1.02	1.14	1.14	1.18	1.21	1.29	1.31	1.35	1.41	1.50								
180			1.07	1.08	1.11	1.14	1.22	1.24	1.27	1.33	1.41								
190			1.04	1.05	1.07	1.11	1.18	1.20	1.23	1.29	1.37								
210					1.02	1.05	1.12	1.14	1.17	1.22	1.29	1.45							
230							1.06	1.08	1.10	1.16	1.23	1.37							
240							1.03	1.05	1.08	1.13	1.19	1.34	1.49						
270										1.05	1.11	1.24	1.38	1.46					
300											1.03	1.15	1.29	1.36					
330												1.07	1.20	1.26	1.47	1.49			
350												1.02	1.14	1.21	1.40	1.42	1.47		
360													1.12	1.18	1.37	1.39	1.43	1.47	
375													1.08	1.14	1.33	1.34	1.39	1.42	1.46
390													1.04	1.10	1.28	1.30	1.34	1.38	1.41
395													1.03	1.09	1.27	1.28	1.32	1.36	1.39
420															1.20	1.21	1.25	1.29	1.31
450															1.12	1.13	1.17	1.20	1.23

TYPICAL PEUKERT'S EXPONENTS

Typical Values for Peukert's Exponent *"n"*

This table contains values for the exponent *"n"* for various batteries and manufacturers. They are calculated from the 20 hour rating and the Reserve Minutes @ 25A as supplied by the manufacturer. They should be considered only a guide for selecting *"n"*.

Prevailer & SeaGel Batteries

Model	Volts	Res. Min.	20 Hr. Rating	*"n"*
8GGC	6	375	180	1.14
8GU1	12	140	43	1.20
8GU24	12	130	70	1.13
8GU27	12	167	86	1.12
8GU30H	12	188	95	1.12
84D	12	388	180	1.11
8G8D	12	500	225	1.10

Trojan Batteries

Model	Volts	Res. Min.	20 Hr. Rating	*"n"*
T-105	6	447	225	1.24
T-125	6	488	235	1.19
T-145	6	530	244	1.14
J250	6	535	250	1.17
J305	6	660	305	1.21
L16	6	760	350	1.28
24TM	12	135	85	1.23
27TM	12	160	105	1.28
30XHS	12	225	130	1.24
SCS225	12	225	130	1.24
EV8D	12	450	216	1.17

TYPICAL PEUKERT'S EXPONENTS

Surrette and Rolls Batteries

Model	Volts	Res. Min.	20 Hr. Rating	*"n"*
EHG-208	6	345	208	1.42
EIG-225	6	350	225	1.54*
EIG-262	6	395	262	1.72*
24/90	12	165	90	1.16
27/12M	12	190	112	1.23
30H/108	12	230	108	1.08
HT/4D	12	348	170	1.15
HT/8D	12	450	221	1.20

*Use Max allowed *"n"* of 1.50

CALCULATING PEUKERT'S EXPONENT

Example of using Reserve Minutes @ 25 Amps and the 20 hour rate to calculate "*n*".

First convert Reserve Minutes to hours, then find the discharge current at the 20 hour rating. Finally use a calculator to solve the arithmetic.

Trojan T-105:

Reserve Minutes = 447 min @ 25 Amps.

t_1 = 447 min = 447/60 = 7.45 hrs

I_1 = 25 Amps

20 Hour rating = 225 Ahr

t_2 = 20 hours

I_2 = 225 Amp-hours/20 hours = 11.25 Amps

$$n = \frac{\log t_2 - \log t_1}{\log I_1 - \log I_2} = \frac{\log 20 - \log 7.45}{\log 25 - \log 11.25} = \frac{1.301 - 0.872}{1.398 - 1.051} = 1.24$$

Freedom ERROR CODES

The following error codes are displayed when the ***Link 1000*** detects a problem. The display alternates between the selected monitoring function and the Error Code. The Error Code continues to flash until the error is corrected. Error codes are the same for all models.

