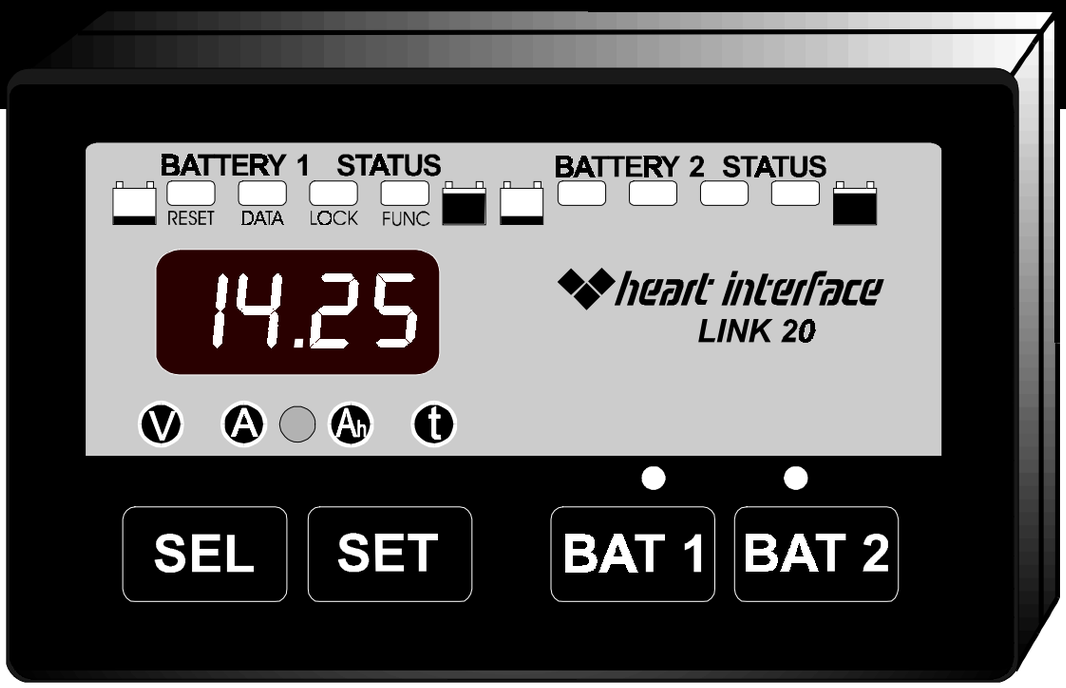
Manual Part # 890028

OWNER'S MANUAL
LINK 20



INSTALLERS: PLEASE LEAVE THIS MANUAL WITH THE OWNER. IT CONTAINS IMPORTANT OPERATING INFORMATION.

APPLICATIONS: The ***Link 20*** provides instrumentation of two banks of batteries. The ***Link 20*** does not control an inverter/charger. For installations involving a ***Freedom*** inverter/charger and two battery banks, the ***Link 2000*** is recommended. If a Freedom inverter/charger and *one* battery is anticipated, the ***Link 1000*** is recommended. For instrumentation of a single battery bank with no inverter/charger controls, the ***Link 10*** is ideal.

OPERATION: Instructions on how to operate your ***Link 20*** begin on page 4 of this manual.

INSTALLATION: This manual contains easy to follow installation instructions beginning on page 32.

WARRANTY ISSUES: Warranty issues will be resolved directly through Heart Interface. Please do not route warranty issues through your dealer.

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LINK 20 SPECIFICATIONS

Power Supply Voltage	8-40 Volts DC (Do not power with 32V System!)
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 to 19.95V (0.05V resolution) 20.0 to 50.0V (0.1V resolution)
Voltage Accuracy	± (0.6% of reading + 1 least count of resolution)
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	± (0.8% of reading + 1 least count of resolution)
Current Shunt	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)

LINK 20 INTRODUCTION

Congratulations! You have purchased the world's only ***Dual Watch***™ battery monitor. In order to understand, use, and install it, PLEASE read this manual!! It provides important information. Please contact us with suggested improvements. For ***Link 20*** installation, operation, warranty support, and repair questions please contact Heart Interface.

☞ 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 20***. Failure to read and follow these special notes can lead to damage to the ***Link 20*** or other electrical equipment.

POWER CONNECTION WARNINGS

1. When installing your ***Link 20***, make all shunt and ground connections **BEFORE** applying power to the unit.

2. The wires connecting the battery to the dual shunt, and from the dual shunt to your system ground, will carry large current. Size the wire appropriately. Large batterry banks contain enough energy to start a fire if improperly sized wire is used.

3. Disconnect all charging sources during the installation process.

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. Many batteries designed for deep cycling service are rated at their ***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 will not maintain 10.5 Volts under load is considered "dead" - it's completely discharged.

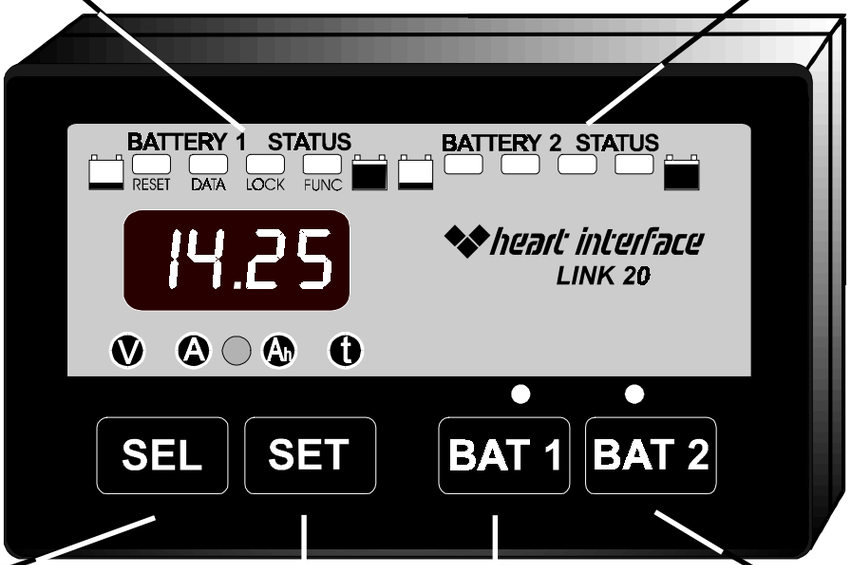
3. Our ***Mid-Capacity Rule*** says discharging more than 50% of a battery's capacity shortens life. Charging more than 85% takes too long with an engine driven charging system. So, 35% of the battery capacity is all that is normally available. If you regularly need 100 Amp-hours of energy, your battery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

FRONT PANEL OF YOUR *LINK 20*

The exclusive ***Dual Watch***™ light bars give you battery state-of-charge information at a glance. It's easy to train your whole crew, even the kids, to turn off loads and start charging when the light bar shows two yellow lights. When the light bar is green, you've got plenty of energy. With one flashing red light, you'd better charge or start hunting for jumper cables!

