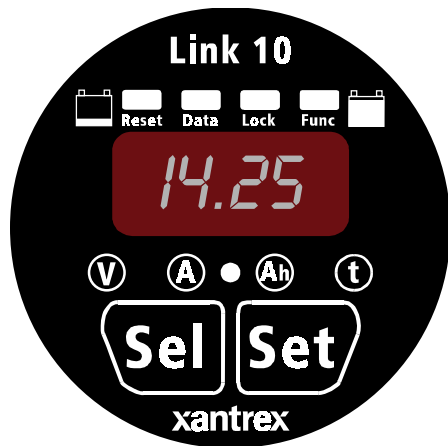


Smart choice for power

xantrex



Link 10

Owner's Manual

**Xantrex
Link 10
Battery Monitor**

www.xantrex.com

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Date and Revision November 2002, Revision 1

Part Number 445-0195-01-01

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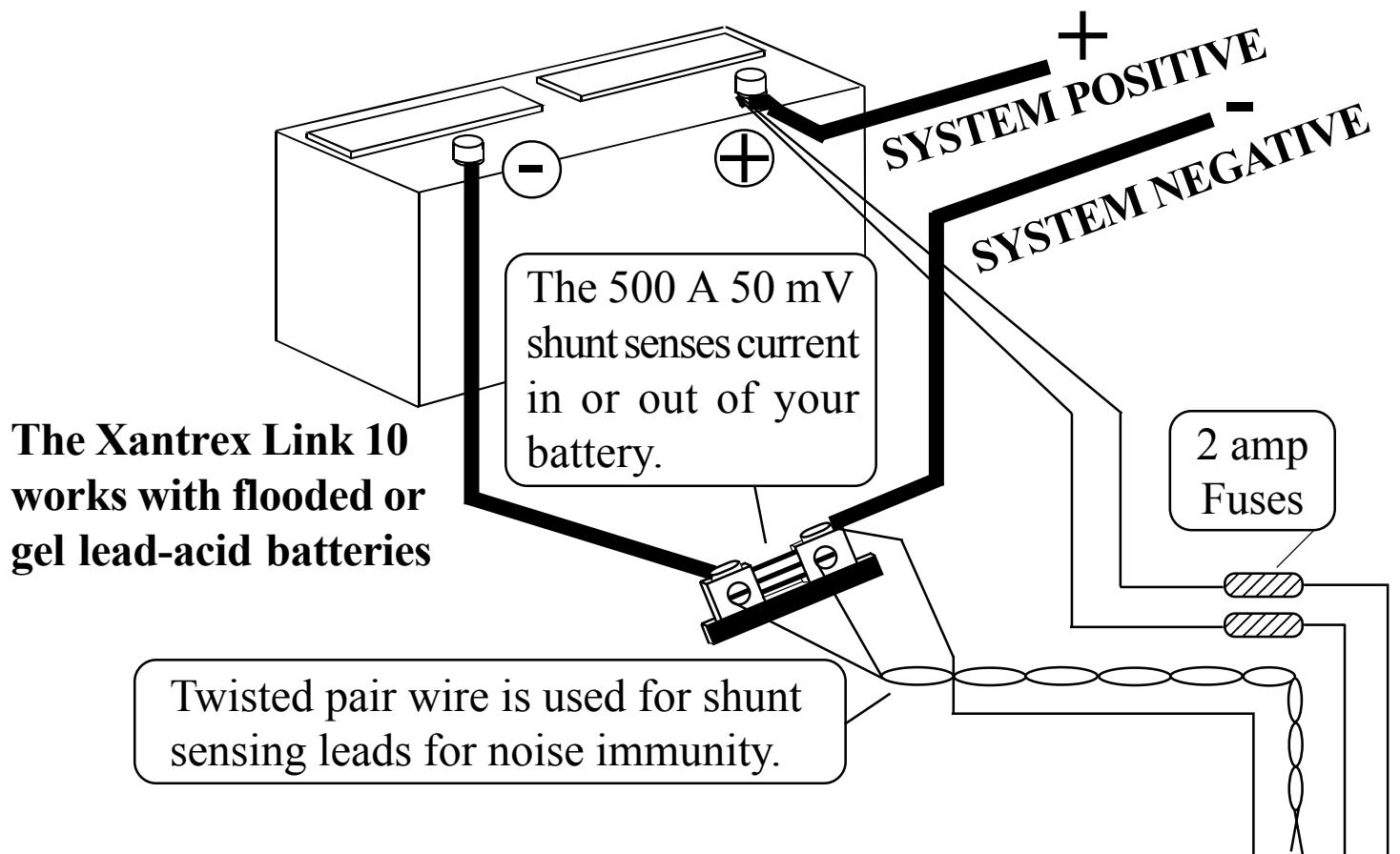
Fax: 1 604 420 2145

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Basic Wiring Diagram

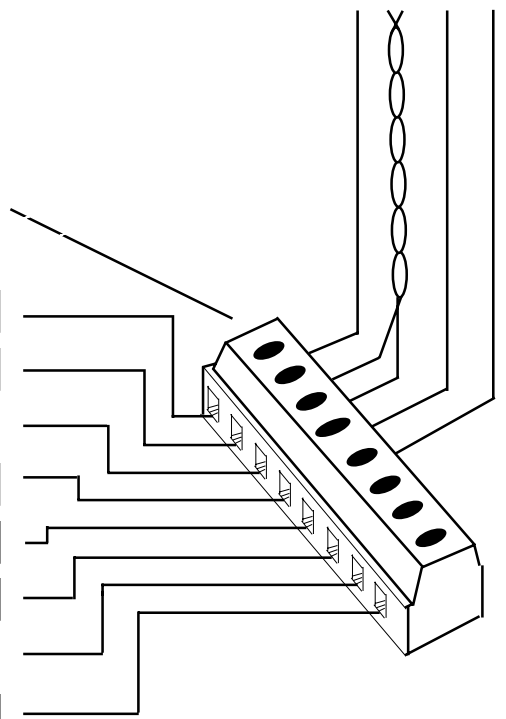


Battery Compartment

Meter Location

Top Rear View of Meter

- | | |
|---|-----|
| -DC Meter Negative (BLACK) | [1] |
| Shunt Sense Lead Load Side (GREEN) | [2] |
| Shunt Sense Lead Battery Side (ORANGE) | [3] |
| Battery Volt Sense (0–50 V DC ¹) (BLUE) | [4] |
| +DC Meter Power (9.5–40 V DC) (RED) | [5] |
| Optional Temperature Sensor Input | [6] |
| Optional Low Battery Alarm | [7] |
| Optional Temperature Sensor Ground | [8] |



Quick Reference

Amps **A**

Amps is the present *flow* of current in or out of your battery. For example, a refrigerator may draw 6.2 amps of current. This is displayed as **-06.2** (6.2 amps are being *consumed*).

Volts **V**

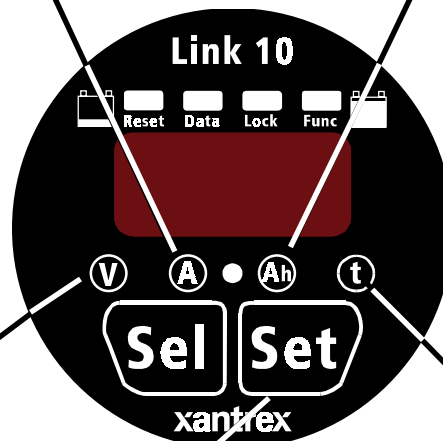
Volts is electricity's *potential to do work*. Voltage helps assess approximate state-of-charge and to check for proper charging. A 12 V battery is considered 100% discharged when it drops below 10.5 V.

Ah **Amp hours**

Amp hours consumed represents the *amount of energy removed* from the battery. If you run a 10-amp load for one hour, the Link 10 will show **-10.0** in the display.

t **Time**

Time is an estimate of how long your battery will sustain a load. A Time display of 3.7 hours means you have approximately 3 hours 42 minutes of operating time remaining.



Advanced Functions

Press and hold the **SET** button for 3 seconds to enter the Setup and Advanced Functions mode. **SEL** appears in the display.

Setup Features

RESET | **DATA** | **LOCK** | **FUNC**
LOCK Locks front panel.

DATA Shows charging efficiency and historical data.

RESET Resets amp hours (**AH**) or (**ALL**) defaults.

Advanced Functions:

Customizes the Link 10's functions. For details read pages 29–30 and pages 34–37.

Key Advanced Functions

RESET | **DATA** | **LOCK** | **FUNC**

F01 Scanning
F02 Sleep Mode
F09 Discharge Floor
F15 S/W Version
F17 Test Lights

Introduction

Congratulations! The Xantrex Link 10 is the most advanced (Patents Pending) DC power measurement instrument available. It shows you:

Battery State-of-Charge on a multicolor light bar.

System voltage accurate to 1/20th of a volt (<20 VDC).

System current accurate to 1/10th of an amp (<40 amps).

Amp hours removed from, or put into, your battery.

Time of operation remaining until recharging is required.

For installation and operation questions, please contact Xantrex at 1-800-670-0707 (toll free) or 1-604-422-2777 (direct). You can also email Xantrex at CustomerService@xantrex.com. For warranty and technical support please follow the process outlined on page 52.

If you wish the Link 10 to support an external Low Battery Alarm, such as a bell or buzzer, or if you need the Link 10 to report data to a computer or data logging unit, these options must be included at the time of manufacture and cannot be retrofitted in the field.

The installation of the Link 10 is simple, as is its operation. However, there are many advanced features and functions, so please take the time to read and thoroughly understand this manual.

Installer's Note: This manual contains operating instructions. Please leave it with the meter!

Battery Basics

Why monitor a battery?

Batteries can be ruined by excessive discharge. They may also be damaged by under-charging. A battery (or bank of batteries) may be storing less energy than you think. The Link 10 provides all the key data you, or your technician, need to make decisions about battery use and charging.

How does the Link 10 work?

The Link 10 uses sophisticated microprocessor technology to report all significant battery information. The Link 10 monitors battery voltage and current over time to report amp hours consumed and time remaining—precisely the information necessary to maximize system performance.

What's an amp hour?

Batteries are rated by amp hour capacity. A battery that delivers one amp for one hour has delivered one amp hour. Marine and RV deep-cycle battery capacity is based on their 20-hour discharge rate. A battery that delivers 10 amps to a load for 20 hours before battery voltage drops to 10.5 volts, is considered a "200 amp hour" battery. 10 amps times 20 hours equals 200 amp hours (200 Ah).

For maximum life you should never discharge more than half the rated capacity of a battery. Therefore, if you have a 200 amp hour battery, you should recharge when the Link 10 shows ~~100~~ in the amp hour display. The ~~100~~ means 100 amp hours have been *removed* from your battery.

FOR MAXIMUM BATTERY LIFE, RECHARGE YOUR BATTERIES WHEN YOU HAVE DISCHARGED 50% OF THEIR AMP HOUR CAPACITY.

Installation

Basic installation of the Link 10 on a 12 or 24 volt system involves only five wires. Because the Link 10 will work on systems up to 500 volts, special high voltage installation techniques are discussed beginning on page 44. You need to read this section if you're working on an electric vehicle or system where more than 50 volts is encountered. If your installation is on a 12 or 24 volt system, let's get to work!

Installation Planning

First, gather all the tools you'll need for installation. We recommend:

- * A 2" or 2 1/16" (52 mm) hole saw to make the panel cutout.
- * A 3/8" drill with bits to run power and shunt wiring.
- * An adjustable 9/16" wrench for shunt bolt connections.
- * Wire stripper/crimper and a small flat blade screwdriver.

Make sure you have all the parts you'll need to complete the job:

- * A 500 A–50 mV shunt (included)
- * #18 or #16 *twisted pair* shunt wire long enough to reach from the battery to the meter location. Ask your dealer for Xantrex Technology PN 84-2014-00 - 25' 4 twisted pair cable or PN 84-2015-00 - 50' 4 twisted pair cable (not included).
- * 2 in-line fuse holders with 2-amp fuses.