CODE	***DEFINITION***
E01	**INVERTER HIGH DC/BATTERY VOLTAGE SHUTDOWN:** Battery Voltage has risen above 15.5V for 12V inverters or above 31V for 24V inverters. (Check all charging sources.)
E02	**INVERTER LOW DC/BATTERY VOLTAGE SHUTDOWN:** Battery Voltage has dropped below 10.5V for 12V units or below 21V for 24V inverters. (Check for dead battery or poor battery connections.)
E03	**INVERTER OR CHARGER OVER TEMP SHUTDOWN:** Unit will reset automatically after it has cooled sufficiently. Be sure there is adequate ventilation around the inverter.
E04	**BATTERY OVERLOAD:** Caused by excessively discharged batteries or shorted battery. See section in inverter owner's manual titled "Charging over-discharged batteries."
E05	**AC BACKFEED:** AC power from an outside source has been fed to the AC output of the inverter. Potentially damaging to the unit!! Disconnect incoming AC power and correct immediately!! See a qualified electrician if you do not know how to check for this condition.
E06	**ELECTRONIC OVERLOAD:** Inverter overload caused by too large a load on the output of the inverter or shorted inverter output. Reset by cycling the inverter on and off or connecting AC power from an outside source.
E07	**TRIAC CONTROL ERROR:** The Triac is used in the battery charging circuit. This error indicates that the Triac has overheated, turn off charger and allow to cool. Be sure there is adequate ventilation around the inverter.
E08	**HIGH BATTERY VOLTAGE SHUTDOWN DURING CHARGING:** Check all charging sources (solar panels, alternators, other battery chargers, etc.) for proper voltage. Reset by cycling the charger off and on.
E09	**SPARE:**

E10 **DEPOWERED:**
Displayed on first power up and whenever power has been interrupted or dipped below the operating voltage of the ***Link 1000***. This can be caused by voltage dips during engine starting if the meter is powered by the same battery that starts the engine.

E11 **SPARE**

E12 **BATTERY #1 VOLTAGE SENSE LEADS OPEN:**
Check the fuse or any other connections in the voltage sense lead (Blue wire) to battery #1.

E13 **SPARE**

E14 **INAPPROPRIATE CHARGED VOLTAGE SELECTED FOR THE SENSED VOLTAGE:**
This error is displayed if the Charged Voltage parameter is above 20V and the sensed voltage is below 20V or if the sensed voltage is above 20V and the Charged Voltage parameter is below 20V. This error code is to help avoid an erroneous set up.

E15 **INCOMING AC POLARITY REVERSED:**
Check incoming AC wiring for a reversed polarity (hot and neutral reversed) condition. See a qualified electrician if you do not know how to check for this condition.

OL **METER READING OUT OF RANGE.**

To Verify Current Measurements:

You may use a digital multimeter to verify that the ***Link 1000's*** current measurement is displayed correctly. Place at least a 20 to 30 amp load on the system. Use the multimeter to check the millivolt reading across the battery shunt. The shunt has a 50mV@ 500A rating, which means a load of 30 amps generates 3 mV across the shunt. The reading at the shunt and at the back of the ***Link 1000*** should be the same, and when multiplied by 10 should equal the reading in the amps display of the meter.

SET UP & HISTORICAL DATA

The following table is a summary of the major values that may be changed through Set Up or by accumulating historical data. The column on the right is provided to write down your set up values or historical data. Be sure and know these values before calling for customer service. Multiply values by two for 24 Volt systems.

PARAMETER	DEFAULT	VALUE
BATTERY VOLTS$_{CHARGED}$	13.2 V	_____
BATTERY AMPS$_{CHARGED}$	2%	_____
BATTERY CAPACITY	200 A hrs	_____
POWER SHARE	30A (Off if ***Freedom 25***)	_____
IDLE MODE	4W	_____

DATA	VALUE
CEF	_____
# OF CEF RECALC'S	_____
AVG DEPTH OF DISCHARGE	_____
DEEPEST DEPTH OF DISCHARGE	_____

FUNCTIONS	DEFAULT	VALUE
DISPLAY SCAN (F01)	Off	_____
DISPLAY SLEEP (F02)	ON	_____
AMBIENT TEMP. (F03) (Depends on F16 setting)	70^0F	_____
AHRS/KWHRS (F04)	Ahrs displayed	_____
ALT. ENERGY (F05)	Off	_____
Manual *CEF* (F06)	95% (This value should only be set if you do NOT want your ***Link 1000*** to automatically calculate ***CEF***)	_____
TEMP. COEF. (F07)	0.5	_____
PEUKERT EXP. (F08)	1.25	_____
DISCH. FLOOR (F09)	100%	_____
BATTERY TYPE (F10)	#1 LIQUID LEAD ACID	_____
SECOND BAT. (F11)	Off	_____
SOFTWARE REV. (F15)	***	_____
TEMP. COMP. (F16)	OFF	_____

LIMITED WARRANTY

LINK products are a joint venture of two Valley Forge Companies. Installation and operation questions should be directed to Heart Interface. Warranty issues should be directed to Cruising Equipment Co..