This light bar shows Battery 1

This light bar shows Battery 2



SEL selects the units being displayed: Volts, Amps, Amp-hours, Time of Operation Remaining.

When BAT 2 is pressed, the display numbers are for battery 2.

SET picks from among choices. You'll SET a battery size from a list of choices when you first install your Link 20.

When BAT 1 is pressed, it means the numbers displayed are for battery 1. The light above each button reminds you which battery you're looking at.

USING YOUR *LINK 20*

STATUS LIGHTS

These green lights tell you what units are 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 20 hour rated battery is 100% discharged when it reachs 10.5Volts with a 20 hr. rated load applied. Typical charging voltages may range from 12.9 to 14.9 Volts.

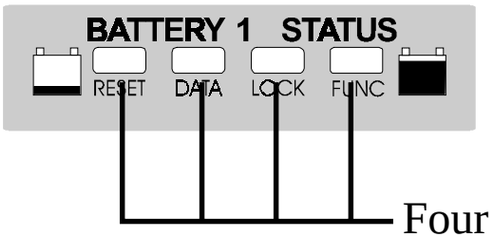
Amps is the present *flow* of current into (or out of) the battery. For example, a refrigerator may draw 6 Amps of current. This is displayed as -6.0 (6 Amps are being *consumed from the battery*). Discharge is shown as a negative number. Charging is shown as a positive (unsigned) number.

Amp-hours (A hrs) consumed represents the *amount of energy removed from* the battery. When a 10 Amp load is on for one hour, 10 Amp-hours are consumed. If you started this discharge with a full battery, your ***Link 20*** will show -10 in the Ah display. During charging the ***Link 20*** compensates for charging inefficiency and counts back up toward 0.

Time is an ***estimate*** of how many hours the battery will sustain a load before it reaches a settable discharge floor. The estimate may be based on the instantaneous load or averaged. Four minute load averaging is the default. During charging the **Time** display reads CCC, indicating the battery is charging. When charging, Amps is a positive number).

☞ For the **TIME** function to operate correctly, you must correctly enter your battery capacity, type, and check that an appropriate Peukert Exponent has been selected through the **SET UP** routines.

READING THE LIGHT BARS

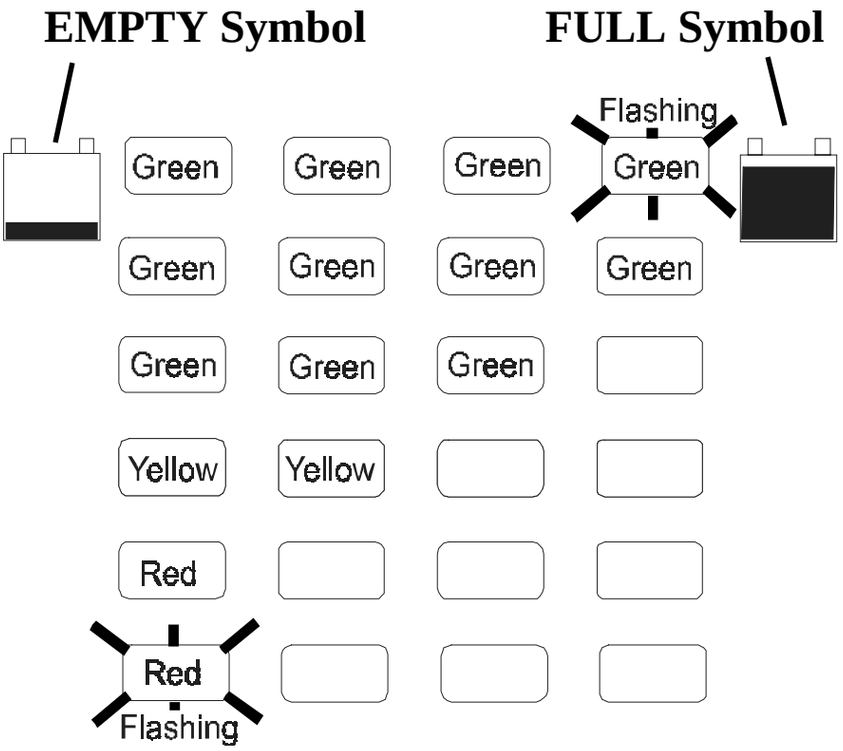


Above the ***Link 20*** numeric display are two light bars, each with four lights. They show you battery state-of-charge at a glance.

Four green lights means your battery is nearly full (80-100% charged).

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

Light bar scaling is independently settable. As the ***Link 20*** 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 set a discharge floor other than 100%, 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*
100% floor	50% floor

☞ The Light Bars operate on *rate corrected* Amp-hours. If you have heavily discharged a battery bank, the light bar may tell you to charge *before* you would normally make that decision based on the Amp-hour display. See High Discharge Rates, Page 26.

WE RECOMMEND: Charge your batteries when the Light Bars tell you to!

LINK 20 BATTERY MANAGEMENT

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

The ***Link 20*** is a guide to the battery's state of charge. Our ***Mid-Capacity Rule*** says you should begin charging when your ***Link 20*** 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 genset, 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 20*** 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 alternator or generator supplied battery charger you do not need to charge until the meter counts back up to 0 Amp-hours consumed. You may end charging even though the final 15% of battery capacity has not been restored. Later, when you are able to charge for a long period of time, the remaining Amp-hours consumed will be replaced.

Periodic conditioning or ***Equalizing*** removes any negative Amp-hours that are not replaced during normal charging.

OVERCHARGE AMP-HOURS

If the batteries are 100% charged, and the ***Link 20*** is in sync, 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 about 0.1 Amp flowing into it. This means you would expect about 2.4 A hrs of overcharge to accumulate each 24 hours. If your battery system is larger, proportionately more current flows and A hrs accumulate.

With a constant voltage charging system set at 14.2 volts, as much as 1 Amp of current may be flowing all the time *even after* the battery has reached the charged parameters. This causes a small overcharge A hr reading to appear in the Ah display. When discharging begins, these overcharge A hrs are erased and the ***Link 20*** resets to zero and begins to report Amp-hours consumed.