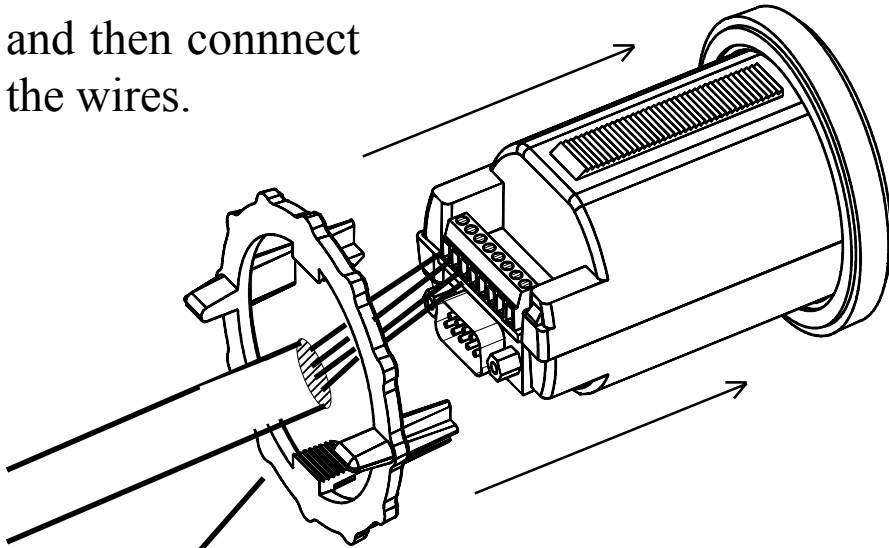
CAUTION: DO NOT INSTALL FUSES UNTIL YOU COMPLETE INSTRUCTIONS ON PAGES 10–15.

- * A short heavy-duty battery cable to run from one shunt bolt to the battery. Cable is available at auto and marine shops.
- * Assorted small-gauge crimp type terminals for connecting the power, shunt, fuses, and voltage sense leads.

Mounting

Our Patent Pending "Ratchet Ring" makes mounting easy and fast.

TIP: When installing from the front of a panel or dashboard slide the Ratchet Ring onto cable with correct orientation and then connect the wires.

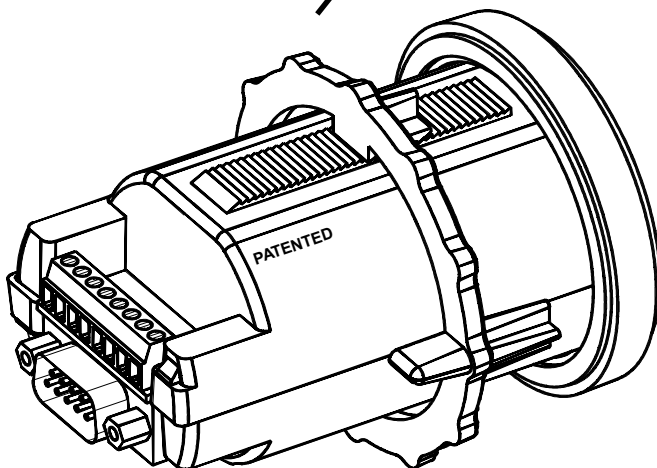


Push Ratchet Ring on until firmly in contact with panel.

CAUTION!

Orient ring so the ratchet teeth will engage properly. Practice installing and removing ring before final assembly. Considerable force is required—this ensures the ring will not loosen over time.

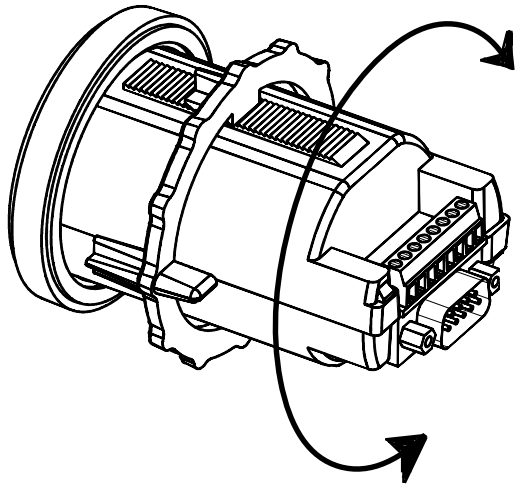
Install the meter from the front of your panel. The panel thickness may range from 1/16" to 1 1/2". Slip the locking ring on from the rear and press forward until its teeth hold the meter securely in place.



The gasket around the ring of the Link 10 should provide an adequate seal against moisture. If a sealant is used be sure it is **silicone** so that the Link 10 may be removed without damage.

Removing

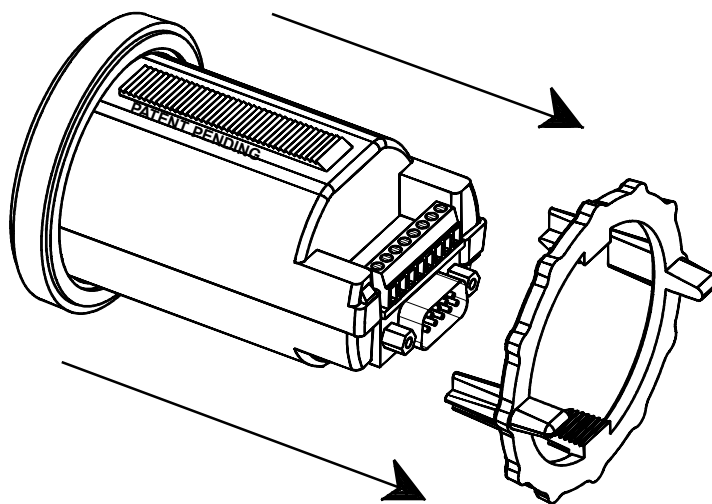
Removing the Link 10 is the reverse of mounting with a TWIST as shown in the following diagrams.



Twist 1/8th turn to unlock teeth.

Then pull lock ring straight back as shown below.

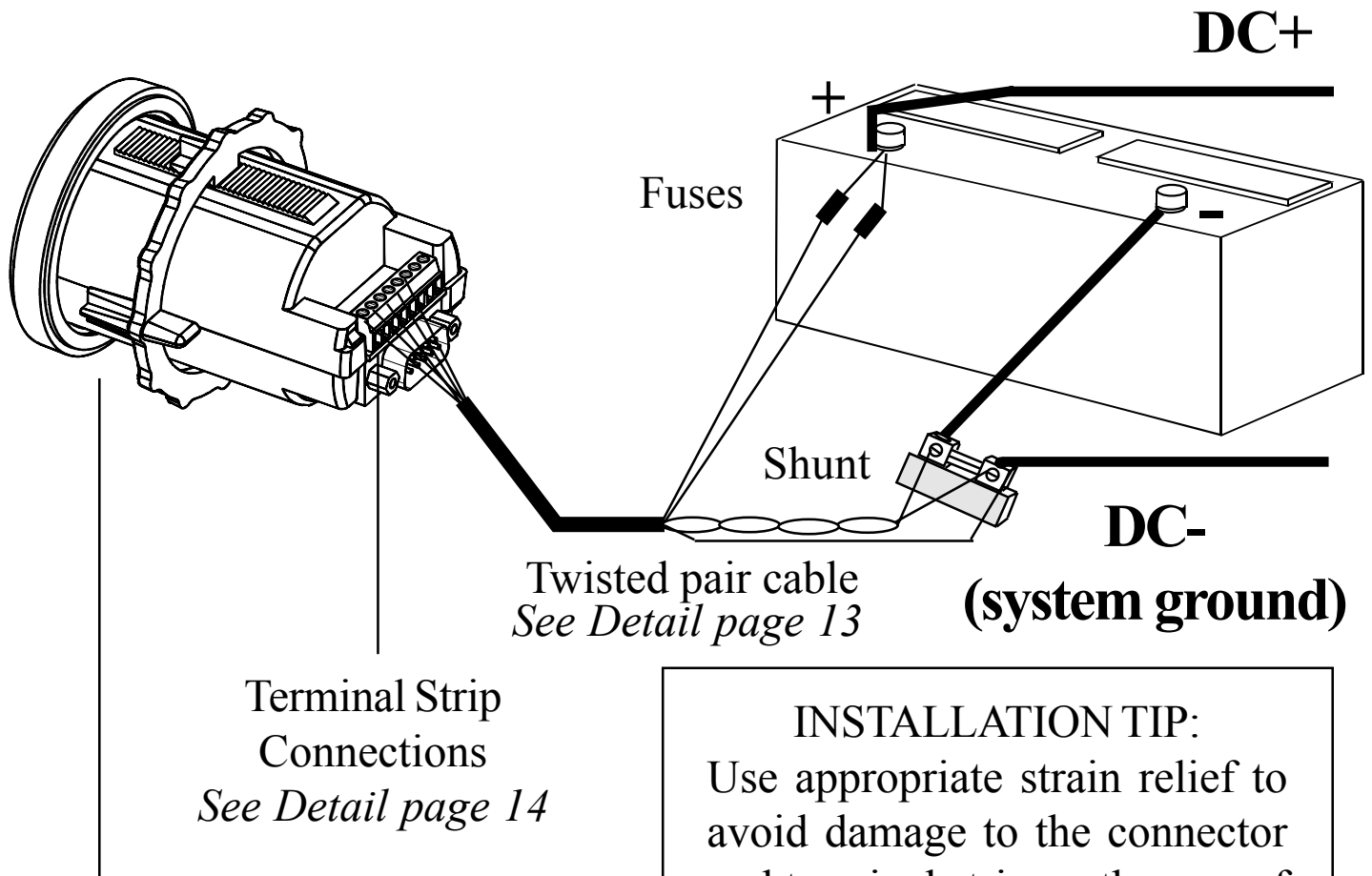
Pull both sides of the lock ring equally



Patented

Wiring Overview

This drawing is for 12 V & 24 V systems.
For higher voltages see Prescaler use on page 44.



Mounting Page 10

Removing page 11

INSTALLATION TIP:
Use appropriate strain relief to avoid damage to the connector and terminal strip on the rear of the Link 10.

TIP: For a neat and professional looking installation use plenty of:

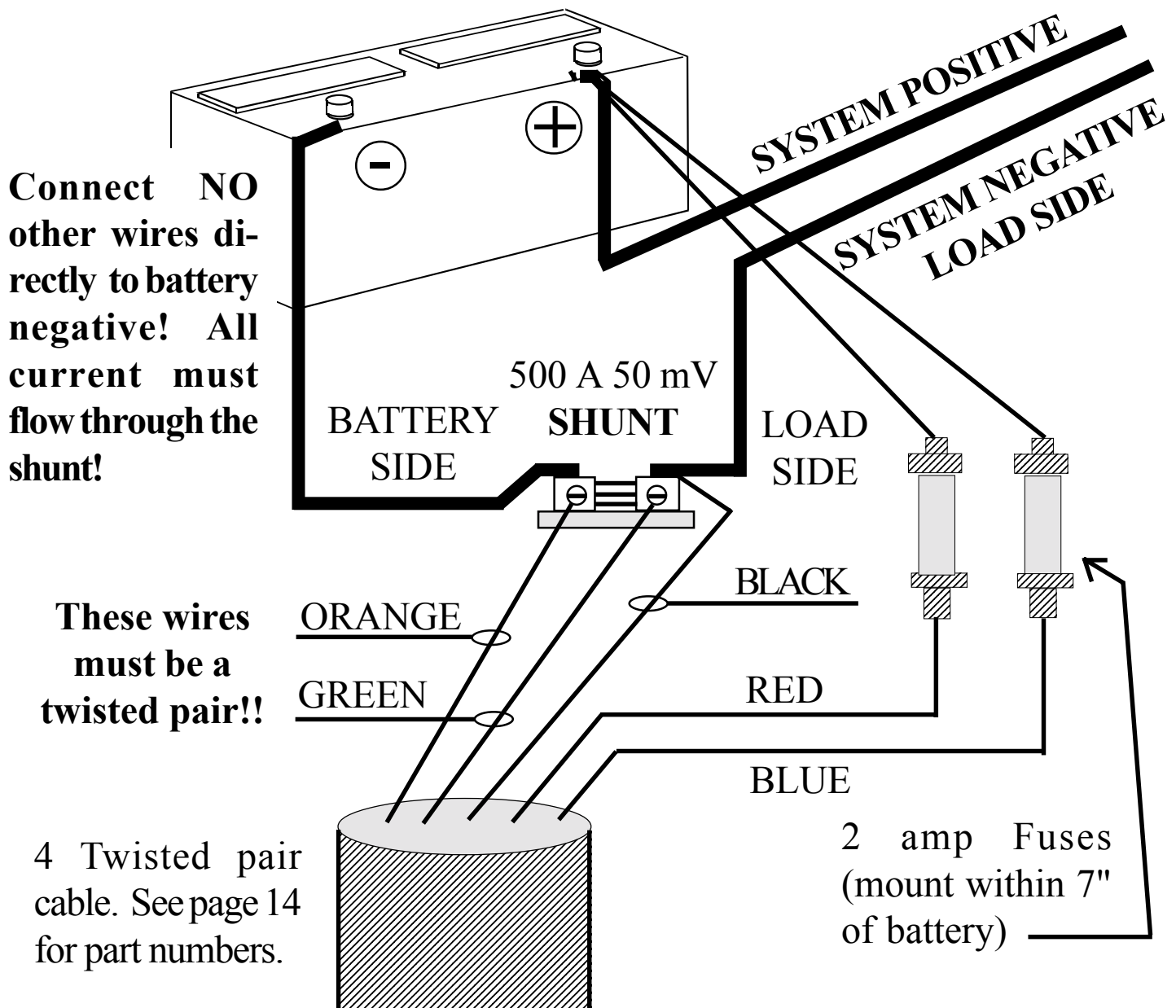
- * Nylon wire wraps
- * Wire wrap anchor points.