DO NOT INSTALL OR ATTEMPT TO USE THIS PRODUCT UNTIL YOU HAVE READ THE OWNER'S MANUAL IN ITS ENTIRETY. IMPROPER INSTALLATION OR USAGE OF THIS DEVICE MAY BE HAZARDOUS AND MAY CAUSE DAMAGE TO OTHER ELECTRICAL EQUIPMENT.

Cruising Equipment Co. (CECO) warrants to the original purchaser only for 30 months from the date of purchase that your (hereafter Meter) will be in good working order when properly installed and operated as described in this Manual.

If your Meter fails to perform or becomes defective under normal use and service, CECO will, without charge, at CECO's place of business, within a reasonable time after delivery, repair, or at CECO's option, replace with a new or factory reconditioned part any part found defective, or at its further option, refund to you the entire purchase price.

In order to avail yourself of the warranty you must:
1. First contact:
   Heart Interface Corp. at 21440 68th Ave. So. Kent, WA 98032, (206) 872-7225 or
   Toll Free 1-800-446-6180;
   or Cruising Equipment Co. at 5245 Shilshole Ave. N.W., Seattle, WA 98107, (206) 782-8100
2. Obtain warranty return authorization from CECO or Heart;
3. Ship the Meter, charges prepaid, with proof of purchase within 30 months of its sale to you.

This warranty is void and will not apply if:
1. Your Meter has been modified or repaired without written authorization from CECO:
2. The identification markings on your Meter have been altered or removed:
3. Your Meter has been damaged through abuse, neglect, exposure to sea spray, lightning strikes, high voltage, accident: or
4. Your Meter was not installed and operated according to the owner's manual or was operated under conditions more severe than those specified in the owner's manual.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, INCLUDING THE WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND MERCHANTABILITY, EXPRESS OR IMPLIED, AND OF ALL OBLIGATIONS OR LIABILITIES ON THE PART OF CECO FOR DAMAGES, INCLUDING, BUT NOT LIMITED TO LOSS OF TIME, INCONVENIENCE, COMMERCIAL LOSS OR CONSEQUENTIAL DAMAGES, WHICH MAY ARISE OUT OF OR IN CONNECTION WITH THE USE OR PERFORMANCE OF THE METER.

Some states do not allow the exclusion or limitation of incidental or consequential damages, and some states do not allow limitations on how long an implied warranty lasts, so if the law of that state applies, the above limitation or exclusion may not apply to you. This warranty gives you specific legal rights and you may also have others which vary from state to state.

Shipping Policy: CECO will ship to any location in the United States or Canada, at its cost, via UPS surface or surface US mail, all warranty repairs. Shipment outside of the United States or Canada or by methods other than UPS surface or surface US mail will be at the expense of the customer.

❖ heart interface
21440 68th Ave. So. Kent, WA 98032
(206) 872-7225 Toll Free 1-800-446-6180

READ BEFORE WIRING !!!!!

Before wiring the *Link 1000*, install the shunt as indicated.
All wiring should be done before installing the meter power fuse.

GENERAL NOTES

1) Wiring to the ***Link 1000*** should be #16 or #18 AWG. (Larger is OK, but not necessary.) Wiring should be in accordance with the NEC, ABYC, or other applicable standards.

2) The Shunt Sense Leads should be a twisted pair. Leads up to 250 feet long may be used if they are not run close to other noise producing conductors and #16 AWG or larger twisted pair wire is used. Offset error should be less than 0.2 Amps.

For the easiest installation you may wish to purchase our four twisted pair cable with the same color code as enclosed wiring diagram. This cable may be run between the meter and the batteries to supply all needed signals. This cable is available from your dealer or from Heart Interface in various convenient lengths.

Note: You may make your own twisted pair wire by chucking up two wires in an electric drill and twisting them by running the drill motor until there is a twist or two every inch. A wrap of tape every 16" will keep the wires together and make them easier to pull through holes and raceways.

