

**BATTERY MANAGEMENT SYSTEM**

**OWNER'S MANUAL  
VER 1.4 08/23/02**

**NOTE: PLEASE READ MANUAL  
COMPLETELY BEFORE OPERATION**

**INTRODUCTION:**

**CONGRATULATIONS!** Your choice of the Einstein XL Battery Management System assures you of the highest standards of design, manufacturing, and functionality available to the R/C industry. The Einstein XL is a laboratory-quality instrument (accurate to within 3%) designed specifically for the R/C enthusiast to condition, charge, and test the capacity of practically any Nicad or Metal Hydride battery pack. The Einstein XL System comes loaded with many features unavailable on other battery charger/cyclers in its price range. Its microprocessor control enables "push button" ease-of-use so you don't have to be a rocket scientist to perform 100% diagnostics on the quality and reliability of your batteries - the life-blood of your R/C investment! Just plug it in, select a charge rate, the number of cells in your battery pack, press the CYCLE START button and walk away. When you return 16 hours later, you're ready to fly, confident that your batteries are tested, fully charged, and at peak capacity. And if there is a problem with your battery pack, you'll know just by looking at the "oversized" LCD. If the number on the display is not within 80 to 90% of the capacity rating of your pack, it's probably time to replace the pack. Now isn't that better than risking the thousands of dollars and countless hours invested in your hobby to a battery pack failure? Whether the battery pack being tested 1) has developed "memory" (a classic phenomenon associated with *all* Nicad batteries), 2) has a bad cell, or 3) is just getting old, the Einstein XL will safely detect the problem and notify you of any trouble by displaying the true capacity of the battery pack in mAh on the LCD. Simple to set up, highly flexible, complete diagnostics, no complex formulas or calculations, and highly accurate readings every time make it so smart we just had to call it Einstein!

**SPECIFICATIONS:**

SIZE:	5.94"L X 4.14"W X 1.16"H
WEIGHT:	7.2 OZ.
FUNCTION:	TWO CHANNEL, MICROPROCESSOR CONTROLLED, NICAD, METAL HYDRIDE BATTERY NORMAL CHARGER, TRICKLE CHARGER, CYCLER
CELL CAPABILITIES:	ALLOWS CHARGE/DISCHARGE FROM <b>2-12 CELLS</b> ON EITHER OF TWO CHANNELS
MAX CAPACITY RATINGS:	1500 mAh (CHARGE), 19,999 mAh (DISCHARGE)
NORMAL CHARGE RATES:	FIVE, NORMAL, SELECTABLE, CONSTANT CURRENT <b>CHARGE RATES (25, 50, 80, 120, 140 mA)</b> FOR 16 HOURS
TRICKLE CHARGE RATE:	CONSTANT CURRENT 12 mA
DISCHARGE RATE:	PRECISION CONSTANT CURRENT DISCHARGE RATE (300mA) ACCURATE TO WITHIN 3%.
READOUT:	LARGE (.5" DIGIT), FOUR SEGMENT, LCD - DISPLAYS CAPACITY DIRECTLY IN mAh
BATTERY BACK-UP:	9V ALKALINE (NOT INCLUDED), KEEPS DISCHARGE FUNCTION OPERATIVE OR RETAINS OPERATION MODE DURING AC DROP OUT.
POWER SUPPLY:	EXTERNAL 1 AMP 18V AC/DC, UL APPROVED POWER SUPPLY WHICH CAN BE USED FOR FUTURE FMA PRODUCTS.
PROTECTION:	1A, FAST BLOW FUSE PROTECTED CIRCUITRY.
INTERCONNECTION:	ADAPTER CABLES (2) AND VERSATILE ADAPTER INCLUDED AS STANDARD EQUIPMENT

**PACKAGE CONTENTS:**

1. One Einstein XL (Main Unit)
2. One UL Listed 18V DC External Power Supply (FMA Part No. PS1-18)
3. Two DC Power Connector Cable (FMA Part No. 304BC) – Deluxe Model Only
4. Two Versatile Adapter (FMA Part No. 501MC) – Deluxe Model Only
5. Six Selector Jumpers (2 spares)
6. One Einstein XL Owner's Manual
7. One Versatile Adapter Owner's Manual – Deluxe Model Only
8. One Einstein Battery Management Quick Reference