NOTE: To limit Voltage measurement error do not exceed wire lengths shown below. Error assumes 16 AWG wire and max. power consumption.

| | |
|------------|------------------|
| 0.5% Error | 72 Feet Maximum |
| 1.0% Error | 150 Feet Maximum |
| 3.0% Error | 450 Feet Maximum |

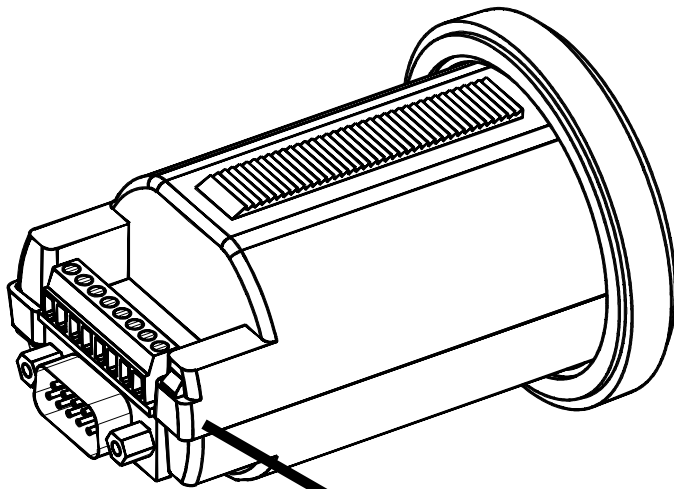
Shunt & Battery Wires

The shunt is the current sensor for the Link 10. Its 500 A, 50 mV rating means that when 500 amps flows through it there is 50 mV generated across it. The millivolt signal is translated into an amps display in the Link 10. For example: a 50 A load would generate 5 mV 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!



Meter Wiring Detail

Make the necessary wire connections to the Link 10 as shown in the following diagram:



Color code shown for Xantrex 4 twisted pair cable. P/Ns below:

P/N 84-2014-00 -25'

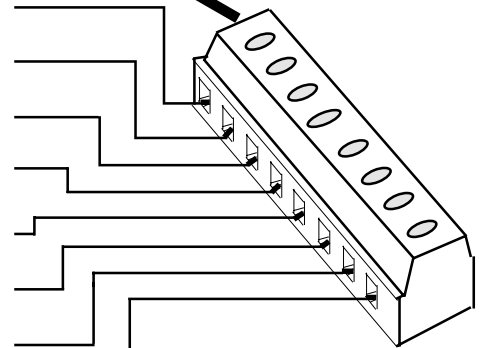
P/N 84-2015-00 -50'

CAUTION

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

Top Rear View

- | | |
|--|-----|
| DC - Meter Negative (BLACK) | [1] |
| Shunt Sense Lead Load Side (GREEN) | [2] |
| Shunt Sense Lead Battery Side (ORANGE) | [3] |
| Battery Volt Sense (0–50 V DC ¹)(BLUE) | [4] |
| DC + Meter Power (9.5–40 V DC) (RED) | [5] |
| Optional Temperature Sensor Input | [6] |
| Optional Low Battery Alarm | [7] |
| Optional Temperature Sensor Ground | [8] |



1) For Voltages above 50 V a Prescaler must be used. See page 44.

Wire by Wire Check

Most failures and problems are due to wiring errors. Please double check the wiring. (Color code shown is for Xantrex wire P/Ns on page 14.)

- #1 - DC Power (Black Wire).** Start at terminal #1 of the Link 10 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 side of the shunt. **This wire must be a twisted pair** with the Orange wire described below. To check this wire start at 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:** Also 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. If Voltage is greater than 50 V, see High Voltage Prescaler, page 44.
- #5 + DC Power (Red Wire).** This wire should run from terminal #5 to a 2 amp fuse holder located within 7" of the battery. The fuse should not yet be installed. The other side of the fuse holder goes to the battery. If power supply voltage is above 24 V, see the Electric Vehicles section, page 46.

Startup

Once you have completed ALL instructions on page 15, insert the voltage sense wire fuse, then the meter power fuse. (BLUE wire fuse 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 lockup. Both the bar graph and digital display should come on.

Factory Default Settings

The Link 10 comes on in the **V** (Volts) mode with the display flashing to indicate that it has been powered up from the de-powered state (see page 26). Left untouched for 10 minutes, the Link 10 will go to "sleep," turning off the digital display leaving only the bar graph on. (This is a power-saving feature.) Touching either the **SEL** or **SET** buttons will return the Link 10 to the function the Link 10 was in when it went to "sleep."

The Link 10 is designed to work "out of the box." The factory default values are appropriate for a moderate capacity 12 V 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 appropriate Peukert's exponent for your battery (see page 26). Special functions and display options are described beginning on page 27.

The Link 10's Factory Default Settings Are:

1. **Automatic Scanning** of V, A, amp hours, and time will be **OFF**.
2. **Sleep Mode is ON**. Turns digital display off after 10 minutes.
3. Charge Efficiency Factor (CEF) equals 90% and **learn CEF mode is on**.
4. **Charged Parameters:** Voltage =13.2, Charged Current =2%. The battery must exceed 13.2 V and the current must be less, in amps, than 2% of declared capacity for five minutes for the Link 10 to consider the battery full.
5. **Battery capacity** set to 200 amp hours.
6. **Peukert Exponent** = 1.25.

Synchronizing the Link 10

Synchronize the Link 10 to a Full Battery

After installing the Link 10, charge the battery until the far right Green LED begins flashing, which indicates the Charged Parameters have been met. Amp hours will have started at 0 and counted up as a positive number. As you begin discharging the battery, the LED will stop flashing and the numeric amp hour display resets to 0. The Link 10 is shipped from the factory assuming a 200 amp hour battery. Your battery may be a different size. To change battery size, see page 21.

Staying in Sync, Removing Accumulated Negative Amp Hours

Should the Link 10 ever become out of sync with the battery state-of-charge simply charge until the far right LED flashes Green. You may also get back in sync by charging until the battery is full and then resetting the amp hours to zero through the RESET function.

If the Link 10 should accumulate a negative number in the amp hour display you will have to charge until you meet the conditions for a recalculation of the Charging Efficiency (CEF) as described on pages 22 & 23. If you do not meet all five of the conditions listed below you will not get a recalculation of the CEF and a reset to zero amp hours consumed.

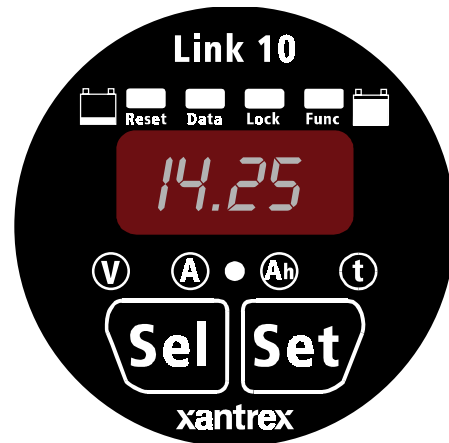
CONDITIONS TO RESET TO ZERO

- 1) Discharge 10% of declared battery capacity to trigger algorithm.
- 2) Recharge until 100% of the kWh removed have been returned.
- 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 default)

Operation

Although the Link 10 is a very sophisticated device, obtaining basic battery information from it is simple. With the unit turned on and the **V** (Volts) LED on, let's learn how to display the four most important DC system parameters.

When you touch the **SEL** button, you are **SEL**ecting the display you wish. Each time you touch **SEL** in normal operation, you will toggle to the next item to the right **V** (volts) goes to **A** (amps) to **Ah** (amp hours) to **t** (time).



Now press **SEL** to bring up these functions.

- V** **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 12.8 V. A 12 V battery is 100% discharged when it reaches 10.5 volts with a 20-hour rated load applied. A typical charging voltage would be 14.2 V.
- A** **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*). Discharge is shown as a negative number and charging is shown as a positive number (unsigned).
- Ah** **Amp hours** consumed represents the *amount of energy removed from* the battery. If you run a 10-amp load for one hour then ten amp hours are consumed. The Link 10 will show -10 in the **Ah** display. During charging the Link 10 will compensate for charging efficiency and count back up toward 0.
- t** **Time** is an estimate of how long (in hours) the battery will sustain a load. It is based on a selectable, time averaged, rate of discharge. Default is the average of the last four minutes of use (see page 24).

Reading the Bar Graph

Above the digital display are four LEDs. They tell you the battery's state-of-charge at a glance. Four green LEDs means your battery is full. One flashing red light means it is nearly discharged. The table below shows the six different displays indicating battery state-of-charge. Under certain light conditions green may appear yellow.

| BATTERY STATE-OF-CHARGE | EMPTY | | FULL | |
|-------------------------------|-----------|--------|-------|-------------|
| | E | | | F |
| Full (Charged Parameters Met) | GREEN | GREEN | GREEN | FLASH GREEN |
| 80–99%+ | GREEN | GREEN | GREEN | GREEN |
| 60–79%+ | GREEN | GREEN | GREEN | |
| 40–59%+ | YELLOW | YELLOW | | |
| 20–39%+ | RED | | | |
| 0–19%+ | FLASH RED | | | |

Under the LED bar graph are the words **RESET**, **DATA**, **LOCK**, and **FUNC**. These words are ignored during normal operation. They are used to indicate programming and advanced function modes which are explained beginning on page 28.

Setting Battery Capacity is Important

The LED bar graph display shows how much of your battery has been consumed. If you do not set your battery capacity correctly, your bar graph will not give you an accurate indication of battery state-of-charge. The Link 10 also uses declared capacity to calculate the Time Remaining, the charged current for Charge Efficiency Factor calculations, and other control functions.

Setting capacity correctly is *very* important—see page 21

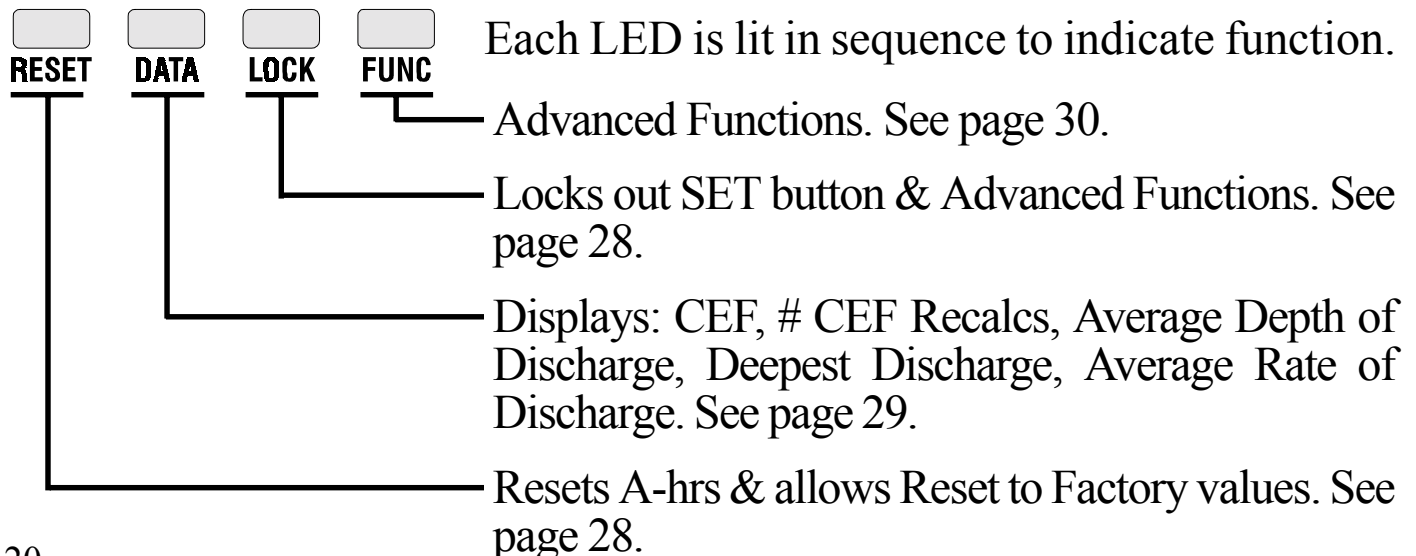
Using the **SEL** **SET** Buttons

Pressing and holding the **SET** button for three seconds enters the Setup and Advanced Functions mode. The word **SEL** appears in the display, prompting you to press the **SEL** button to choose what function you want to **SE**Lect.