3) **Caution!** If your starter draws more than 500 amps see #5 below.

CAUTION!!!!

The output voltage of the shunt is very small. It is critical that all of the connections for the shunt sense leads have the highest possible integrity. Every effort must be made to prevent corrosion that might affect the sense leads.

4) Battery current is sensed with a shunt which is a very precise, small resistance. It is inserted in series (in line) in the negative wire of the battery (battery bank) you wish to measure. The current is measured by sensing the voltage drop across this resistance. The ***Link 1000*** uses a 50 mV @ 500 Amp shunt. When 500 Amps flows through the shunt, there is a 50 mV drop across it. Thus 10 Amps equals 1 mV or 1 Amp equals 0.1mV The meter displays this small voltage as Amps. If you wish to check this you will need a *very* accurate digital meter (Fluke 87 in 4 1/2 digit mode or better) if the current is below 30 Amps (3.0mV). Above 50 Amps most digital meters can be used for testing.

5) **Big Engine Note:** If your starter current exceeds 500 Amps for more than 10 seconds, as may be the case with gas engines of more than 350 cubic inches or diesel engines of more than 100 horsepower, you'll need to either use a heavy duty shunt or connect the starter negative directly to the battery side (BSHB) of the shunt so that starter current does not flow through it. The problem with wiring so that starter current doesn't go through the shunt is that if the alternator is of the grounded case type, its charging current will not be flowing through the shunt either. The alternator ground must be isolated from the engine and run to the load side (BSHG) of the battery shunt to be able to measure the current going into the battery from the alternator. Isolated negative output alternators are

available and we strongly recommend them. With isolated negative output alternators, remember that instrumentation and other loads grounded directly to the engine block will not be measured unless their negatives are relocated to the load side of the Battery Shunt.

Special high current shunts are really the right solution and may be ordered from Heart Interface. A separate engine starting battery whose negative is connected directly to the engine also solves the problem.

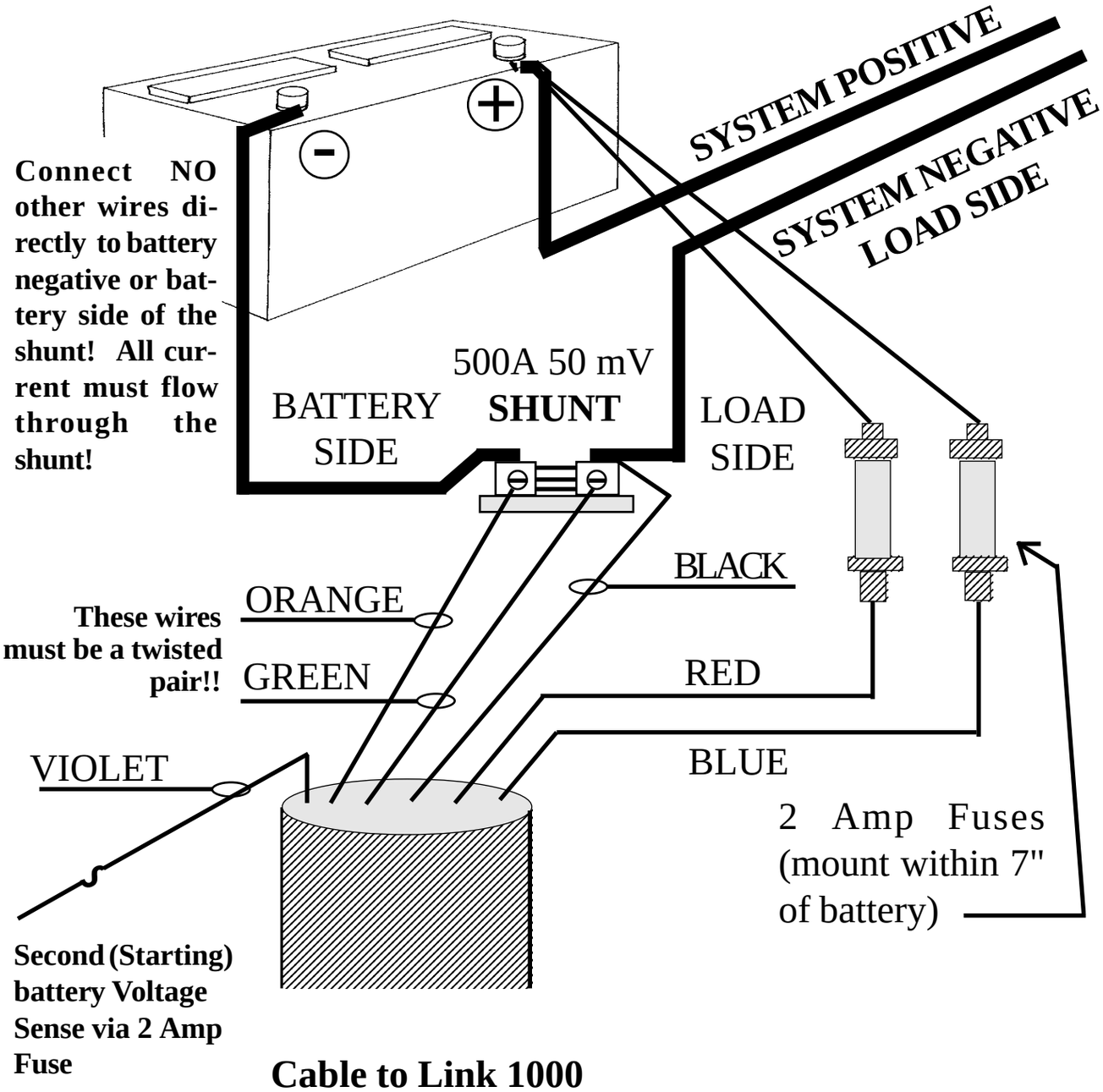
6) We have shown several wires connected to the load side of the battery shunt in the wiring diagram. If more than a few wires must be connected here, it is best to use a 2/0 jumper from the load side of the shunt to a good negative bus. We recommend that no more than two, or at a maximum three, connections per large bolt be made on the negative bus side of the shunt. The negative bus should be a solid copper or brass bar with many threaded screws under which the negatives for all of the loads may be secured. It should be fed with a conductor of sufficient size so that there is no appreciable voltage drop even under full load.