**OVERVIEW:**

FMA, Inc.  
5716A Industry Lane  
Frederick, MD 21704  
Sales: (800) 343-2934 - Technical: (301) 668-7614  
Internet Site: <http://www.fmadirect.com>  
email: [support@fmadirect.com](mailto:support@fmadirect.com)



Designed and manufactured in the U.S. using Surface Mount Technology (SMT) and automated assembly, the Einstein XL is a two channel charger/cycler that is capable of charging and/or discharging two battery packs simultaneously. Designed from the ground-up to offer the utmost in flexibility, the system provides 5 user-selectable, overnight (C/10), constant current charge rates on either channel. These charge rates are 25, 50, 80, 120, and 140 mA. The charge section is capable of safely and completely charging any Nicad or Metal Hydride battery pack containing from 2 to 12 cells and having a capacity of from 250 mAh to 1500 mAh. The microprocessor-controlled timer section always forces the unit back to trickle charge (12 mA) after 16 hours of charging at normal rate so there's no need to worry about overcharging. The discharge section removes a constant current of 300 mA from the battery pack connected. The discharge section can safely and completely remove all of the available power from any Nicad or Metal Hydride battery pack containing from 2 to 12 cells (user-selectable on either channel) and having a capacity of from 250 to 19,999 mAh. The discharge section measures the capacity removed from the battery and updates the LCD in real-time to indicate the quality of the battery pack being tested. The discharge section will continue to deplete the battery until the battery pack voltage reaches 1.1 volts per cell, the RMS or average end-of-life for a typical Nicad cell under "normal" load requirements. Unlike its competition, the Einstein XL enables you to charge or cycle virtually any battery pack configuration on either channel. For instance, you could charge or cycle a flight pack and a transmitter, or two flight packs, or two transmitters, or a flight pack and a video camcorder pack, etc., simultaneously. Additionally, one side of the unit can be set up to cycle a battery pack while the other side is charging a pack. The Einstein XL Battery Conditioning System has three modes of operation. These are 1) the **Trickle Charge Mode**; 2) the **Normal Charge Mode**; and 3) the **Cycle Mode**. The Trickle Charge Mode is the default mode. Initiated at power up, it supplies a constant current 12 mA trickle charge to the connected battery pack(s). While in Trickle Charge mode, the LCD accumulates the time (up to 99:59 or 99 hours and 59 minutes) that the batteries have been on Trickle Charge. After 99:59, the display will reset to 00:00 and start over. The Normal Charge Mode supplies one of 5 user-selectable, constant current charge rates listed previously and can be initiated by pressing the CHARGE START button. The unit will charge the battery for 16 hours at which time it will revert to the Trickle Charge Mode. The Cycle Mode discharges the battery pack at a fixed 300mA constant current discharge and is initiated by pressing the CYCLE START button. When the battery has been discharged to 1.1 volts per cell, the microprocessor initiates the Normal Charge Mode. After the pack has been charged at the Normal Charge Rate for 16 hours, the Einstein XL reverts to the Trickle Charge Mode. The unit will remain in the Trickle Charge Mode and all Cycle and Charge mode readings are retained until the unit is either turned off or another mode of operation is initiated by the user. Batteries can be left on trickle charge indefinitely. In addition to the LCD, six LEDs (three per channel) indicate the mode of operation for each battery pack connected. The Normal Charge Mode is indicated by a GREEN LED; Trickle Charge Mode by a YELLOW LED; and Discharge Mode by a RED LED. By placing the power supply for the Einstein XL external to the unit, FMA Direct engineers were able to reduce the size, weight, and internal heat of the product and reduce cost while at the same time providing to the industry a true, UL compliant product with greater accuracy and longer life. The Einstein XL also comes equipped with 9V battery backup circuitry which provides power to the unit in the event of A/C power outage (9V battery is not included). In addition, the Deluxe model is shipped with two FMA Direct unique Versatile Adapter, as well as two 2.5mm to 2.5mm barrel cables. Used in combination, these accessory products will allow you to easily interface the system to most of the current connector brands (Futaba, JR, Airtronics, ACE, HITEC). FMA Direct, Inc. warrants the product to be free of manufacturing defects for the term of one year (Parts and Labor).