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

LIGHT DESCRIPTION

- V** Charged Voltage (the voltage above which the battery must rise to be full)
- A** Charged Current % (charging current must be below this percentage times the battery capacity to be considered full. See page 22–23)
- Ah** Battery Capacity in amp hours
- t** Time interval over which current is averaged for time remaining function.



Setting Battery Capacity

The first time you use the Link 10, it assumes you have 200 amp-hour lead acid batteries. If your battery capacity is different you must change the declared battery capacity. Follow these instructions to declare a new capacity:

- 1) Press and hold the **SET** button for three seconds to enter SETUP (and Advanced Functions) menu. **SEL** appears in the display. Press **SEL** and notice that the green **V** LED is on.
- 2) Press **SEL** again and note that the **A** light comes on. Press again and now the **Ah** LED is on and 200 appears in the display. This is the default battery capacity.
- 3) Now press and hold the **SET** button to scroll through battery size options. The display will show 1 amp-hour increments from 20–40 amp hours of capacity, 5 amp-hour steps from 40–100 amp hours capacity and 20 amp-hour steps over 100 amp hours of capacity. If you continue to hold **SET**, after four 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 amp hours, after which the display will roll over and begin scrolling up starting from 10 amp hours. NOTE: Versions of the Link 10 prior to serial number 05000 increment only in 20 amp-hour steps from 20–1980 amp hours.
- 4) After 10 seconds the meter exits the Setup mode and the selected value is stored as the new battery capacity and the display returns to **V** (Volts).

TIP: All SETUP and ADVANCED FUNCTIONS begin with the **SET** button. SETUP is normally done at installation. The **SET** button may be **LOCKed** to prevent unauthorized personnel from tampering with the **SET** functions. See "LOCK" on page 28.

The Charged Parameters

The Link 10 depends on the Charged Parameters to stay in sync with the battery state-of-charge, to automatically reset to zero, and to automatically calculate the CEF. The default settings are for 12 V lead acid (liquid or gelled) batteries. They have been carefully chosen to work on most systems, including constant voltage and multiple step charging systems.

The factory Charged Parameters are 13.2 volts and 2% of battery capacity as a charged current. (2% of the default battery capacity of 200 Ah equals 4 amps). Several conditions must be met for a recalculation of the CEF and a reset to zero: First 100% of the energy removed from the battery must be returned, additionally the battery must be above 13.2 volts and the current must fall below 4 amps for five minutes. When all these conditions are met the battery is considered full.

CAUTION: If your battery voltage is other than 12 V you MUST set up an appropriate Charged Voltage.

If the charged parameters are not set correctly,

The Link 10 will never recalculate the CEF!

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.

Charged Parameters & CEF

If you change the Charged Parameters please use the following rules:

- 1) **The Charged Voltage Parameter MUST BE AT LEAST 0.1V BELOW the voltage at which the charging system finishes charging.**

Example: If your charging system finishes the battery at 13.8 volts, a Charged Voltage Parameter of 14.0 volts will not work. Lower the Charged Voltage Parameter to 13.7 volts or less.

- 2) **The Charged Current % times declared Battery Capacity MUST be GREATER than the minimum current at which the charging system maintains the battery, or turns off.**


If the Charged Current % times the Battery Capacity is less than the current at which the charging system switches off, the Charged Current Parameter cannot be met. For example, if the charging system shuts off when the current is 10 amps, using the factory default value of 4 amps (2% of 200 Ah), will not work. Changing the Charged Current % to 6% would give a Charged Current of 12 amps, which would work.

WHY THE CHARGE EFFICIENCY FACTOR (CEF) IS IMPORTANT:

The CEF determines the rate at which the meter counts back up during charging to compensate for the inefficiency of the charging process. The CEF has a factory default value of 90%. This means that you must return 10.0 amp hours to store 9.0 Ah in the battery.

If you have a charging system that cannot satisfy the Charged Parameters, the CEF will not be recalculated and the meter will use the default CEF of 90%. This will work fine in most systems. You may notice an accumulation of negative amp hours. If so, set up appropriate Charged Parameters or resynchronize periodically.

Setting Up

Five different displays are available in the Time function. You may select present consumption level, a 4-minute average, a 16-minute, or a 32-minute average, or display the percent of rate compensated capacity remaining. Which method is best for you depends on your installation. Most installations will find four-minute averaging appropriate. To SET UP  follow the procedure outlined on page 20. As you press the **SET** button the following values will appear. Use the table below to choose the appropriate averaging period.

| | |
|---------------------------|-----------------------------------|
| Instantaneous: | Time Remaining Setup Display: 000 |
| 4-Minute Average: | Time Remaining Setup Display: 001 |
| 16-Minute Average: | Time Remaining Setup Display: 002 |
| 32-Minute Average: | Time Remaining Setup Display: 003 |
| Percent Remaining: | Time Remaining Setup Display: 04P |

Operating Tips: Use the longest period of time you can to ensure long-term load variations are considered. For instant feedback, use the 000 (no averaging) display. Time is in hours and 1/10ths of hours. In the Percent of Capacity Remaining mode, a full battery is displayed as 100P and counts down as your discharge. The Percent of Battery Capacity Remaining is referenced to the selected discharge floor and uses the instantaneous (not averaged) rate of discharge. The percent of capacity remaining display shows the percent number which drives the Bar Graph. This function is very useful on electric vehicles.

CAUTION: Time displays are an *estimate* of how long your battery will sustain a load (to your selected discharge floor; default: 100% discharge). Variations in discharge current, incorrectly set battery capacity, Peukert's exponent, temperature, and prior battery history may affect the accuracy of this estimate. Please use Time displays only as a guide. Use all displays (volts, amps, amp hours, and time) to make an informed decision about battery state-of-charge. Do not rely on a single value!

(optional) **Temperature Sensor**

The Link 10 may support an optional two wire temperature sensor. The temperature sensor is activated by turning Advanced Function F16 ON.

With F16 ON, F03 shows battery temperature in degrees Celsius. When activated, F03 will continue to display temperature after exiting the Setup mode until one of the two front panel buttons, **SET** or **SEL**, is pressed.

The limits of the temperature sensor are 0 °C (32 °F) to 99 °C (210 °F). Versions of the Link 10 prior to Serial Number 005000 do not support this function.

Introduction to Peukert Exponent

The Link 10 shows true amp hours consumed in the amp hour display. However, the light bar shows how much *of the available* battery has been consumed. In 1897 a scientist named Peukert demonstrated that as you discharge a battery more quickly, its *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 its 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 amp hours before dropping below 10.5 V!

Peukert's Exponent

Peukert's Exponent is a number which describes how battery capacity shrinks as the rate of discharge is increased. The Link 10 uses a number between 1.00 and 1.50 to describe how fast a particular battery will "shrink" when a heavy load is connected. A more complete technical discussion of the Peukert Exponent, and typical value tables is included on pages 39–41. The Peukert Exponent set at the factory, 1.25, will be satisfactory for many liquid cell batteries. Gel cell batteries, or liquid cells with atypical plate structures, may require a different Peukert Exponent. To change the Peukert Exponent, proceed as follows:

- 1) Press and hold the **SET** button for three seconds to enter SETUP (and Advanced Functions) menu. **SEL** appears in the display. Press **SEL** and notice that the green **V** LED is on.
- 2) Press **SEL** again and note that the **A** light comes on. Continue to press the **SEL** button until F8 appears in the display. This will require 18 presses of the **SEL** button. The **FUNC** LED will be lit.
- 3) Now press and hold the **SET** button. The default value of 1.25 (or the previously programmed value) will appear in the display. 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 four 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. You also have to scroll all the way through to declare exponents between 1.00 and 1.25.
- 4) After 10 seconds the meter exits the Setup mode and the selected value is stored as the new Peukert's exponent and the display returns to **V** (Volts).

Alarms

Two Types of Alarms

The Link 10 is equipped with both a visual *Power Loss* Alarm and a visual *Low Battery* Alarm. It is important that you understand the difference between these functions.

Power Loss Alarm: Shows when power being supplied to the Link 10 has dropped to an unsafe level. Certain display features are turned off as meter power drops below internally set levels.

Low Battery Alarm: Shows when the battery being monitored has reached either a predetermined depth of discharge *or* has encountered at least 15 seconds of continuous low voltage below a settable level. The Low Battery Alarm is controlled by functions F10, F11 and F12 in the *Advanced Functions* Section.

Power Loss Alarm & Reset Annunciation

If the voltage-supplying terminal #5 falls too low an automatic shutdown occurs. This voltage varies from a low of 7.2 V to about 9.2 volts depending on how fast the voltage drops. When power is restored, the display defaults to the **V** function and the digital display flashes. Pressing either the **SEL** or **SET** buttons cancels the flashing display. If the meter is in the sleep mode when power loss occurs, the display will flash for 10 minutes and then go to sleep if no buttons are pressed. Once asleep, the first button press will wake the display in the flashing mode to annunciate the power loss. The second button press will cancel the flashing display.

Reset and Lock

In addition to reporting primary system values, the Link 10 is capable of many other front panel functions and will also display important historical battery data. The words below the bar graph display indicate which of these functions you are accessing. To use these functions you must read and understand the following section of this manual.

Resetting the Link 10

RESET Resets amp hours to zero and resets the Link 10 to factory values.

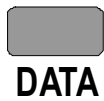
To **RESET** the amp-hour display to zero, **SE**Lect the **RESET** function as previously described. The letters **AH** will appear in the display. Press and hold the **SET** button. After five seconds the amp-hour display will be reset to zero and the letters **ALL** will appear. If you continue to hold down the **SET** for another five seconds all variables and functions are reset to the factory defaults.

Front Panel Locking

LOCK Prevents user access to Set Up and Advanced Functions.

To **LOCK** the Link 10, **SE**Lect the **LOCK** function as previously described. The letters **LDC** will appear in the display, indicating you are in the **LOCK** function. Press **SET** and the letters **OFF** appear, indicating the front panel is not locked. Press **SET** again and the letters **ON** will appear, indicating the front panel is locked. Repeating this procedure toggles the lock off and on. The display will report **OFF** or **ON**, indicating Lock off or on.

Historical Data



Key Battery Data Displayed

DATA Key historical battery information is available through this function. Each time the **SEL** button is pressed while in the **DATA** mode the next piece of data is displayed. To see **DATA**, select **DATA** as previously described.

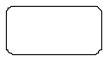
CEF (Displayed as *E99*): The Charging Efficiency Factor (CEF) is displayed. A display of *E99* indicates a 99% CEF. This number sets the rate at which amp hours are counted back up during charging. This is an amp-hour CEF, not kWh efficiency. The Default setting is 90%. **NOTE:** If the CEF display has a *U* in front of it, this means the CEF has been selected by the user. See Advanced Function F06 for details.

#CEF Recalculations (Displayed as *+1999*): This is the number of times that the battery has been discharged more than 10% and then recharged until the Charged Parameters have been met. May be considered as the number of charge/discharge cycles the battery has experienced.

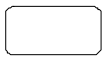
Deepest Discharge (Displayed as *-1999*): Shows the deepest discharge in amp hours recorded by the meter since its last **RESET** to factory defaults.

Average Discharge (Displayed as *1999*): The running average of all discharges as an amp-hour value since last **RESET** to factory defaults.

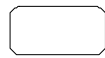
Advanced Functions



RESET



DATA



LOCK



FUNC

Advanced Functions

FUNC Allows setup of Advanced Functions.

To access the **FUNC** mode, **SEL**ect the **FUNC** mode as previously described. The letters **F01** will appear in the display and the **FUNC** LED will be lit, indicating you are in the **FUNC** mode. Continue pressing the **SEL** button until the function you wish to set up appears. Now press **SET** until the desired value or mode appears. Repeat this procedure until you have set up all of the desired advanced functions. Whatever functions you have set up will become active when the display reverts to its normal mode.