7) We are frequently asked about battery isolators. We don't recommend them. The reason is that battery isolators have a noticeable voltage drop across them which may be greater than 0.5V. In most instances, a better solution is to use a battery combiner which keeps a starting battery charged without a voltage drop.

8) Second (Starting) Battery Voltage Sensing is an option on your ***Link 1000***. As supplied from the factory, the optional voltage sense circuit is Off. If you connect the positive terminal (+) of your starting battery to Pin #6 of the meter (through a 2 Amp fuse!), you can read the voltage of the starting battery. Remember if you choose to look at starting battery voltage that it is only an *indication* of the battery's state of charge if the battery has been at rest for at least 8 hours. This function is included as a convenience only. A battery with an 8 hour at rest voltage of 12.4 Volts or more will likely start an engine. A battery reporting 11.1 Volts after 8 hours will likely ***not*** start your engine, particularly if you have dirty injectors and the engine doesn't fire up right away!

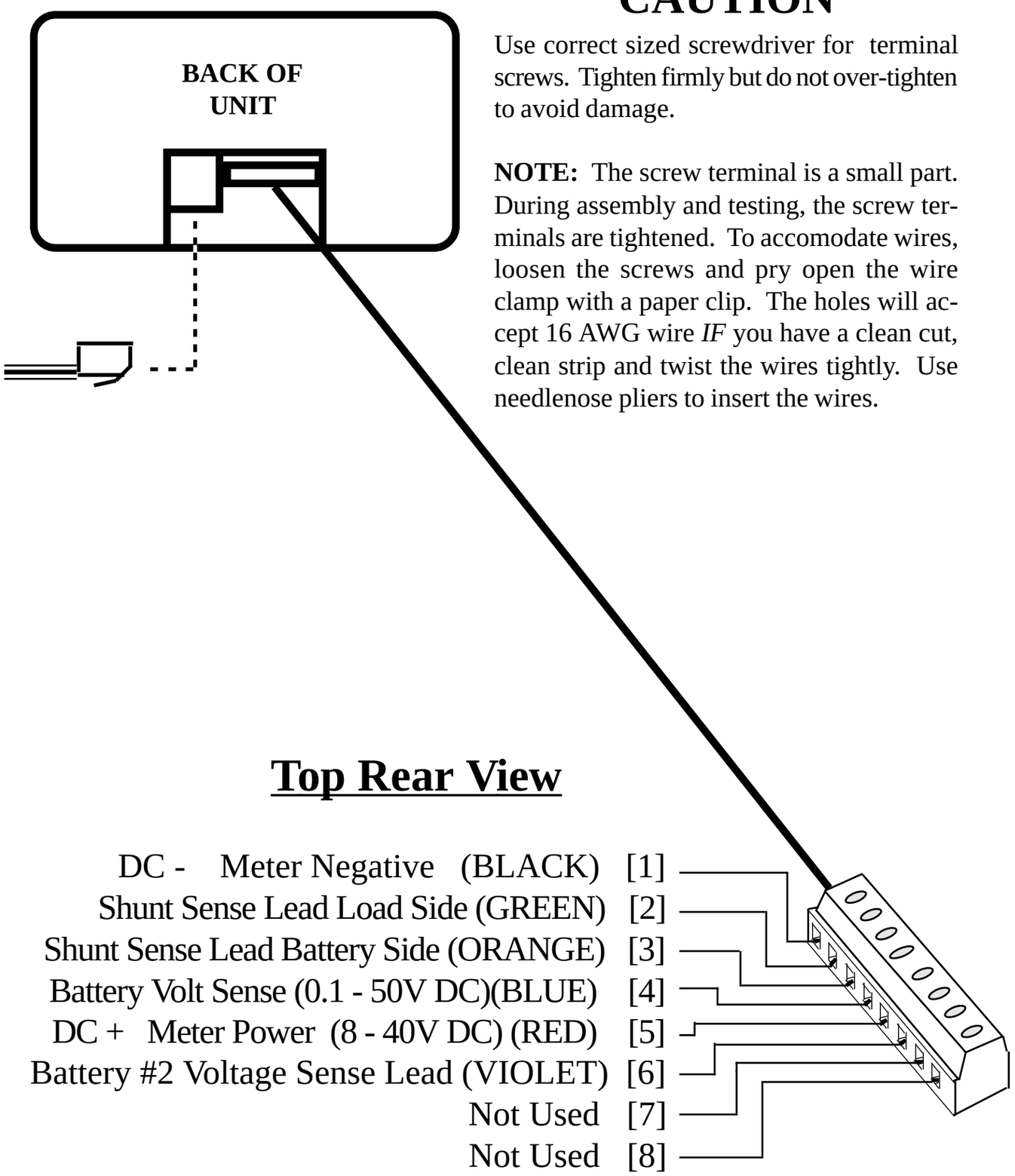
WIRE BY WIRE DETAIL
BATTERY COMPARTMENT

The shunt is the current sensor for the ***Link 1000***. Its 500A 50mV rating means that when 500 Amps flows through it there is 50mV generated across it. The millivolt signal is translated into an Amps display in the meter. For example: A 50A load would generate 5mV across the shunt and would be displayed as -50 Amps. **Caution:** In the diagram below, the **darker wires** represent primary wiring and should be able to carry full battery load current. Size appropriately!



WIRING CONNECTIONS TO THE *Link 1000*

Make the necessary wire connections to the ***Link 1000*** as shown in the following diagram:



CAUTION

Use correct sized screwdriver for terminal screws. Tighten firmly but do not over-tighten to avoid damage.