Prolonged high voltage applied to a fully charged battery will probably cause gassing. So, if you see a large A hr overcharge occuring daily, consider it a warning to check your system. It could indicate that you are destroying your battery by overcharging.

When you Equalize your batteries, you will accumulate some overcharge A hrs. *This is normal* and keeps the ***Link 20*** synchronized with the battery state of charge.

BATTERY CAPACITY TESTING

Your ***Link 20*** 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.

Many times, deep cycle battery capacity is 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	84%
5	67%
3	56%
1	47%

To test battery capacity, reset Amp-hours to zero. Then turn on a load that draws approximately 5% of the expected battery capacity. Measure the current with Amps display. The load should be constant, such as incandescent lighting. Now put the ***Link 20*** 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 20***. 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 20*** would display -50 A hr. This is the 10 hour capacity. Dividing 50 by 84% (10 hour rate) from the table above, you determine that the actual 20 hour capacity is about 60 Amp-hours. You could repeat the test at 5% of the tested capacity (3A) to verify the actual capacity.

USING YOUR INVERTER TO TEST BATTERY CAPACITY

Your inverter might be the type which makes testing battery capacity easy. First, fully charge (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. Many inverters will shut down on low voltage below about 10.2V. When the inverter shuts down, 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.**

SYNCHRONIZING TO YOUR BATTERY

A charged battery has zero A hrs removed. Synchronizing your ***Link 20*** 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 20***:

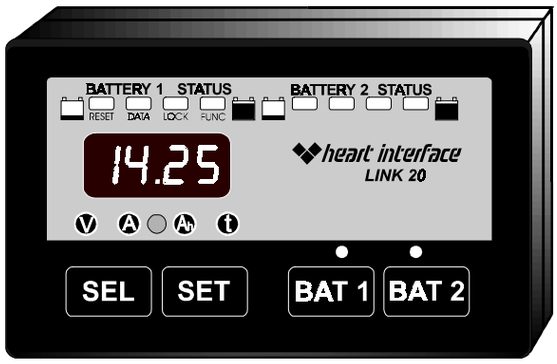
1) Install the ***Link 20*** on a fully charged battery and it will be in sync.

2) If the ***Link 20*** is installed on a partially charged battery, simply charge until the charged parameters are met. The ***Dual Watch*** light bars show this by flashing the right green lights. The ***Link 20*** 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 20*** resets Amp-hours to zero, starts counting down, and is in sync.

If the ***Link 20*** should ever get out of sync with the battery state of charge it must be resynchronized. The best way is to be sure the battery is discharged at least 10% of the declared battery capacity and then recharge until the charged parameters are met. When the next discharge cycle begins, the Amp-hour display should reset to zero.

Remember: Periodic controlled extra charging insures that the ***Link 20*** remains in sync with the battery's state-of-charge**.**

SETUP PROCEDURES



Your ***Link 20*** comes with default values chosen to work with most systems. Normally the only values that need to be changed are: The battery capacity, battery type (liquid or gelled), and high discharge rate compensation (Peukert) exponent. Please be sure you understand each function before changing the factory default values outlined below.

Holding the **SET** button 5 seconds accesses the *Set Up* and *Advanced Functions*. The display will read **SEL**. 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 averaging period for Time Remaining. Corresponding status lights come on for each.

If you continue pressing **SEL**, you will step through *functions* named in small text below each of the lights on the Battery 1 Light Bar. Some *functions* have multiple displays. These are described in later pages devoted to **RESET**, **DATA**, and **LOCK***ing* of your meter. The next (right) battery status light indicates you've entered the *Advanced* **FUNC***tions* area *(see Page 17).*

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, the display begins 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

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	= #1 (Liquid cells)
Peukert Exponent	= 1.25

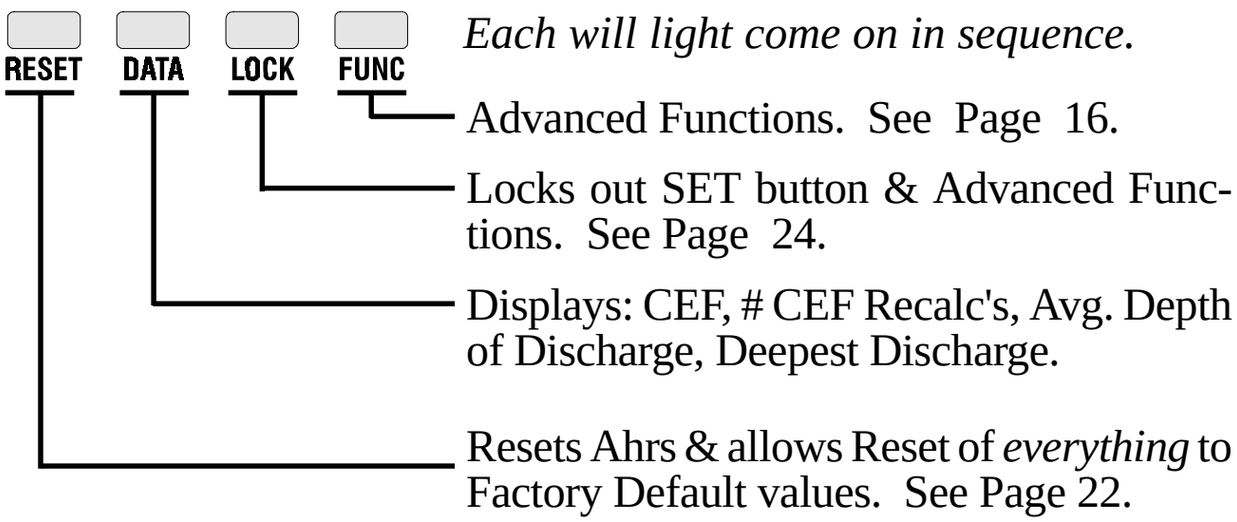
USING SET AND SEL BUTTONS

Pressing and holding the **SET** button for 5 seconds enters the **Set Up** and Advanced Functions modes. The word SEL appears in the display, prompting you to press the **SEL** button to choose what function you want to **SEL**ect.

PRESS **BAT 1** *OR* **BAT 2** *TO PICK THE BATTERY YOU WISH TO SET UP.*

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** (Battery must be above this Voltage to be considered "full".)
Ⓐ	**Charged Current %** (Charging current in Amps must remain below this percentage of battery capacity to be considered full.)
Ⓐh	**Battery Capacity** in Amp-hours
ⓣ	Time interval over which current is averaged for ***Time Remaining*** function.