F01 AUTO DISPLAY SCANNING

Automatically scans V, A, Ah, and T. Each value is displayed for four seconds. **DEFAULT: OFF** RANGE: OFF or ON

F02 ENHANCED SLEEP MODES

DEFAULT: ON RANGE: ON, OFF, AU (AUTOMATIC)

When the Sleep Mode is ON, the Link 10's numeric display turns off after 10 minutes in order to reduce power consumption. Pressing either SET or SEL buttons returns the numeric display to operation.

When the Sleep Mode is OFF, the numeric display stays on at all times. In the special automatic sleep mode (displayed as **AU**), the numerics are on whenever charging or discharging exceeds 1 amp. When the rate of charge or discharge remains less than 1 amp for 10 minutes, the numeric display is turned off to conserve power. When asleep, pressing either SET or SEL reactivates the numeric display. The numeric display automatically wakes up when the rate of charge or discharge exceeds 1 amp. The Automatic Sleep Mode is ideal for electric vehicles.

DEFAULT: ON RANGE: OFF or ON

Advanced Functions

F03 DISPLAY OR SET BATTERY TEMPERATURE

If there is no external temp sensor and F16 is OFF (factory default), this function sets ambient battery temperature used to calculate *rate corrected* battery capacity which drives the LED bar graph and the Time remaining display. Feature not available on units with serial numbers prior to 05000.

DEFAULT: 20 °C **RANGE: 0–40 °C** **STEP: 1 °C**

If F16 is ON and an optional external temperature sensor is connected between Pin 6 and Pin 8 (ground), F03 will display temperature (0–99 °C). Temperature will continue to be displayed until one of the two front panel buttons is pressed. Active Temperature display is annunciated by the absence of front panel status indicators. If 0 is displayed at normal (~ 20 °C) temperatures, an open temperature probe should be assumed. If >99 is displayed at normal temperatures, a shorted probe should be suspected.

F04 TURN ON KWHRS DISPLAY

Kilowatt hours are displayed in the Ah mode. (**Note:** The kWh display does not take into account Charging Efficiency. As a condition for a recalculation of the CEF and an automatic reset of amp hours to zero, 100% of the energy removed from the battery must be returned. The number in the kWh display must be zero or positive to allow a recalculation of the CEF and an automatic reset to zero. You may use this function to verify that this condition has been met.)

DEFAULT: OFF **RANGE: OFF or ON**

F05 USE ALTERNATIVE ENERGY (AE) DEFAULTS

Changes time to meet Charged Parameters to one minute from the normal five minutes. (Also consider changing Charged Current to 4%.)

DEFAULT: OFF **RANGE: OFF or ON**

Advanced Functions

F06 MANUALLY SET CEF (Not Recommended)

Allows manual setup of CEF. Displayed as two digits. Default display *A90* indicates automatic CEF recalculation feature active. Returning to *A90* from a user CEF turns the automatic CEF feature back on. A user-set CEF will appear as a *UXX* in the **DATA** mode. See page 29.

DEFAULT: A90 **RANGE: 65–99** **STEP: 1**

F07 SETTEMPERATURECOEFFICIENT

Compensates for capacity change with temp. $\sim 0.5\%$ Cap/ $^{\circ}\text{C}$. This coefficient must be supplied by the battery manufacturer. The default value is typical for lead acid liquid or gelled batteries.

DEFAULT: 0.5 **RANGE: 0.1–0.9** **STEP: 0.1**

F08 SETPEUKERTEXPONENT

Sets exponent for Peukert's equation. A setting of 1.0 defeats Peukert's calculation. See pages 39–42 for a discussion of Peukert's equation and typical values for various batteries.

F09 SETDISCHARGE FLOOR

Sets the discharge floor used to calculate bar graph status and time of operation remaining functions. The factory default is to calculate time remaining, and bar graph based on a rate-corrected discharge of 100% of declared amp-hour capacity. In other words, the bar graph will flash red when less than 20% of your rate-corrected (Peukert amp hour) capacity remains. Default time remaining is essentially "time till dead battery."

To ensure a margin of safety you may wish to set a different discharge floor. You may wish to set 80% or some other discharge floor for your bar graph.

Advanced Functions

CAUTION: If you set the discharge floor high, such as 50%, and continue to discharge well beyond this point, you will notice that the bar graph does not "fill up" until you have charged the battery above the discharge floor. In other words, if you set the discharge floor at 50% and discharge 75%, you must recharge back up to the 50% level before your bar graph and time of operation will again give you meaningful information.

DEFAULT: 100% **RANGE: 50–100%** **Step: 5%**

F10–F12 SEE LOW BATTERY ALARM, PAGES 35–38

F13 SEE HIGH VOLTAGE NOTES, PAGE 50

F14 ENABLE LOW BATTERY ALARM

In versions of the Link 10 equipped with the Low Alarm Switch, this function allows the Low Battery Alarm to be disabled.

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

F15 SOFTWARE REVISION

Displays revision of software.

Please note that the software enhancements to the Link 10 may not be retrofitted into earlier versions of this product. If the Link 10 has serial number 005000 or larger, it will come with software version E1.3 or greater installed. Earlier versions of the Link 10 do not support temperature sensing, small amp-hour increments, separate alarms for meter power and low battery conditions. Early versions display 255 instead of [] when the battery is being charged.

Advanced Functions

F16 TEMPERATURE SENSOR ON/OFF

This function turns the optional external temperature sensor on or off. This feature is only operable when a temperature sensor has been connected between Pin 6 and Pin 8 of the Link 10.

To fully understand this feature, please refer to F03 on page 31. Not available prior to Serial Number 005000.

DEFAULT: OFF RANGE: ON, OFF

F17 LIGHT TEST

This function confirms proper operation of the Link 10's front panel display. When the **SET** button is pressed in the F17 mode, the two top left lights on the Light Bar will display orange/yellow color, the numeric display will read 188.8 and all four status lights will be on. The display returns to normal when the **SET** button is released. Operation of the two top-right green lights on the Light Bar is confirmed when power is initially applied to the Link 10.

DEFAULT: OFF RANGE: ON only while F17 is active.

Low Battery Alarm

Units with serial numbers greater than 005000 allow access to an enhanced Low Battery Alarm feature. To activate this feature, change Function **F14** to **ON**. When F14 is ON, the Link 10 displays a visual alarm when the monitored battery meets either of two conditions:

- 1) A settable rated compensated (Peukert) amp-hour depth of discharge is exceeded or,
- 2) Voltage remains below a settable level for 15 seconds or longer.

When operating the Link 10 with the visual Low Battery Alarm function ON, three additional software functions are active. Two of these functions, F11 and F12, set the low amp-hours and low voltage levels which turn the visual alarm ON. Function F10 is the Low Battery Alarm OFF (Recharge) Set Point.

Visual Alarm Indication

There are two levels of visual alarm.

Level 1: The normal display alternates with a blank Bar Graph and **LO** appears in the numeric display.

Level 2: Once the Level 1 alarm display is acknowledged by the operator by pressing either **SET** or **SEL** once, the Level 2 Alarm flashes the amp-hours function light while dimming the presently displayed function light. In the event amp hours are displayed, the amp-hours light will go off at half-second intervals. Once the battery alarm feature is activated, a visual alarm display (Level 1 or Level 2) will continue until amp hours are above the Low Battery Alarm OFF (Recharge) Set Point (F10) *and* voltage is above the Low Voltage Alarm Threshold F12 for at least 15 seconds.

Alarm Circuit

Special versions of the Link 10 close a circuit to ground when either Visual Alarm level is active. This circuit may be used for audible alarms, generator starting, and so forth. Because additional internal circuitry is included, this option may not be retrofitted to the Link 10 in the field.

Alarm Functions

Refer to F14 in the Owner's Manual

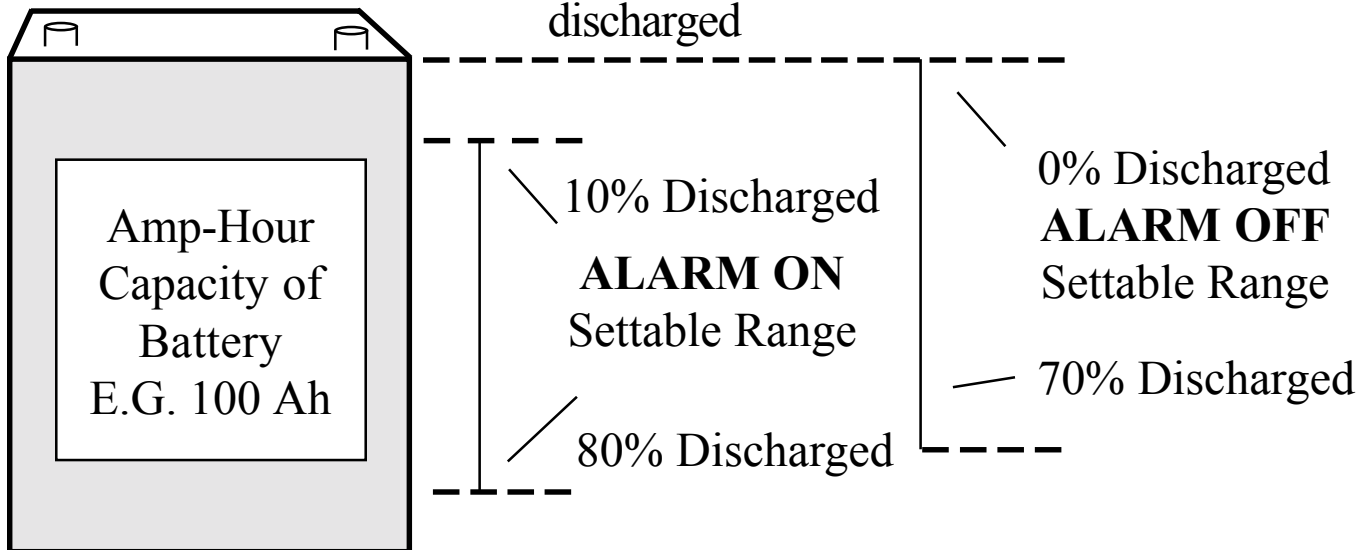
Functions F10, F11, and F12 define operation of the Visual Low Battery Alarm as follows:

F11

TURNS ON Low Battery Alarm at a set % of rate-compensated amp hours discharged

F10

TURNS OFF Low Battery Alarm when amp hours are restored



F10 LOW BATTERY ALARM OFF (RECHARGE) SET POINT

Once the Low Battery Alarm is activated, recharging the battery to this point turns the alarm OFF. This recharged point must always be at least 10% higher than Low Battery Line closure point.

DEFAULT: 70% RANGE: 0%–70% STEP: 5%

F11 LOW BATTERY ALARM ON SET POINT

Sets when the Low Battery Alarm goes ON point based on percent of amp hours discharged. F11 is displayed as a percentage: i.e. 10 is 10% discharged. F11 may set anywhere in its range but at least 10% below the **F10 Low Battery Alarm OFF Set Point** set point.

DEFAULT: 80% RANGE: 10%–80% STEP: 5%

NOTE: The Low Battery Alarm ON and OFF points operate on rate compensated (Peukert) amp hours consumed. Once the alarm is activated, the battery must be charged until **Alarm OFF Set Point** is reached to turn the alarm off.

F12 LOW VOLTAGE ALARM THRESHOLD

F12 sets the voltage below which the Low Battery Alarm is activated. But the voltage must remain below this set point for a full 15 seconds before the Low Battery Alarm goes ON. Dropping below the Low Voltage Alarm Threshold for less than a full 15 seconds will not activate the alarm.

If low voltage activates the alarm while the battery is *above* the **Alarm OFF (amp hour) Set Point**, the alarm goes OFF as soon as voltage remains *above* the low voltage threshold for 15 seconds. If the battery is *below* the **Alarm OFF (amp hour) Set Point** when low voltages turn the Alarm ON, the alarm stays on until the battery is recharged to *above* the **Alarm OFF (amp hour) Set Point**.