NOTE: The screw terminal is a small part. During assembly and testing, the screw terminals are tightened. To accomodate wires, loosen the screws and pry open the wire clamp with a paper clip. The holes will accept 16 AWG wire *IF* you have a clean cut, clean strip and twist the wires tightly. Use needlenose pliers to insert the wires.

WIRE BY WIRE CHECK

Most failures and problems are due to wiring errors. Please double check the wiring. (Color code shown is for Heart Interface cable)

#1 - DC Power (Black Wire). Start at terminal #1 of the ***Link 1000*** and follow it to the big bolt on the Load side of the shunt. **Do not connect this wire to the small screw terminal with the Green shunt sense lead.**

#2 Shunt Sense Lead Load Side (Green Wire). This wire connects to the small screw on the Load ("house") side of the shunt. **This wire must be a twisted pair** with the Orange wire described below. To check this wire start at ***Link 1000*** terminal #2 and follow it to the small screw on the Load side of the shunt. **There should be no other wires connected to this screw.**

Note: Now is a good time to check the primary wiring from the shunt to the battery. There should be only one heavy cable from the Battery side of the shunt to the battery. All loads and sources must be connected on the other side of the shunt. ***Only the shunt may be connected directly to battery negative!***

#3 Battery Side of Shunt (Orange Wire). **This wire must be a twisted pair** with the Green wire described above. To check this wire start at terminal #3 and follow it to the small screw on the Battery side of the shunt. **There should be no other wires connected to this screw.**

#4 Voltage Sense Wire (Bat.+) (Blue Wire). From terminal #4 this wire should run to a 2 amp fuse holder, located within 7" of the battery. The other side of the fuse holder should go to the positive (+) battery post. Don't install fuse yet.