☞ **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 20*** 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 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.

Based on extensive studies, we have selected a default Charged Voltage of 13.2 volts 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 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 24V**, you *must* set up an appropriate Charged Voltage.

☞ If the charged parameters are not set correctly, the ***Link 20*** will 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. For example, below 45F or above 90F.

HOW TO SET Ⓥ

Your ***Link 20*** automatically selects an appropriate Charged Voltage for 12 Volt liquid and gel cells when you set Battery Type. (We'll cover setting Battery Type on page 20). If you operate a 24 Volt system, or if extremes of temperature are involved, 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* 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 Ⓐ

The ***Link 20*** is factory set to use 2% of battery capacity as 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 20***, it assumes you have two banks of 200 Amp-hours battery capacity each. 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. Press **SEL** three times. — The Ⓐh light will come on and 200 will appear in the numeric display.
3. Press and hold **SET**. — 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 20*** can approximate 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 20*** 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:	*001*
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.

INTRODUCTION TO RATE COMPENSATION AND THE PEUKERT EXPONENT

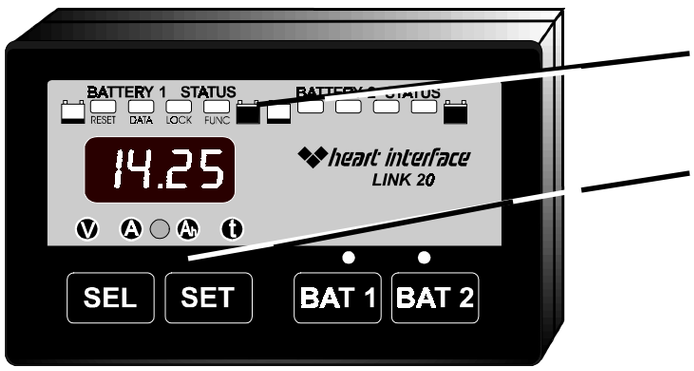
Your ***Link 20*** shows true Amp-hours consumed in the numeric Amp-hour display. However, the light bar above it shows how much *of the available* battery capacity has been consumed. You may experience times when the light bar shows more than 60% of capacity consumed, yet according to the numeric display less than half of the battery capacity has been consumed. How can this be?

In 1897 a scientist named Peukert demonstrated that as you discharge a battery more quickly, it's *effective size temporarily decreases*. A battery is considered fully discharged when it is no longer able to maintain 10.5 Volts under load. As you'll see in the following table showing the effect on a typical liquid cell battery, the faster the discharge rate, the smaller it's effective capacity:

Hours to Discharge	Capacity as percent of 20 hr rating
20	100%
10	84%
5	67%
2	56%
1	47%

In other words, a 100 Amp-hour battery, discharged completely in one hour will only supply 47 useful Amp-hours!

HOW TO SET UP FUNCTIONS



When the **FUNC** light is on, you can access Advanced Functions of the ***Link 20***. 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 *F01* will appear in the display. Your 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 5 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 5 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.

Scanning applies only to the battery selected with the BAT button.

F02 - DISPLAY SLEEP

DEFAULT: ON RANGE: ON, OFF

Turns off all lights on the front panel except for the light bars after 10 minutes of no front panel key presses. Touching any button "wakes up" all displays.

F03 - SET AMBIENT BATTERY TEMPERATURE

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

The ***Link 20*** default ambient temperature setting is 70^0F. The ambient temperature may be set in 10^0F increments. The set up procedure is the same as previously described.

The ambient temperature setting adjusts effective battery capacity lower when colder and larger when warmer. Adjust the temperature to best reflect the battery temperature during discharge. High temperatures are destructive to batteries. If your batteries are regularly subjected to temperatures above 100^0F you should relocate them or supply forced fresh air ventilation.

IMPORTANT!

Your Link 20 incorporates a precision volt meter. This may be used to check that your charging sources are set to the correct Accept and Float voltage values for your battery temperature. Refer to the following table.
If your batteries are operating significantly (0.3 Volt) different from the values below, you are likely undercharging or overcharging. This will result in degraded performance of your system and shortened battery life.

TEMPERATURE COMPENSATION TABLE

		TYPE #1=WET		TYPE #2=GELLED		
TEMP ^{0}F	^{0}C	ACCEPT	FLOAT	ACCEPT	FLOAT	
120	49	13.4	12.5	13.9	13.3	
110	43	13.6	12.7	14.0	13.4	Caution above this temp.
100	38	13.8	12.9	14.1	13.5	
90	32	14.0	13.1	14.2	13.6	
80	27	14.2	13.3	14.3	13.7	
70	21	14.4	13.5	14.4	13.8	**<"Average" settings**
60	16	14.6	13.7	14.5	13.9	
50	10	14.8	13.9	14.6	14.0	
40	5	15.0	14.1	14.7	14.1	Caution below this temp.
30	-1	15.2	14.3	14.8	14.2	

F04 - DISPLAY A HRS OR KWHRS

DEFAULT OFF = A HR DISPLAY MODE

ON = KWHR DISPLAY MODE

When this function is selected the **A hr** display shows kilowatt hours. Kilowatt hours are used internally by the ***Link 20*** to determine if 100% of the energy consumed from a battery returned during charging. 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 as a negative number. During charging it counts back up with 100% efficiency. *CEF* recalculation is prevented until the kWhr counter is a positive number. This prevents premature *CEF* recalculation and Ahr reset. Kilowatt hours is a very precise measurement of energy removed from or returned to your battery banks.

F05 - ALTERNATIVE ENERGY MODE

DEFAULT: OFF

ON: BATTERY/SOURCE MONITORING MODE

This function selects between the normal two battery monitoring mode and the battery/source monitoring mode. When this mode is OFF, the meter works as a two battery monitor as described elsewhere in this manual.

SOURCE MONITORING: When this mode is ON, the BAT 1 position works normally, showing energy flowing into (or out of) Battery #1. The BAT 2 Volt and Amps displays report the charging source voltage and current. The BAT 2 Ah display reports cumulative A hrs from one (or more) charging source(s). The BAT 2 A hr display will count up to 1999 and then roll over to 0 and continue to count up. This is the total number of A hrs supplied since the meter was powered up (or RESET). You may also use the kilowatt hours display (see previous function, F04). The BAT 2 Time display will read CCC. The BAT 2 *CEF* is set to 100% and is displayed as 100.