RANGE: 5.0–40 V (0–50 V Scaling) STEP: 0.1 V Default 10.5 V

RANGE: 5.0–80 V (0–100 V Scaling) STEP: 0.1 V Default 10.5 V

RANGE: 50–400 V (0–500 V Scaling) STEP: 1.0 V Default 105 V

THINGS TO REMEMBER:

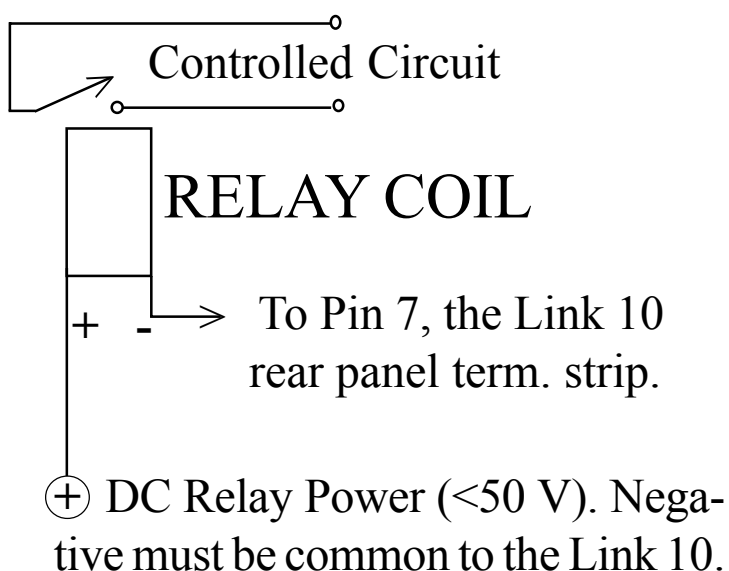
- 1) The Low Battery Alarm may be activated by *either* a low Voltage **OR** a low amp-hour condition.
- 2) There must be a 10% difference between the Low Battery Alarm ON set point and Low Battery Alarm OFF (Recharge) Set Point.
- 3) Because Low Battery Alarm ON may be triggered by rated compensated (Peukert) amp hours, you may see fewer amp hours removed in the numeric display than expected. The more rapidly you have discharged your battery, the more pronounced this variance will be.

Optional Alarm Switch

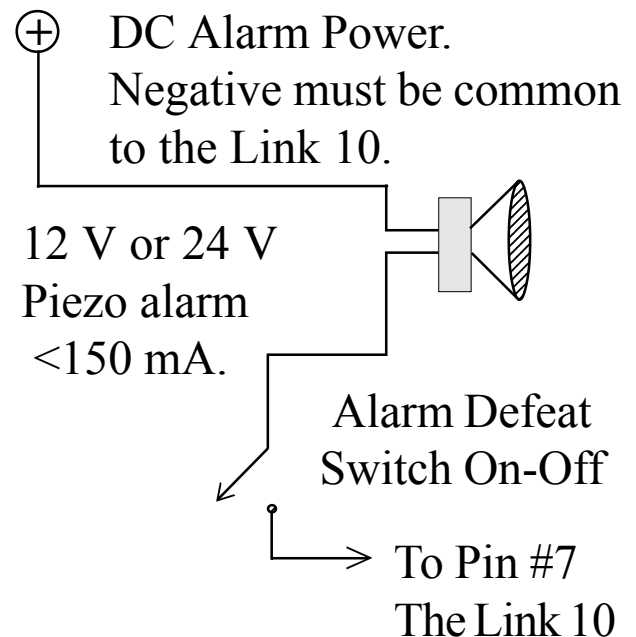
Special versions of the Link 10 are available, for additional charge, which include a solid state Alarm Switch to ground via rear panel terminal strip Pin #7. This option is used in a variety of settings such as lift pump lock out on fork lifts, two wire generator start/stop, audible low battery alarms, and charge controllers. The additional circuitry of the switch may not be retrofitted to the Link 10 in the field. It must be included at the time of manufacture.

The Low Battery Alarm Switch goes low to meter ground when the alarm is activated. In other words, a sinking FET switch to the meter's negative power lead is completed while the alarm is active. This lead is protected against polarity reversal so the "switch" connection has about 1 ohm of resistance. This should be taken into account when sizing relays or designing logic interfaces. The maximum amount of current that may be controlled by this circuit is 150 mA (0.150 A) at no more than 50 V. Below are two typical applications for the optional Low Battery Alarm Switch:

RELAY DRIVER DIAGRAM



AUDIBLE ALARM



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 table and examples on the following page illustrate this effect and how to use the table to estimate the exponent " n ". The tables on pages 40 and 41 have typical values of " n " for common batteries.

Making two discharge tests, one at a high discharge rate and one at a low rate, that bracket your normal range of operation, allows you to calculate an " n " that will describe this varying effect. The Link 10 uses an " 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. From this description, if a battery is discharged at this rate for the period of time called out, you will be able to remove the rated capacity.

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 coefficient). You will need a calculator that has a Log function to solve the equation above. See example on page 42. After you solve for your Peukert's coefficient you may enter it using Advanced Function F8.

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-Ah 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 Ah BATTERY AT DIFFERENT DISCHARGE RATES USING DIFFERENT PEUKERT'S EXPONENTS

| | | DISCHARGE RATE IN AMPS | | | | | | | | | | | | | |
|----------|------|------------------------|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| n | | 5 | 10 | 16.7 | 25 | 50 | 75 | 100 | 150 | 200 | 250 | 300 | 400 | 500 | |
| EXPONENT | 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: Suppose you have a 200 Ah battery. Now discharge at a 50-amp rate until the battery reaches 1.75 V per cell (10.5 V for a 12 V battery). This would be equivalent to a discharge rate of 25 A for a 100 Ah battery. If the battery delivered 67% (134 Ah) the appropriate Peukert's exponent would be 1.25.

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

Peukert's Exponent

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 @ 25 A 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 |

Peukert's Exponent

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

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 for the 20-hour rating. Finally, use a calculator to solve the arithmetic.

Trojan T-105:

Reserve Minutes = 447 min @ 25 amps.

$$t_1 = 447 \text{ min} = 447/60 = 7.45 \text{ hrs}$$

$$I_1 = 25 \text{ amps}$$

20-hour rating = 225 Ah

$$t_2 = 20 \text{ hours}$$

$$I_2 = 225 \text{ amp hours} / 20 \text{ hours} = 11.25 \text{ amps}$$

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

Troubleshooting

| Problem | Suggestion |
|---------------------------------------|--|
| No lights or display | Check Power Connections Reset meter (page 28) |
| No keyboard response | Check Lock is not invoked Reset meter (page 28) |
| Time Remaining Not Accurate | Check Battery Capacity (page 21) Check Temperature Coefficient (page 32) Check Peukert Exponent (page 26) |
| Digital Display Dim | Clean front panel photo-sensor (Between A and Ah lights) |
| Current Polarity Reversed | Current Shunt leads reversed (page 13) |
| Intermittent Operation | Corrosion or loose wires. Loosen and reconnect all rear panel connections. Check voltage sense and shunt wiring at battery location. |
| Accumulates Negative Amp-hour reading | Charge Parameters not met. Check Charged Parameter values—has 100% of kWh been returned? Charging Current is not passing through shunt (pages 13, 22, 23, and Function F04). |

Xantrex Technology, Inc. warrants that the Link 10 will measure voltage, amperage, and amp hours within the published specifications. The Time Remaining and LED bar graph functions are complicated and require appropriate user setup and are therefore beyond the control of Xantrex and are not covered by warranty. Similarly, installation wiring and specific applications are beyond our control and are not covered by warranty. See page 52.

Options & Versions

User-installable **OPTIONS** available include:

Prescalers: Extend the voltage range covered by the Link 10 to either 0–100 V (Xantrex P/N 84-6000-0) or 0–500 V (Xantrex P/N 84-6000-05).

Temperature Sensor: Reports battery temperature in Degrees Celsius (Xantrex P/N 84-2024-00)

All other options must be installed at the time the Link 10 is manufactured, as additional circuitry is involved.

Special order **VERSIONS** of the Link 10

RS-232 (9600, 8, N, 1 ASCII computer port)

Alarm Switch Switch closure when Low Battery Alarm is active.

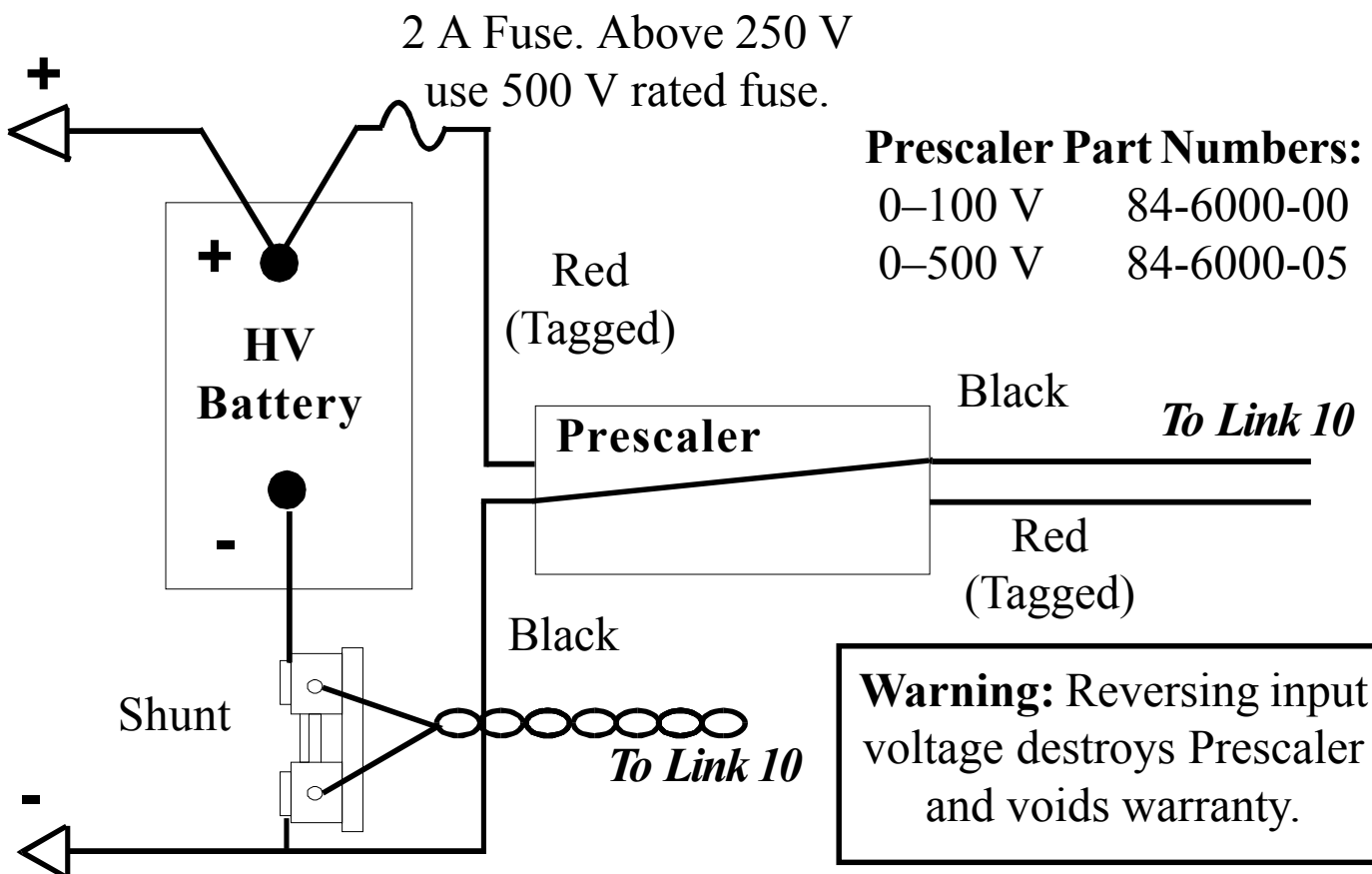
RS-232 + Alarm Switch (Both options above)

High Voltage Prescaler

CAUTION!

1. Installation of the Prescaler Option involves work with potentially fatal voltages. **NEVER** work alone—have at least one person present who can render assistance and CPR in the event of an accident. If you have any doubt about your qualifications to work on a high-voltage system, **DON'T DO IT!**
2. When working with any DC system, even so-called ungrounded ("floating") systems with no *planned* chassis connection, disconnect the negative battery terminal first.

**Use a Prescaler if system voltage *EVER* exceeds 50 V!
Then set voltage scaling with F13 (see page 50).**



Note: Black wires are common within Prescaler. 45

Electric Vehicles (EVs)

The Link 10 is the ideal energy meter for EV instrumentation. It not only provides volts, amps, amp hours and time remaining, it adds two important bonuses: kilowatt hours and optional serial computer output.

If you design or work with electric vehicles or battery-powered equipment of any type, you should realize that kilowatt hours are a more accurate measure of energy used than are amp hours. Here's why:

The term "amp hour" defines current (amps) multiplied by time (hours). Amp hours is one way to state battery capacity. Amp hours is *not* a measure of energy consumed by a vehicle. Energy is defined as:

Energy in watt hours = voltage x amperage x time.