#### **OPERATION: PREPARATION**

1. Unpack the Einstein XL system and lay the contents out in front of you. Verify that your package contains all of the items listed above under "PACKAGE CONTENTS". If the package is missing any item(s), contact FMA Direct immediately.
2. Plug the external AC/DC power supply (PS1-18) into the Einstein XL unit where the label indicates D.C. POWER IN.
3. Plug the AC portion of the PS1-18 into an ordinary AC home outlet (120V U.S., 230V Germany, 240V England, etc.)
4. Open the package containing the Selector Jumpers. Install two jumpers in the slots labeled CHARGE RATE (mA) next to the numbers 25. Install two jumpers in the slots labeled NUMBER OF CELLS next to the numbers 2. The remaining 2 jumpers are spares.
5. Slide the power switch to ON and observe the LCD. The display should blink all segments on for 2 or 3 seconds, go off completely for about 1 second and then blink between 00:00 (the trickle timer) and 0 (battery capacity indicator). The 0 indicates that no capacity has been removed from any battery. After initial power up, the trickle timer will begin to accumulate time indicating how long the unit has been in the trickle charge mode. This will occur whether or not there are batteries connected to the unit.
6. Einstein XL is equipped with a 9V battery backup. Although the Einstein XL will function properly without the battery, you should install the battery to prevent losing valuable test data in the event of an A/C drop-out. For best results, a good quality alkaline is recommended. To install the 9V battery, remove the four screws in the case back, clip the battery into the snap cable provided, mount the battery in the P.C. board cutout and fasten the box together again. The estimated battery life is about 5 hours when A/C is not present. The Einstein XL will discharge any battery running only on 9V backup power. It will not charge on backup power.

#### **BATTERY CONNECTION**

The Einstein XL is designed to be completely flexible when connecting batteries. Unlike most brands on the market, the Einstein XL *does not* limit you to charging/cycling a flight pack on one channel and a transmitter pack on the other. For instance, you could charge or cycle a flight pack and a transmitter, or two flight packs, or two transmitters, or a flight pack and a video camcorder pack, etc., simultaneously. Furthermore, the Deluxe model comes with two DC power cables and two Versatile Adapters, so hooking up batteries is a snap.

#### **HOOKING UP A RECEIVER BATTERY PACK**

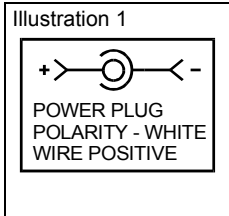
1. Before connecting batteries to the Einstein XL, slide the power switch to OFF.
2. If you purchased the Deluxe model, connect a receiver battery pack to the Einstein XL by plugging one end of the supplied, double-ended, 2.5mm to 2.5mm power cable (304BC) to either CH 1 or CH 2 INPUT. Plug the other end of this cable into the Versatile Adapter input labeled 2.5mm. Now plug your receiver battery pack into the Versatile Adapter on the input labeled with your radio system brand. For example, if you have a Futaba system and your battery is equipped with a Futaba "J" style connector, plug the battery into the slot labeled FUT. For more information, consult the Versatile Adapter owner's manual included with the system.
3. In order for the Einstein XL to charge and/or cycle your battery pack properly, you must establish two pieces of information regarding your battery pack. One is the Charge Rate best suited to the battery connected, and the other is the Number of Cells in the pack. This information is determined by where you install the selector jumpers for a given channel. The normal charge rate (C/10) for a given battery pack is determined by dividing the mAh capacity of the pack by 10. If the exact charge rate is not available, use the next lowest charge rate available. At the C/10 charge rate, the battery will be fully charged in 10 hours. To allow for battery capacities that fall between the standard charge rate options and the fact that no charger is 100% efficient, the Einstein XL remains in Charge Mode for 16 hours. It is completely safe to charge batteries at the normal rate for 16 hours or longer without fear of overcharge.