CHARGED PARAMETERS: Also, when this mode is ON, the time necessary to meet the Charged Parameters is reduced from 5 minutes to 1 minute. This is useful if your alternative energy installation uses solar panels and you have clouds periodically obscuring the array causing your charging to be intermittent. It's also useful if you're using an ON/OFF (high-low voltage set point window) controller. If you're using this type of controller, you may wish to increase *Charged Current %* to 3 or 4% of Battery Capacity.

(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 1). When F10 is set to gelled electrolyte batteries (F10 set to Type 2), a default exponent of 1.11 is used.

F09 - LOW BATTERY DISCHARGE FLOOR

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

Your ***Link 20*** allows you to declare the discharge floor used for meter calculations. An independent discharge floor may be selected for each battery bank. The display floor will be applied to the battery bank selected (BAT 1 or BAT2) at time this function is invoked. As supplied by the factory, the discharge floor is 100% of Amp-hour capacity, corrected for high discharge rates. With the discharge floor to 100%, the **TIME** remaining display essentially reports **TIME** to "dead battery". If you change the discharge floor to 50%, you would essentially see the **TIME** "till the battery is 50% discharged. This is when charging should begin 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

DEFAULT = 1 **RANGE:** **1 = WET (LIQUID) ELECTROLYTE**
2 = GELLED ELECTROLYTE

This function declares your choice of liquid or gelled electrolyte batteries. Battery Type is applied to both battery banks. We strongly recommend against designing systems using both liquid and gel cells as their charging requirements are quite different.
The default value is Type #1, a liquid electrolyte lead acid battery. To select Type #2, (gelled electrolyte lead acid batteries) set TYPE to 2. Changing the battery type sets an approximately appropriate Peukert rate compensation exponent (1.25 for liquid cells and 1.11 for gel cells). When type 1 is selected, a Charged Voltage of 13.2 (or 26.4V) is selected, while Type 2 sets a default Charged Voltage of 13.5 (or 27V). You may wish to select a different Charged Voltage. See Temperature Compensation Table on Page 17.

F11 - Not Used

F12 - Not Used

F13 - Not Used

F14 - DISPLAY TEST

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

This function confirms proper operation of the ***Link 20*** 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 20***.

F15 - DISPLAY SOFTWARE REVISION NUMBER

Function F15 selects display of the software revision number. This number is used internally with Heart Interface to keep track of which version of software is installed in your ***Link 20***. This number should be written down in the Set Up table contained in this manual for your future reference.

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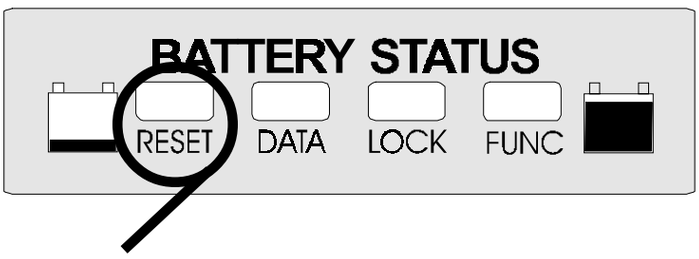
HOW TO RESET YOUR UNIT



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:

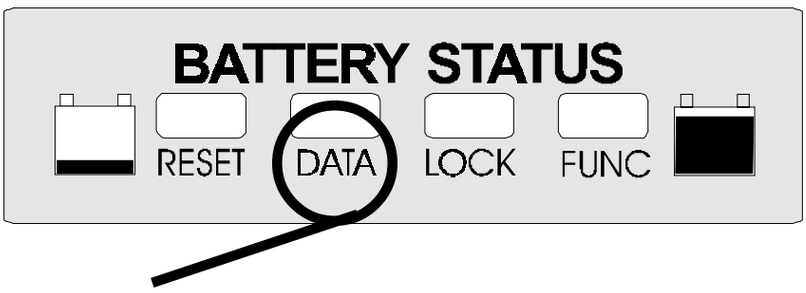
Before you begin, select the battery you wish to reset. To reset both batteries, you'll need to go through the reset procedure twice, once for each battery.

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 reset *ALL* settings to the factory defaults.
5) If you hold **SET** 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 history you have accumulated. This reset function would be the one to use when you install a new set of batteries, for example.

DATA: YOUR BATTERY HISTORY



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

To access the DATA displays:

Before you begin, select the battery whose data you wish to see!

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) ***Charging Efficiency Factor*** is the first number displayed.
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:

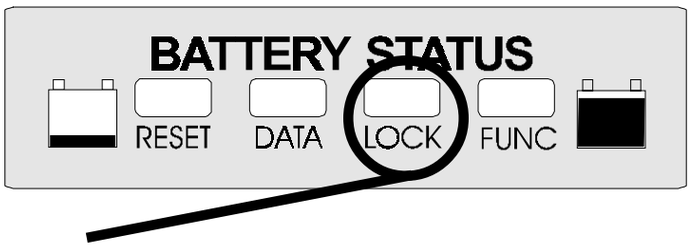
CEF **(Displayed as *E99*):** The Charging Efficiency Factor (CEF) is the rate at which Amp-hours are counted back up during charging. The Amp-hour CEF, not kilowatt-hour CEF, is displayed. A display of *E99* indicates a 99% CEF based on Amp-hours. The Default setting is 95%. **NOTE:** If the CEF display 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 since **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 20*** 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**. The word *ON* or *OFF* will appear in the numeric display.
5) Press **SET** again to change **LOCK** status.

SETTING PEUKERT EXPONENT

When you select Battery Type (See Function F02 on Page 20), your ***Link 20*** 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:

Before you begin, select the Battery you wish to apply the new exponent to: BAT 1 or BAT 2.

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. Press **SEL** again and note that the Ⓐ light comes on. Continue to press the **SEL** button until F08 appears 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 (liquid cells), the default value of 1.25 (or the previously programmed value) will appear in the display. If Battery Type #2 (gel cells) 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 20*** 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 and examples on the following pages illustrate this effect and how to use the table to estimate the exponent "*n*". The tables on pages 27 & 28 have typical values of "*n*" for common batteries.

The ***Link 20*** uses Peukert's equation in calculations to forecast the Time Remaining and run the light bars. 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 (to get $\mathbf{I}_{1[\text{current}]}$ and $\boldsymbol{t}_{1[\text{time}]}$) and one at a low rate (to get $\mathbf{I}_{2[\text{current}]}$ and $\boldsymbol{t}_{2[\text{time}]}$), that bracket your normal range of operation, allows you to calculate an "*n*" which will describe this varying effect. The ***Link 20*** uses a default value of *"n"* equal to 1.25 which is typical for many batteries.