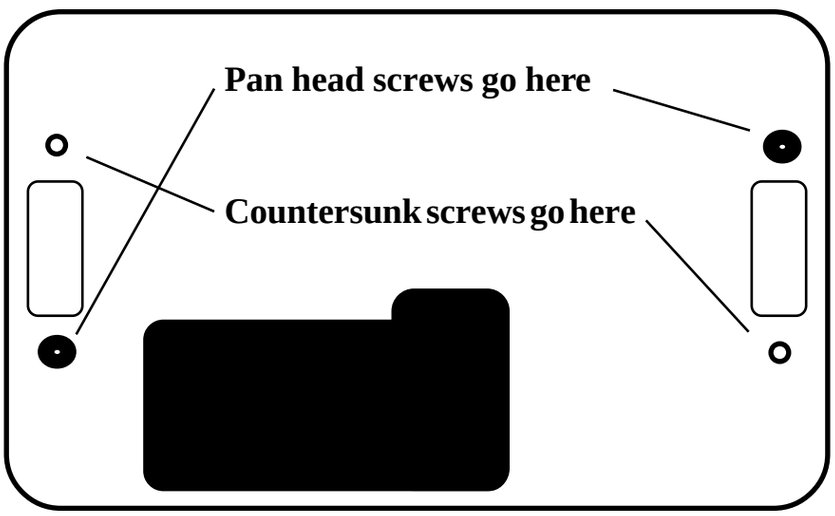
#5 *Link 1000* Meter Power (Bat.+) (Red). From terminal #5 this wire should run to a 2 Amp fuse holder, located within 7" of the battery. The other side of the fuse holder should go to the positive (+) battery post. This is a separate wire from #4 above (although they go to the same place) because we do not want even the small voltage drop from meter power to effect the ***Link 1000*** voltage sense measurement. Don't install fuse yet.

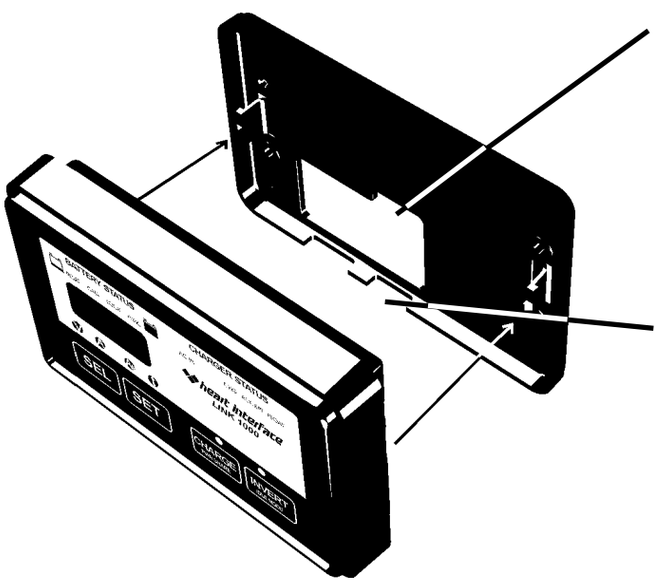
#6 Second Battery Voltage Sense (Bat#2+) (Violet). From terminal #6 this wire should run to a 2 amp fuse holder, located within 7" of the second (starting) battery. The other side of the fuse holder should go to the positive (+) battery post of the second battery. Don't install fuse yet. Remember, if using this function, it must be enabled with Function F11 - See Page 23.

MOUNTING

Surface mounting (Recommended method) . Your ***Link 1000*** is supplied with a nesting type mounting place which allows suface mounting using our exclusive *Thin-Mount* technology.