EXAMPLE 1: If you have connected a 4 Cell, 500 mAh pack to Channel 1, set the Charge Rate Jumper to 50 and the Number of Cells Jumper to 4.

EXAMPLE 2: If you have connected a 5 Cell, 600 mAh pack to Channel 2, set the Charge Rate Jumper to 50 and the Number of Cells Jumper to 5.

### HOOKING UP A TRANSMITTER BATTERY PACK (OVERVIEW)

Because of the vast array of transmitter battery pack configurations and installations, hooking up a particular transmitter battery brand may be a bit more complicated than hooking up a receiver pack. Most current transmitter designs are equipped with either a 2.5mm or a 2.1mm DC Power Jack for charge input. In order to prevent damage to the circuitry, most transmitters also contain a reverse polarity protection diode to prevent reverse charging. Unfortunately, this protection feature also prevents you from discharging the battery pack while it is installed in the transmitter. Although FMA does not recommend doing so, it is possible to bypass the protection diode (as well as the protection feature of your transmitter) by soldering a wire across this component, thus allowing you to charge or cycle a battery pack installed in the transmitter. *FMA Direct will not be held liable for any damage resulting to any piece of equipment modified by anyone other than authorized FMA Direct service personnel!* *Modification of your R/C radio system usually means voiding your original equipment warranty!* **In addition, not all brands of transmitters use the same polarity on the DC power jack (see warning below). FMA Direct brand products follow the standard convention whereby power jacks are wired such that tip is positive and sleeve is negative (see Illustration 1).**



**WARNING: Certain manufacturers, notably JR, do not follow the standard convention of making the tip positive and the sleeve negative on power connectors. JR makes the tip negative and the sleeve positive. FMA, Futaba, Airtronics, HITEC, and ACE use the standard convention. If your equipment is none of the above or you are uncertain of your connector polarity, use a volt meter to determine connector polarity. If your system is reverse polarity from standard, you may modify the power cable to accommodate the reversed polarity by cutting the cable, reversing the white and black wires, and soldering them together again. Failure to do so will **DAMAGE** both your transmitter battery pack as well as the Einstein XL unit thus voiding the product's warranty!**

To make transmitter hook-up easier, remove the battery pack from your transmitter whenever possible before connecting it to the Einstein XL.

1. Before connecting batteries to the Einstein XL, slide the power switch to OFF.
2. If you purchased the Deluxe model, to connect a transmitter battery pack to the Einstein XL, remove the battery pack from the transmitter, plug one end of the supplied, double-ended, 2.5mm to 2.5mm power cable (304BC) to either CH 1 or CH 2 INPUT. Plug the other end of this cable into the Versatile Adapter input labeled 2.5mm.
3. Now plug your transmitter battery pack into the Versatile Adapter on the input labeled with your radio system brand. For example, if you have a Futaba system and your battery is equipped with a Futaba "J" style connector, plug the battery into the slot labeled FUT.
4. In order for the Einstein XL to charge and/or cycle your battery pack properly, you must establish two pieces of information regarding your battery pack. One is the Charge Rate best suited to the battery connected, and the other is the Number of Cells in the pack. This information is determined by where you install the selector jumpers for a given channel. The normal charge rate (C/10) for a given battery pack is determined by dividing the mAh capacity of the pack by 10. If the exact charge rate is not available, use the next lowest charge rate available. At the C/10 charge rate, the battery will be fully charged in 10 hours. To allow for battery capacities that fall between the supplied charge rate options and the fact that no charger is 100% efficient, the Einstein XL remains in Charge Mode for 16 hours. It is completely safe to charge batteries at the normal rate for 16 hours or longer without fear of overcharge.