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. See the example given on Page 29. After you solve for your Peukert's exponent you may enter it using Advanced Function F08.

HIGH DISCHARGE RATES & PEUKERT'S EQUATION

The table below may be used to understand the effect of high rates of discharge on available battery capacity. It may also be used to estimate the exponent "*n*" for a battery after a single discharge test. The table is based on a 100 Ahr battery but may be used for any capacity battery by using an appropriately scaled current. See the examples below:

PERCENTAGE OF AVAILABLE CAPACITY FROM A 100 Ahr BATTERY AT DIFFERENT DISCHARGE RATES USING DIFFERENT PEUKERT'S EXPONENTS

EXPONENT n	DISCHARGE RATE IN AMPS 5	10	16.7	25	50	75	100	150	200	250	300	400	500
1	100	100	100	100	100	100	100	100	100	100	100	100	100
1.1	100	93	88	85	79	76	74	71	69	67	66	64	63
1.2	100	87	78	72	63	58	55	51	48	46	44	42	40
1.25	100	84	74	67	56	51	47	42	40	37	36	33	32
1.3	100	81	69	62	50	44	41	36	33	31	30	27	25
1.4	100	76	61	52	40	34	30	26	23	21	20	17	16
1.5	100	71	55	45	32	26	22	18	16	14	13	11	10

Example #1: Assume you have a 200 Ahr battery and discharge it at the 50 Amp rate until the battery reaches 1.75V per cell (10.5V for a 12V battery). This is equivalent to a discharge rate of 25A for a 100 Ahr battery. If the battery delivered 67% (134 Ahr) the appropriate Peukert's exponent would be 1.25.

Example #2: A 100 Ahr battery with a Peukert's exponent of 1.3 will deliver only 41% of its capacity when supplying a 100A load.

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	43	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	1.27
SCS225	12	225	130	1.27
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_1 = 225 Amp-hours/20 hours = 11.25 Amps

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

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	Bat. 1	Bat.2
BATTERY VOLTS$_{CHARGED}$	13.2 V	_____	_____
BATTERY AMPS$_{CHARGED}$	2%	_____	_____
BATTERY CAPACITY	200 A hrs	_____	_____

DATA	Bat. 1	Bat.2
CEF	_____	_____
# OF CEF RECALC'S	_____	_____
AVG DEPTH OF DISCHARGE	_____	_____
DEEPEST DEPTH OF DISCHARGE	_____	_____

FUNCTIONS		DEFAULT	Bat. 1	Bat.2
DISPLAY SCAN	(F01)	Off	_____	_____
DISPLAY SLEEP	(F02)	ON	_____	_____
AMBIENT TEMP.	(F03)	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 20*** 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	_____	_____
SOFTWARE REV.	(F15)	(Same for either battery)	_____	_____

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 18 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 authorization from CECO or Heart;
3. Ship the Meter, charges prepaid, with proof of purchase within 18 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 that UPS surface or surface US mail will be at the expense of the customer.

READ BEFORE WIRING !!!!!

Before wiring the *Link 20* , install the shunt as indicated.
All wiring should be done before installing the meter power fuse.

GENERAL NOTES

1) Wires used 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 must 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 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. Heart Part Number 84-2014-00 is a 25' cable while Part Number 84-2015-00 is a 50' cable.

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 are 4-5 twists per 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 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. 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. The Heart Interface heavy duty shunt is Part Number 84-2013-00.

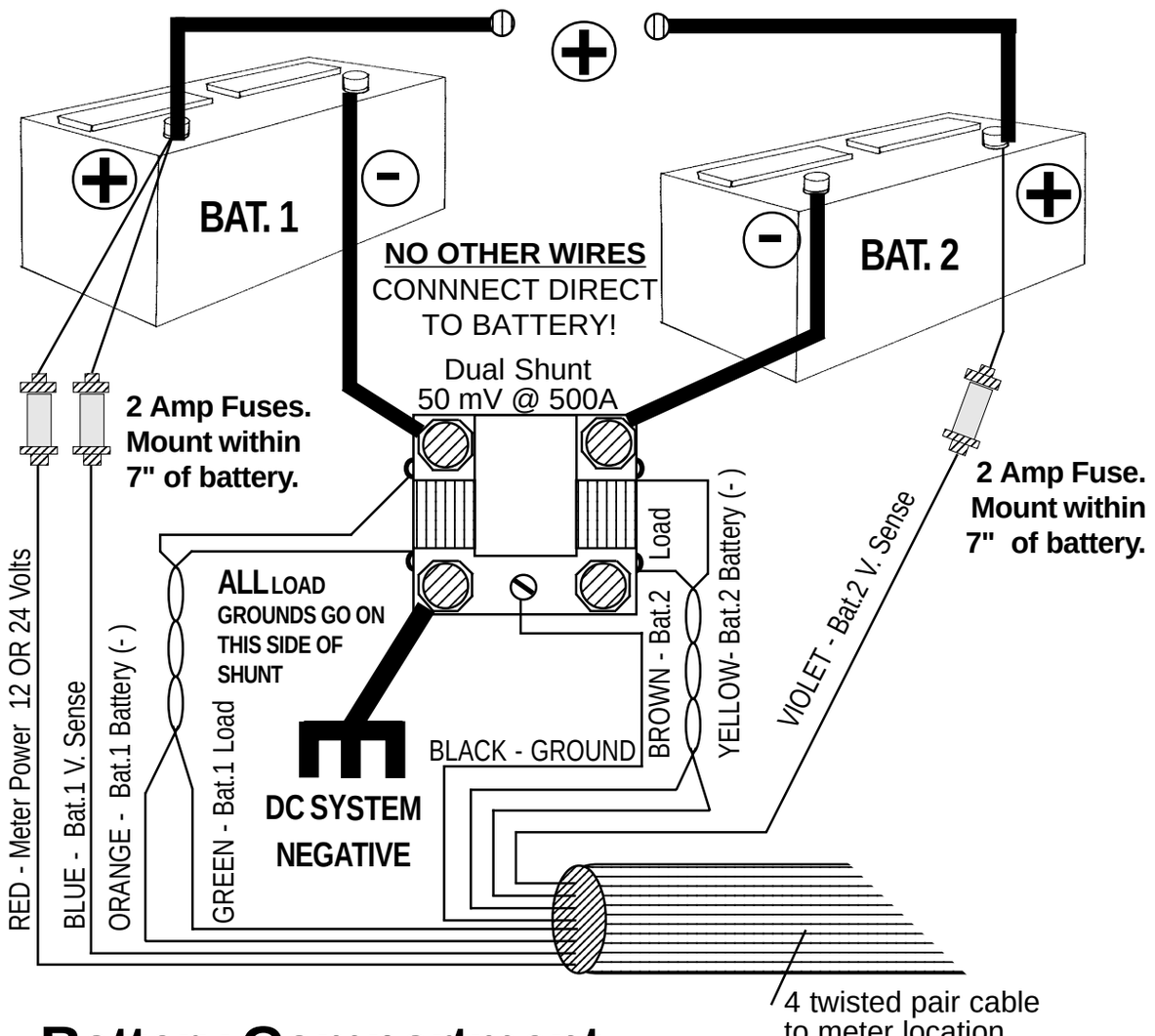
6) We have shown several wires connected to the load side of the battery shunt in the wiring diagram. If more than a few wires must be connected here, it is best to use a 2/0 jumper from the shunt to a good negative bus. We recommend that no more than two, or at a maximum three, connections per large 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.