Consider two examples: First, assume we have a 120-volt battery that supplies a 100-amp load for 1 hour. At the end of one hour, 12,000 watt-hours (12.00 kWh) will have been consumed. In the same period of time, 100 amp hours will be used.

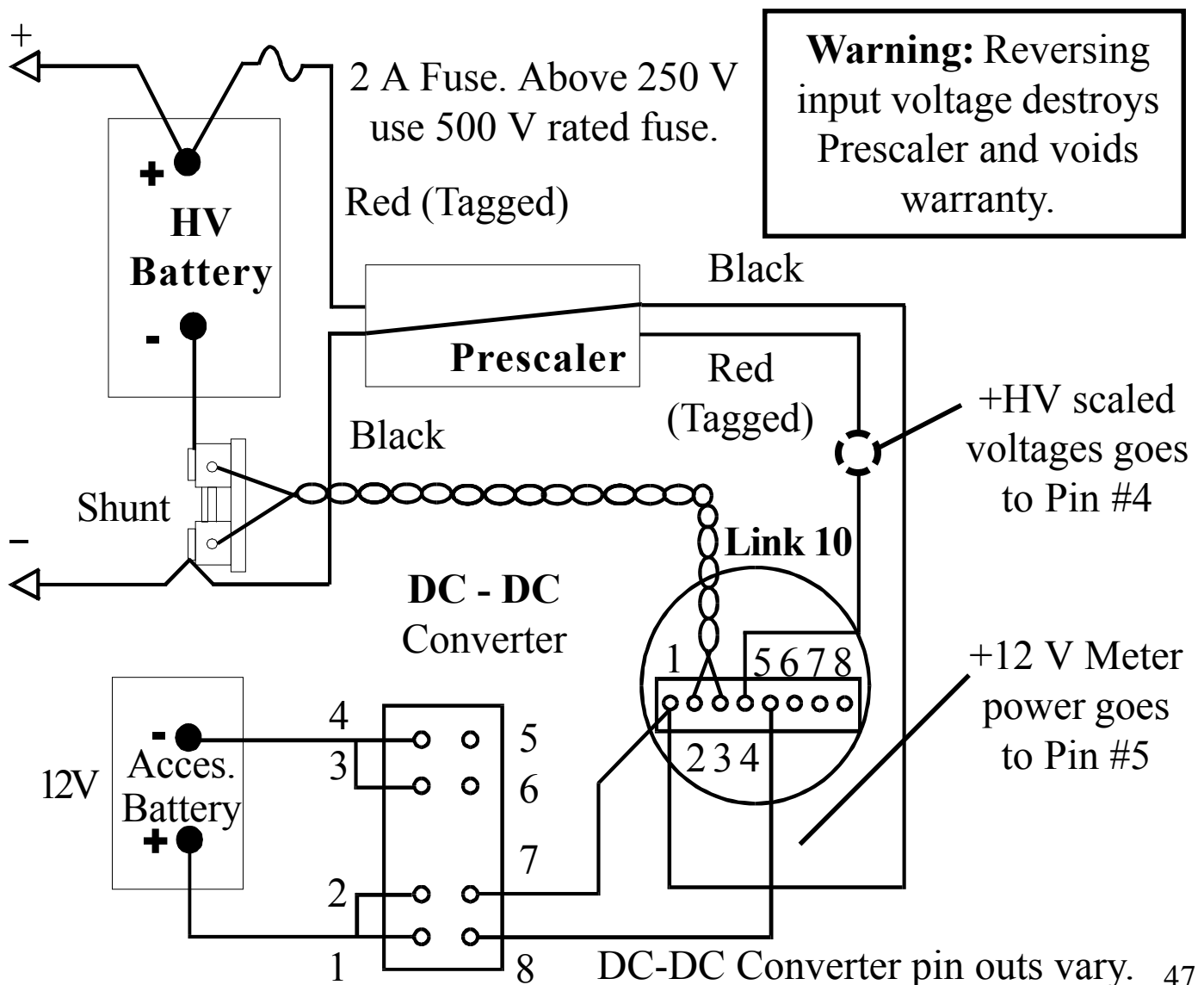
But now suppose we have a 240-volt battery supplying a 100-amp load for one hour. What happens to the math? Well, 24,000 watt hours (24.00 kWh) of power have been consumed. The amp hours consumed is the same as the first example, 100 amp hours, but *twice* the energy has been consumed!

That's why electric vehicle efficiency is judged on kilowatt hours. A kilowatt hour is a 1,000-watt load for a period of one hour. You buy kilowatt hours from the power company (to keep the lights on in your home) at a typical cost of \$0.05 to \$0.15 per kWh. By comparing the cost of kilowatt hours from the electric company with kilowatt-hour consumption of an electric vehicle, you can accurately judge EV operating costs.

Refer to the Owner's Manual for instructions on use of the kWh display.

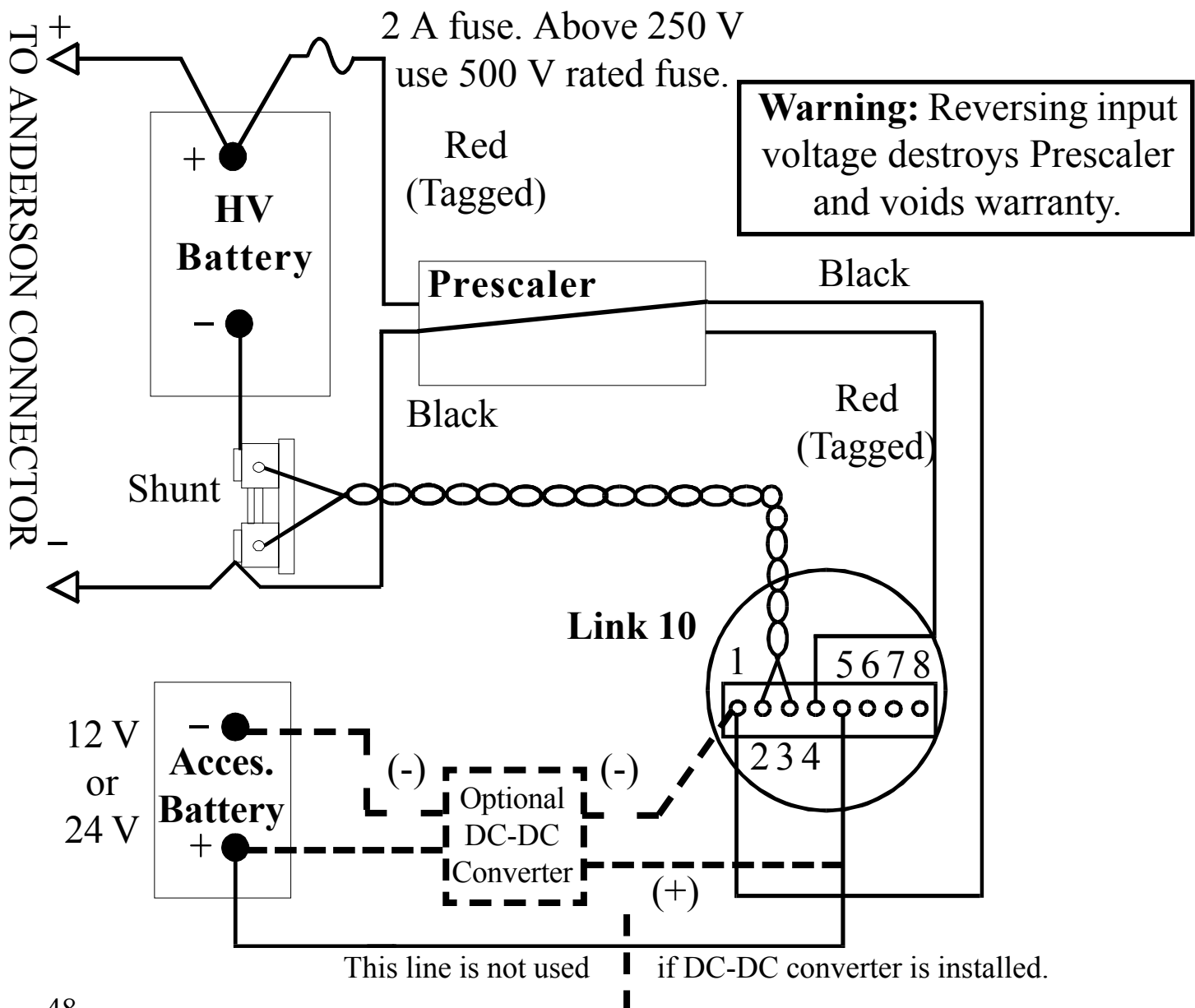
EV Installations

The negative of the Link 10's power supply must be common to the negative of the battery (motive pack) which you are measuring. This may pose difficulty if your electric vehicle uses an "unbonded" or "floating" (no connection to the chassis) motive pack and a "bonded" (connected to the chassis) accessory battery. **In these instances, the use of a DC-DC converter, or a separate battery with a common negative with the motive battery is required.** This device provides power for the Link 10 without electrically connecting the motive battery negative to the chassis. The diagram shown is for a typical DC-DC converter. If you use a different DC-DC converter, the pin-out may be different:



Lift Truck Installations

Installation of the Link 10 in lift trucks, which have the motive pack bonded to the chassis and also have a 12 V accessory battery bonded to the chassis, may use the diagram below for proper wiring of the appropriate Prescaler. The 0–100 V Prescaler is used where system voltage does not exceed 100 V at any time, including during onboard charging. In any other instance, a 500 V Prescaler must be used. If possible, install separate Anderson (SMH) connector so pack can be charged in truck if batteries are not changed. This way, battery cycles will be counted.



(optional) Serial Port, RS-232

The Link 10 may be equipped to transmit serial communications data to a personal computer or a data logging device. When equipped with the optional RS-232 port, the Link 10 will transmit a data message once a second. The structure of this data is as follows:

Data Rate: 9600 **Data Bits:** 8
Stop Bits: 1 **Parity Bits:** None
Word: ASCII Characters, comma delimited

Output Format:

Time, kWh, amps, volts, amp hours, Peukert amp hours, Peukert amps, time remaining, bar graph state, temperature (degrees C).

Time is elapsed seconds since last amp hour reset. Kilowatt hours are signed + or -, amp hours are signed + or -, amps are signed + or -, volts are positive, time remaining is in hours or tenths of hours.

Peukert amps and Peukert amp hours are compensated for Peukert's equation. These numbers are primarily intended for our development and troubleshooting. Please do not attempt to interpret these numbers.

The Bar Graph state is indicated by the following integers:

1<20%, 2<40%, 3<60%, 4<80%, 5<100%, 6 = Full (Charged Params met)

If the Low Battery Output is activated, the Bar Graph state is indicated as:

A<20%, B<40%, C<60%, D<80%, E<100%, F = Full (Charged Params met)

Pin Out:

The serial connection is via the DB-9 connector on the rear deck of the Link 10. See additional notes on page 11. The pin connections are as follows:

Pin 2 Receive Data line

Pin 3 Transmit Data line

Pin 5 Ground. This is connected to battery pack (-).

The shell of the DB-9 is NOT grounded.

High Voltage Notes

HOW TO SET VOLTAGE SCALING WHEN USING A HIGH VOLTAGE PRESCALER

F13 SET VOLTAGE SCALING

Sets proper voltage scaling when used with an external Voltage Prescaler. **NOTE:** If you use a Prescaler, you need to change the **Charged Voltage** to an appropriate value for your application. See "Charged Parameters" on pages 22 and 23.

DEFAULT: 0= 0–50 V. Options: 1= 0–100 V, 2= 0–500 V

IF YOU USE MOTIVE BATTERIES TO POWER THE LINK 10:

If the HV battery is "tapped" to provide meter power, it is recommended that a 24 V tap, not a 12 V tap, be used. The reason for this is that under heavy acceleration under low battery conditions, voltage may fall to levels low enough to cause the meter display to turn off momentarily. Under extreme circumstances, historical data may also be lost.

AVOID DATA LINE SHOCK HAZARD:

If you have a floating ground system and the Link 10 is equipped with the RS-232 Serial Computer Port option and is being used to record data into a laptop computer, we strongly recommend use of an optical isolator such as Omega Cat #268 to eliminate danger of a HV short to ground or personal shock hazard. Use caution in connecting wires to the DB-9 on the rear of the Link 10 as Pin #5 is connected directly to motive battery (-).