**EXAMPLE 1:** If you have connected an 8 Cell, 800 mAh pack to Channel 1, set the Charge Rate Jumper to 80 and the Number of Cells Jumper to 8.

A complete line of accessory power and battery cables is available through FMA Direct. If you experience problems interfacing your batteries to the Einstein XL, our competent staff is available to offer assistance on our 800 number.

### OPERATION MODES (OVERVIEW)

Mode 1 begins at power on. Select either Mode 2 by pressing the CHARGE START button or Mode 3 by pressing the CYCLE START button. Mode 2 can be accessed at any point during Mode 1 or Mode 3. Mode 3 can be accessed at any point during Mode 1 or Mode 2.

#### MODE 1 (TRICKLE CHARGE) DESCRIPTION:

When a battery pack is connected to either channel 1 or channel 2 of the Einstein XL, the unit automatically supplies 12 mA of constant current to charge the battery. Only the YELLOW LED is lit as long as a battery is connected. This indicates to the user that the Einstein XL is ready to begin charging or cycling a battery. The display reads 00:00 and begins to accumulate time in minutes and then hours to indicate to the user the time that the batteries have been on trickle charge. After 99 hours and 59 minutes or 99:59, the display will reset and start over at 00:00. The unit will remain in trickle charge mode until either power is cycled, or until another mode of operation is initiated.

#### MODE 2 (NORMAL RATE CHARGE) DESCRIPTION:

In order to establish the Normal Charge Mode properly, determine the capacity of the battery pack(s). Divide this number by 10. Next, select the normal charge rate that is closest to or slightly less than the available options (25, 50, 80, 120, 140 mA). The unit can successfully charge batteries in one pass with capacities up to 1500 mAh. Now move the jumper to this rate for the channel where this pack is connected and initiate the Normal Charge Mode by pressing the CHARGE START button. At this time the microprocessor will start Mode 2 operation by pulling in the relay and activating the charge circuitry. The microprocessor also begins a long-range timer that will run for 16 hours. The charge circuit will deliver the constant current charge rate selected to the channel(s) where a battery is connected. In Mode 2, only the GREEN LED will be lit as long as a battery is connected to the side in question. The display will alternately flash between 0 and CHG. The display will flash the same message for either side at this time so the channel selector switch (CH. SEL.) has no effect. The 0 indicates that no capacity has been removed from the pack(s), CHG indicates that the unit is in the Normal Charge mode and has encountered no errors in operation. After 16 hours, the microprocessor will revert to Mode 1 operation. The YELLOW trickle charge LEDs will again light. At this time the trickle charge timer will begin to accumulate time to indicate how long the batteries have been on trickle charge.

#### MODE 3 (CYCLE) DESCRIPTION:

In order to initialize the Cycle Mode properly, you must determine the capacity of your battery pack(s) and the number of cells for each pack. Next, select the normal charge rate that is closest to or slightly less than the closest option available. Move the jumper to this rate for the channel where this pack is connected. You must also move the jumper to the number of cells in the pack connected to the appropriate channel. Mode 3 can be initiated at any point during Mode 1 operation or at any point during Mode 2 operation by depressing the CYCLE START button. At this time, the microprocessor will start Mode 3 operation by pulling in the relay and activating the discharge circuitry. Only the RED LED will be lit. As long as either of the packs connected is above 1.1 volts per cell (times the number of cells connected) and the cell selector jumper is properly set, the Einstein XL will draw a constant current of 300 mA from the packs connected to both channels. At this discharge rate, mathematically, one milliamp hour of capacity will be removed from any battery every 12 seconds. The microprocessor will begin to count at 12 second increments and update the capacity removed from each of the packs connected to channel 1 and 2 independently. The capacity removed from the packs is displayed and

updated every 12 seconds on the LCD. The capacity removed from either pack can now be displayed on the LCD by setting the channel selector switch (CH. SEL.) to view the appropriate channel (1 or 2).