WIRE BY WIRE DETAIL
BATTERY COMPARTMENT

The dual shunt is the current sensor for the ***Link 20***. Its 50mV @ 500A rating means that when 500 Amps flows through it, 50mV is generated across it. The millivolt signal is translated into an Amps display in the meter. For example: A 50A load generates 5mV across the shunt and would be displayed as *050* Amps. **Caution:** In the diagram below, the darker wires represent primary wiring and should be able to carry full battery load current. Size appropriately!

POSITIVE LEADS TO BATTERY SWITCH



Battery Compartment

ABOUT TWISTED WIRE:

We strongly urge you to use the 4 twisted pair cable available through your Heart Interface dealer in order to conform to the wire colors shown on this diagram. Using standard wire colors allows us to do a much better job of troubleshooting and will aid you should a problem develop 4, 5, even 10 years from today. If you are not able to obtain this wire, make sure the shunt sense lead pairs (Orange & Green, Yellow & Brown) are twisted 4-5 twists per inch. Twisted shunt wires minimize noise and insure reliable current readings.

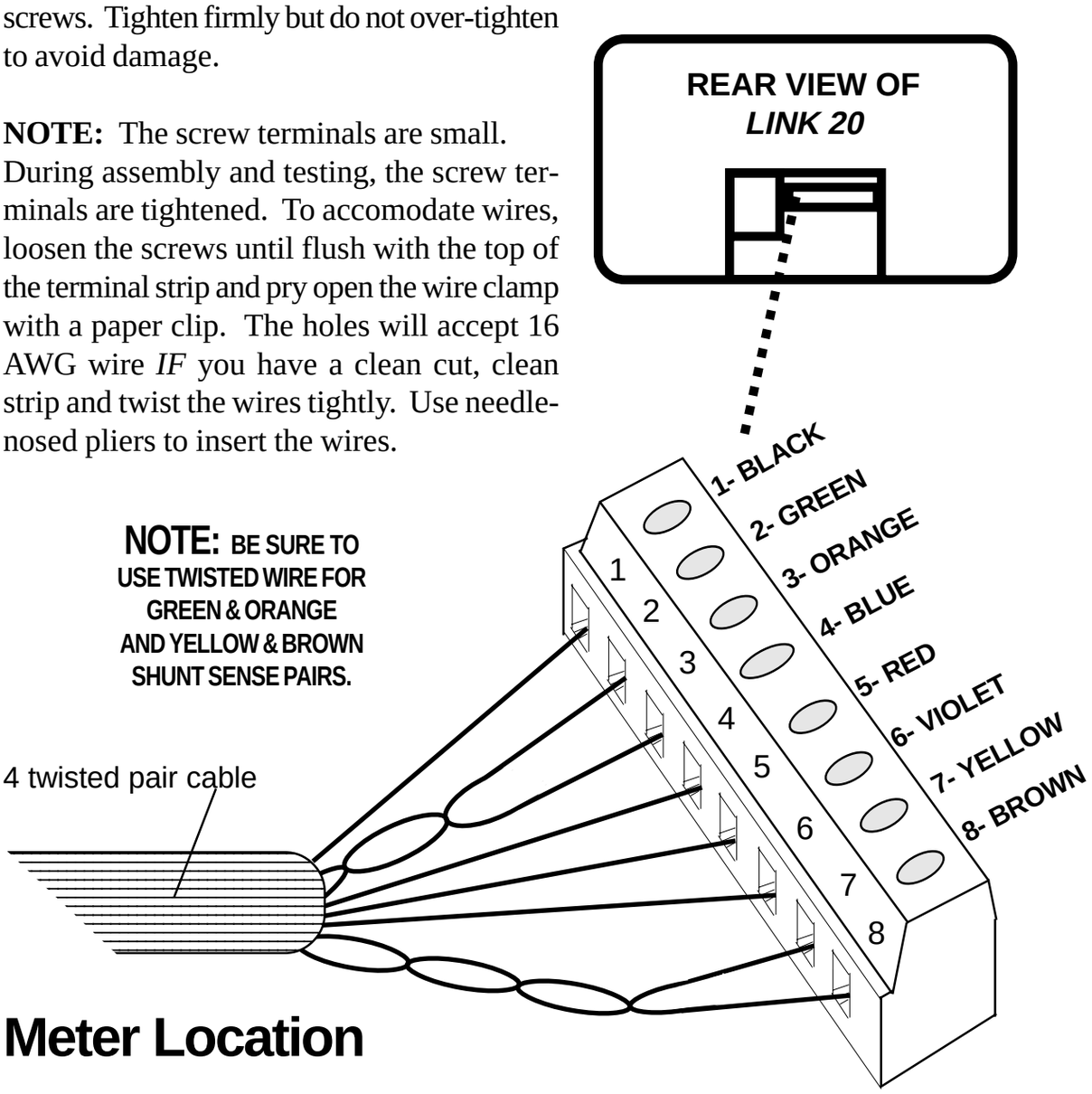
WIRING CONNECTIONS TO THE *Link 20*

Make the necessary wire connections to the ***Link 20*** 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 terminals are small. During assembly and testing, the screw terminals are tightened. To accomodate wires, loosen the screws until flush with the top of the terminal strip 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 needle-nosed pliers to insert the wires.