Looking at nesting plate as it mounts on wall



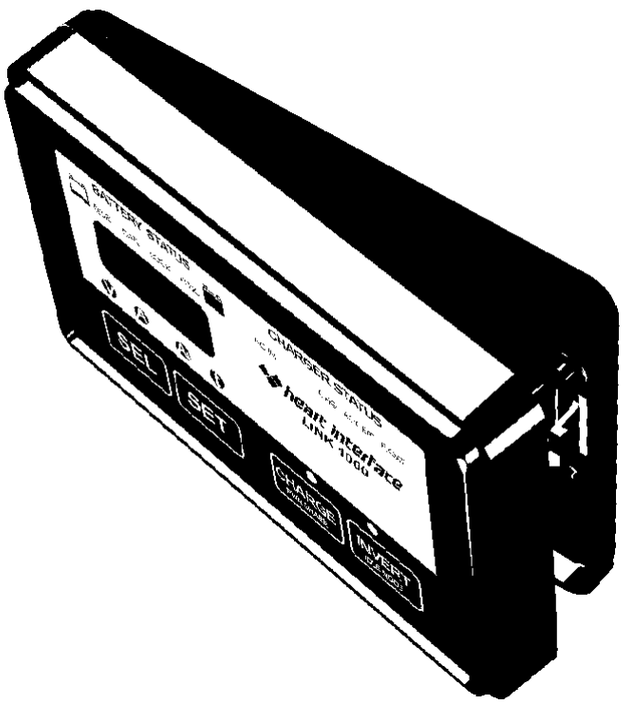


The phone cord to the ***Freedom*** inverter and the wires to the battery compartment may be led out the back of the nesting recepticle...

...or they may be led down from the bottom of the nesting recepticle. No matter which routing you choose, be sure to use strain relief on both wires.

REMOVING THE UNIT

Demounting the Link 1000 from the nesting recepticle is a simple matter of inserting a small coin, knife blade, or small screwdriver blade and pressing inward while gently pulling the meter way from the nest.



Press in on this tab with a thin metal coin while pulling one side of the unit away from the nesting recepticle.

STARTUP

Once you have completed ALL instructions on Page 41, insert the voltage sense wire fuse (Blue Wire to fuse holder on battery #1).

Next, inset the voltage sense wire fuse to your starting battery (Violet Wire to fuse holder on battery #2).

LAST, install the meter power fuse. (BLUE [*and optional VIOLET*] wire fuse[*s*] first, RED wire fuse **LAST!**) The fuse should be in a fuse holder and should be connected in a smooth motion. A "ragged" power up may cause a meter lock up. Both the light bar and digital display should come on.

Next, plug in the phone cable that allows the ***LINK 1000*** to "talk" to the ***Freedom*** inverter/charger. Note that the AC status light should now come on if there's AC power to the ***Freedom***.

FACTORY DEFAULT SETTINGS

The ***LINK 1000*** comes on in the Ⓥ (Volts) mode with the display flashing to indicate that it has been powered up from the de-powered state (**E10**). Left untouched for 10 minutes, the ***LINK 1000*** will go to "sleep", turning off the numeric display leaving only the light bar on. This is a power saving feature. Touching any button **(SEL**, **SET, CHARGE,** or **INVERT)** will clear the **E10** message and return the ***LINK 1000*** to the function it was in when it went to "sleep".

The ***LINK 1000*** is designed to work "out of the box". The factory default values are appropriate for a moderate capacity 12V liquid lead acid battery and a typical user display and function setup. **Often, the only change that must be made is setting the battery capacity.** You may also want to set the appropriate Peukert's exponent for your battery.

LINK 1000 factory default settings are:

1. **Battery capacity set to 200 Amp-hours.**
2. **Time Remaining is set to a 4 minute average.**
3. **Battery Type = 0 (liquid cells)**
4. **Automatic Scanning of V, A, Ahrs, and Time is OFF.**
5. **Sleep Mode is ON. This turns the digital display off after 10 min.**
6. **Charge Efficiency Factor (CEF) equals 95% and learn CEF mode is on.**
7. **Charged Parameters: Voltage =13.2, Charged Current =2%. The battery must exceed 13.2V and the current must be less, in Amps, than 2% of declared capacity for 5 minutes for Your Meter to consider the battery full.**
8. **Peukert Exponent = 1.25.**
9. **Second Battery Voltage Sense is OFF.**
10. **Temperature Coefficient is 0.5.**
11. **Active Temperature Compensation is OFF.**