EC Declaration of Conformity

C E

Manufacturer: ***XANTREX TECHNOLOGY, INC.***

Address: ***Xantrex Technology, Inc.
8999 Nelson Way
Burnaby, BC
Canada V5A 4B5***

Herewith declares that the Xantrex Link 10 is in conformity with the provision of the EEC Directive EMC 89/336/EEC and amendments 92/31/EEC, 93/68/EEC.

The following harmonized standards have been applied:

EN 50081-1: 1992

EN 50082-1: 1992

Limited Warranty

What does this warranty cover?

This Limited Warranty is provided by Xantrex Technology, Inc. ("Xantrex") and covers defects in workmanship and materials in your Xantrex Link 10 Battery Monitor. This warranty lasts for a Warranty Period of 12 months from the date of purchase at point of sale to you, the original end user customer.

This Limited Warranty is transferable to subsequent owners but only for the unexpired portion of the Warranty Period.

What will Xantrex do?

Xantrex will, at its option, repair or replace the defective product free of charge, provided that you notify Xantrex of the product defect within the Warranty Period, and provided that Xantrex through inspection establishes the existence of such a defect and that it is covered by this Limited Warranty.

Xantrex will, at its option, use new and/or reconditioned parts in performing warranty repair and building replacement products. Xantrex reserves the right to use parts or products of original or improved design in the repair or replacement. If Xantrex repairs or replaces a product, its warranty continues for the remaining portion of the original Warranty Period or 90 days from the date of the return shipment to the customer, whichever is greater. All replaced products and all parts removed from repaired products become the property of Xantrex.

Xantrex covers both parts and labor necessary to repair the product, and return shipment to the customer via a Xantrex-selected non-expedited surface freight within the contiguous United States and Canada. Alaska and Hawaii are excluded. Contact Xantrex Customer Service for details on freight policy for return shipments outside of the contiguous United States and Canada.

How do you get service?

If your product requires troubleshooting or warranty service, contact your merchant. If you are unable to contact your merchant, or the merchant is unable to provide service, contact Xantrex directly at:

Phone: 1-800-670-0707 (toll free in North America) 1-604-422-2777 (direct)

Fax: 1-604-420-2145

Email: CustomerService@xantrex.com

Direct returns may be performed according to the Xantrex Return Material Authorization Policy described in your product manual. For some products, Xantrex maintains a network of regional Authorized Service Centers. Call Xantrex or check our website to see if your product can be repaired at one of these facilities.

In any warranty claim, dated proof of purchase must accompany the product and the product must not have been disassembled or modified without prior written authorization by Xantrex.

Proof of purchase may be in any one of the following forms:

- The dated purchase receipt from the original purchase of the product at point of sale to the end user, or
- The dated dealer invoice or purchase receipt showing original equipment manufacturer (OEM) status, or
- The dated invoice or purchase receipt showing the product exchanged under warranty

What does this warranty not cover?

This Limited Warranty does not cover normal wear and tear of the product or costs related to the removal, installation, or troubleshooting of the customer's electrical systems. This warranty does not apply to and Xantrex will not be responsible for any defect in or damage to:

- a) the product if it has been misused, neglected, improperly installed, physically damaged or altered, either internally or externally, or damaged from improper use or use in an unsuitable environment;
- b) the product if it has been subjected to fire, water, generalized corrosion, biological infestations, or input voltage that creates operating conditions beyond the maximum or minimum limits listed in the Xantrex product specifications including high input voltage from generators and lightning strikes;
- c) the product if repairs have been done to it other than by Xantrex or its authorized service centers (hereafter "ASCs");
- d) the product if it is used as a component part of a product expressly warranted by another manufacturer;
the product if its original identification (trade-mark, serial number) markings have been defaced, altered, or removed.

Disclaimer

Product

THIS LIMITED WARRANTY IS THE SOLE AND EXCLUSIVE WARRANTY PROVIDED BY XANTREX IN CONNECTION WITH YOUR XANTREX PRODUCT AND IS, WHERE PERMITTED BY LAW, IN LIEU OF ALL OTHER WARRANTIES, CONDITIONS, GUARANTEES, REPRESENTATIONS, OBLIGATIONS AND LIABILITIES, EXPRESS OR IMPLIED, STATUTORY OR OTHERWISE IN CONNECTION WITH THE PRODUCT, HOWEVER ARISING (WHETHER BY CONTRACT, TORT, NEGLIGENCE, PRINCIPLES OF MANUFACTURER'S LIABILITY, OPERATION OF LAW, CONDUCT, STATEMENT OR OTHERWISE), INCLUDING WITHOUT RESTRICTION ANY IMPLIED WARRANTY OR CONDITION OF QUALITY, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE TO THE EXTENT REQUIRED UNDER APPLICABLE LAW TO APPLY TO THE PRODUCT SHALL BE LIMITED IN DURATION TO THE PERIOD STIPULATED UNDER THIS LIMITED WARRANTY.

Limited Warranty

IN NO EVENT WILL XANTREX BE LIABLE FOR ANY SPECIAL, DIRECT, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, COSTS OR EXPENSES HOWEVER ARISING WHETHER IN CONTRACT OR TORT INCLUDING WITHOUT RESTRICTION ANY ECONOMIC LOSSES OF ANY KIND, ANY LOSS OR DAMAGE TO PROPERTY, ANY PERSONAL INJURY, ANY DAMAGE OR INJURY ARISING FROM OR AS A RESULT OF MISUSE OR ABUSE, OR THE INCORRECT INSTALLATION, INTEGRATION OR OPERATION OF THE PRODUCT.

Exclusions

If this product is a consumer product, federal law does not allow an exclusion of implied warranties. To the extent you are entitled to implied warranties under federal law, to the extent permitted by applicable law they are limited to the duration of this Limited Warranty. Some states and provinces do not allow limitations or exclusions on implied warranties or on the duration of an implied warranty or on the limitation or exclusion of incidental or consequential damages, so the above limitation(s) or exclusion(s) may not apply to you. This Limited Warranty gives you specific legal rights. You may have other rights which may vary from state to state or province to province.

Warning: Limitations On Use

Please refer to your product user manual for limitations on uses of the product. Specifically, please note that the Xantrex Link 10 Battery Monitor is not intended for use in connection with life support systems and Xantrex makes no warranty or representation in connection with any use of the product for such purposes.

Return Material Authorization Policy

Before returning a product directly to Xantrex you must obtain a Return Material Authorization (RMA) number and the correct factory "Ship To" address. Products must also be shipped prepaid. Product shipments will be refused and returned at your expense if they are unauthorized, returned without an RMA number clearly marked on the outside of the shipping box, if they are shipped collect, or if they are shipped to the wrong location.

When you contact Xantrex to obtain service, please have your instruction manual ready for reference and be prepared to supply:

- The serial number of your product
- Information about the installation and use of the unit
- Information about the failure and/or reason for the return
- A copy of your dated proof of purchase

Return Procedure

1. Package the unit safely, preferably using the original box and packing materials. Please ensure that your product is shipped fully insured in the original packaging or equivalent. This warranty will not apply where the product is damaged due to improper packaging.
2. Include the following:
 - The RMA number supplied by Xantrex Technology Inc clearly marked on the outside of the box.
 - A return address where the unit can be shipped. Post office boxes are not acceptable.
 - A contact telephone number where you can be reached during work hours
 - A brief description of the problem
3. Ship the unit prepaid to the address provided by your Xantrex customer service representative.

If you are returning a product from outside of the USA or Canada

In addition to the above, you MUST include return freight funds and are fully responsible for all documents, duties, tariffs, and deposits.

If you are returning a product to a Xantrex Authorized Service Center (ASC)

A Xantrex return material authorization (RMA) number is not required. However, you must contact the ASC prior to returning the product or presenting the unit to verify any return procedures that may apply to that particular facility.

RS-232 Warning

When using an RS-232-equipped version of the Link 10 in an electric vehicle which has a floating motive battery negative, remember that Pin #5 of the DB-9 connector coming out of the back of the Link 10 is connected to the motive battery negative.

This normally causes no problem when used with laptop computers. However, if you plug the DB-9 RS-232 output into a computer with a metal chassis then motive battery negative will be connected to the chassis of the computer.

THIS EXPOSED BATTERY NEGATIVE MAY BE HAZARDOUS, AND POSSIBLY FATAL IF YOU HAVE A HIGH SIDE MOTIVE PACK FAULT.

We strongly recommend that when using a computer to log data, you minimize the hazard by installing an RS-232 Opto-Isolation Module. One such module is available through Omega Engineering, Inc. (Model 268 costs \$126). Call 1-800-872-9436 (phone), 1-800-848-4271 (fax), or visit www.omega.com

Please note you will also have to purchase DB-25 to DB-9 adapters as the Model 268 uses DB-25 connectors. Be certain you purchase straight-through adapters, not the null modem type!

Software History

Software Enhancement Rev. E 1.5

The Link 10 now includes the following additional functions:

F02 - ENHANCED SLEEP MODES

DEFAULT: ON **Range: ON, OFF, AUTOMATIC**

When the Sleep Mode is ON, the Link 10's numeric display turns off after 10 minutes in order to reduce power consumption. Pressing either SET or SEL buttons returns the numeric display to operation.

When the Sleep Mode is OFF, the numeric display stays on at all times. In the AUTOMATIC sleep mode (displayed as *AUT*), the numerics are on whenever charging or discharging exceeds 1 amp. When the rate of charge or discharge remains less than 1 amp for 10 minutes, the numeric display is turned off to conserve power. When asleep, pressing either SET or SEL reactivates the numeric display. The numeric display automatically wakes up when the rate of charge or discharge exceeds 1 amp. The Automatic Sleep Mode is ideal for electric vehicles.

TIME REMAINING DISPLAY

DEFAULT: 001 **Range: 000, 001, 002, 003, P**

When *P* is selected, an averaged Time Remaining number is not displayed. Instead, the Link 10 reports *rate compensated* percent of (declared) Battery Capacity Remaining. A full battery is displayed as *100P* and the display decrements during discharge to *00P*.

If you have selected a discharge floor other than 100%, the percent of battery capacity remaining is referenced to the selected discharge floor and uses the instantaneous (not averaged) rate of discharge.

This function is useful on electric vehicles where time remaining numbers are of little value. NOTE: This display shows the rate compensated capacity percentage which drives the bar graph.

Software Addendum

Software Enhancement

This version of the Link 10 includes special software.




F18 - SMALL BATTERY SENSING

DEFAULT: OFF **Range: OFF, ON**

When this function is OFF, the meter operates as described elsewhere in this manual. When this function is ON, the amp-hour capacity range allows capacities as low as 2 amp-hours to be declared. When ON, capacity may be set from 2–200 amp hours, and small capacity increments are allowed as follows:

From 2–40 amp hours, 1 amp-hour capacity increments are permitted. Above 40 (to 198 amp hours), 2 amp-hour capacity increments are permitted.

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Specifications

Voltage: For 12 V–24 V systems. **Optional Prescalers extend voltage range.**

Ⓥ **Standard Model:** Two Auto-ranges: 0 to 19.95 V (0.05 V resolution)
20.0 to 50.0 V (0.1 V resolution)

Optional Prescalers: 0–100 V, 0–500 V (Used with standard model)

Amperage:

Ⓐ **Low Range:** +0–40.0 amps (0.1 amp resolution)
High Range: +500 amps (1 amp resolution)

Amp-hours:

Ⓐh **Low Range:** +0–199.9 amp hours (0.1 amp hour resolution)
High Range: +200–1999 amp hours (1 amp hour resolution)

Time Remaining:

Ⓣ **Low Range:** 0 to 199.9 hours (0.1 hour resolution)
High Range: 0 to 255 hours (1.0 hour resolution)

Power Requirements:

9.5–40 volts DC

Current: 50–150 mA (Depends on ambient light. Display auto dims.)
28 mA (Sleep Mode—Bar Graph Display Only)

Shunt type required: 50 mV @ 500 amp

Accuracy:

Voltage: + (0.6% of reading + 1 least count of resolution)

Amperage: + (0.8% of reading + 1 least count of resolution)

Amp hours: Ah Error ~ (Time of measurement x current error)

Physical:

Max. Outer Bezel Diameter: 2.5" (63.5 mm)

Max. Barrel diameter: 1.95" (50 mm)

Max. Depth: (from back of bezel) 3.15" (80 mm)

Hole Cutout Size: Use 2" or 2 1/16" hole saw (52 mm)

Water Resistance: Splashproof front panel.

Weight: 8 Ounces (227 g)

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445-0195-01-01 Rev. 1

Printed in the U.S.A.

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