Meter Location

[1] DC - Meter Negative (BLACK)
[2] Bat. 1 Shunt Sense Load Side (GREEN)
[3] Bat. 1 Shunt Sense Battery Side (ORANGE)
[4] Bat. 1 Voltage Sense (0.1 - 50V DC)(BLUE)
[5] DC + Meter Power (9 - 40V DC) (RED)
[7] Bat. 2 Voltage Sense (0.1 - 50V DC) (VIOLET)
[6] Bat. 2 Shunt Sense Battery Side (YELLOW)
[8] Bat. 2 Shunt Sense Load Side (BROWN)

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 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 20*** 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.

 # 5 ***Link 20*** **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 20*** voltage sense measurement.

 # 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.

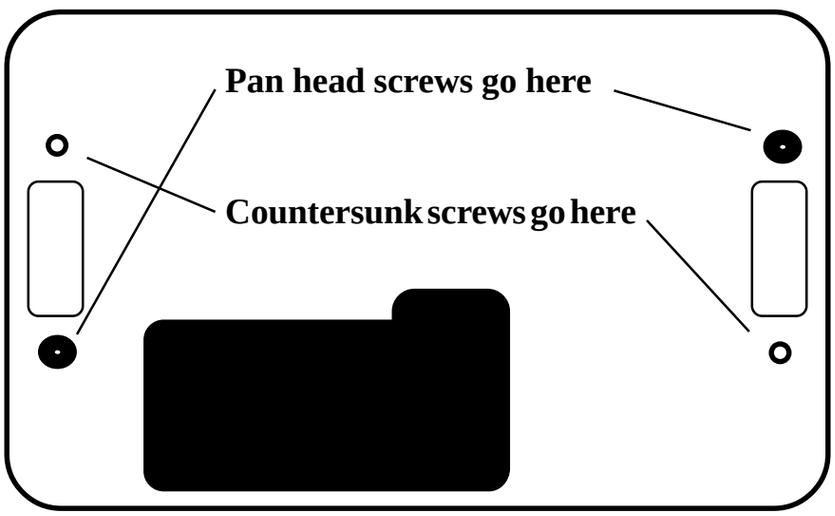
 # 7 **Battery 2 Shunt Sense Battery Side (Yellow)**. From terminal #7 this twisted wire runs to the Battery 2 side of the dual shunt.

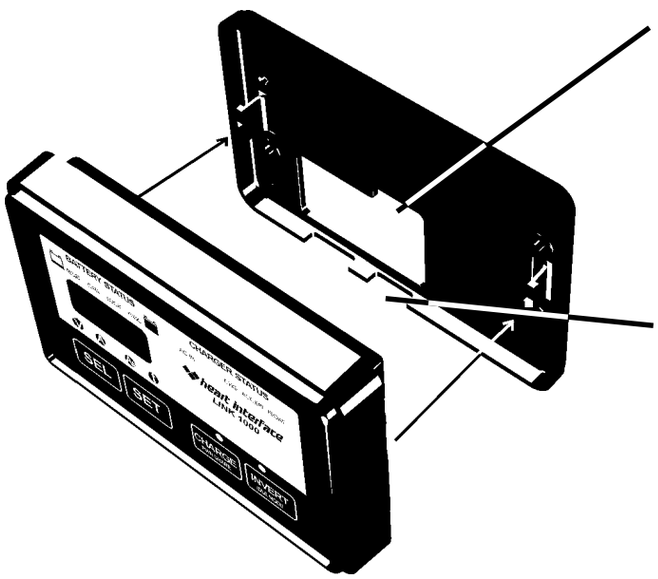
 # 8 **Battery 2 Shunt Sense Load Side (Brown)** From terminal #8 this wire should run the load side of Battery 2.

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



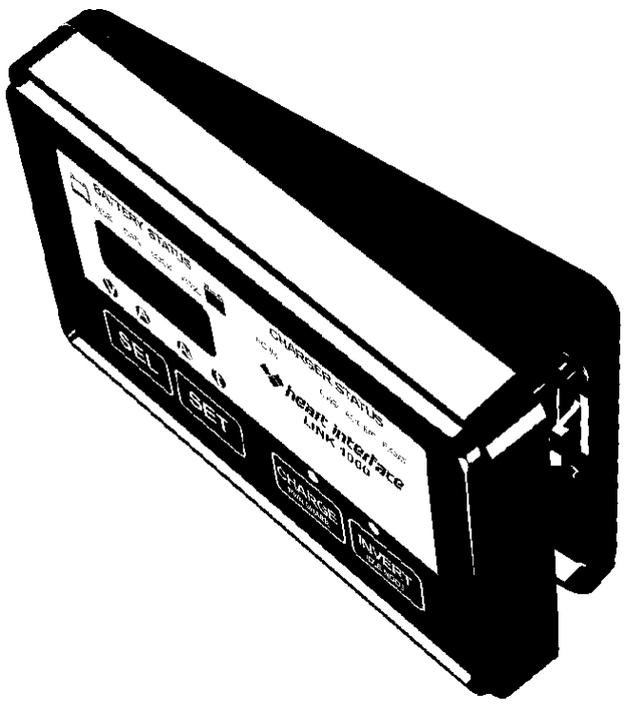


The phone cord to the ***Freedom*** inverter and the wires to the battery compartment may be led out the back of the nesting recepticle...

...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 36, insert the voltage sense wire fuses (Blue Wire to fuse holder on battery #1) (Violet Wire to fuse holder on battery #2).

LAST, install the meter power fuse. Blue and Violet wire fuses 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 light bars and the digital display should come on. The display will be flashing on initial power up.

Factory Default Settings

The ***LINK 20*** comes on in the Ⓥ (Volts) mode with the display flashing to indicate that it has been powered up from the de-powered state. Left untouched for 10 minutes, the ***LINK 20*** will go to "sleep", turning off the numeric display leaving only the two light bars on. This is a power saving feature. Touching either the **SEL** or **SET** buttons will return the ***LINK 20*** to the function it was in when it went to "sleep".

The ***LINK 20*** 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 have to set the battery type and an appropriate Peukert's exponent.

LINK 20 factory default settings are:

1. **Automatic Scanning of V, A, Ahrs, and time is OFF for both batteries.**
2. **Sleep Mode is ON. This turns the digital numeric display off after 10 min.**
3. **Charge Efficiency Factors (CEF's) equal 95% and learn CEF mode is on.**
4. **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 to consider the battery full.**
5. **Battery capacities both set to 200 Amp-hours.**
6. **Peukert Exponents = 1.25.**