As capacity is removed from the batteries, the voltage level measured at the battery falls. When the battery reaches its fully discharged voltage of 1.1 volts per cell, the microprocessor then stops counting capacity removed from the pack and initializes Mode 2 operation for that channel by switching the discharge circuitry off and turning on the normal rate charge circuitry. At the same time, only the GREEN LED is lit, and the microprocessor will start the long-range timer to count 16 hours for charge rate time-out. The LCD will now flash between the final capacity removed from the battery pack and CHG. After the 16 hour timer expires, the microprocessor kicks out the relay and puts the unit back to Mode 1 operation. Only the YELLOW LEDS will be lit and the LCD will alternate between battery capacity removed and the trickle charge timer 00:00.

#### CHARGING ONE CHANNEL WHILE DISCHARGING ANOTHER:

In order to charge one pack while discharging another follow these procedures:

1. Set the Charge Rate and Number of Cells Jumpers for each channel according to the batteries connected.
2. Disconnect the battery to be charged from the Einstein XL.
3. Begin cycling the pack to be discharged by pressing the CYCLE START switch. The discharge indicator LED will now light on this channel.
4. Immediately plug in the channel to be charged. The charge indicator will now light on this channel.

#### BATTERY MAINTAINENCE:

The Einstein XL is an ideal tool for maintaining and checking the quality of your batteries over extended periods of time. It is a good idea to develop a habit of testing and cycling your batteries on a regular maintenance schedule. By testing and recording your readings in a weekly or monthly log, you can easily detect downward trends in battery pack capacity. Although the accuracy of Einstein is exceptionally good, the actual percentage of battery pack capacity may be less important than the trend of a series of tests on the same pack over time. In other words, while a pack may check out at 80% or 90% of capacity, it may be O.K. if it continues to deliver this value over multiple tests. If the same pack drops to 75% or lower in consecutive tests, it might be wise to replace it.

#### CHARGING ERRORS INDICATION AT COMPLETION OF CYCLE MODE (Err1):

The batteries connected to the Einstein XL are fully charged after 10 hours. The normal rate charge, 16 hour timer is not channel independent. Hence, the first battery to reach complete discharge will start the long-range charge timer. The battery which reaches complete discharge last may not be given ample charge time before the microprocessor charge timer elapses and forces the unit back to trickle mode. The long-range charge timer is set to 16 hours to ensure full charge. It does not hurt the batteries to leave them charging at the normal C/10 rate for greater than 10 hours. So if one battery reaches full discharge up to 6 hours before the second pack does, the second pack will still receive a full 10 hour charge before both packs enter trickle mode and no errors will have occurred in charging. In the event the second pack requires longer than 6 hours to fully discharge after the first pack starts the long-range 16 hour timer (for example a 200 mAh pack and a 2000 mAh pack cycled simultaneously), that channel will continue to discharge and accumulate removed capacity. However, when this channel does go to normal charge mode, the LCD will alternately flash between the final removed capacity and Err1 to indicate that although the capacity was tested properly, the battery pack did not receive the minimum required 10 hours of charge time. When the unit reverts to Mode 1, the LCD will alternatively flash between final removed capacity, Err1, and 00:00 (Trickle Timer). This error will rarely be encountered because the maximum capacity that the Einstein XL can handle in charging is 1500 mAh which is less than the 1800 mAh difference that would create these errors.

There will be times when you wish to discharge batteries with a capacity greater than 1500 mAh. Please be aware that this will also create a charge error because battery packs larger than 1500 mAh will not receive a full charge in one pass. If the pack being cycled exceeds 1500 mAh, the LCD will alternately flash between the final removed capacity and Err1. When the unit reverts back to Mode 1, the LCD will alternately flash between the final removed capacity, Err1, and 00:00 (Trickle Timer).

To summarize, Err1 indicates that 1) the battery in question did not receive ample charge time because it took more than 6 hours longer than the other pack to discharge or 2) the battery has a capacity greater than 1500 mAh and did not receive a full charge in one pass. The battery indicating Err1 will need to be charged longer by initiating a second, partial charge mode.

#### DISCHARGING ERRORS INDICATION AT COMPLETION OF CYCLE MODE (Err2):

Once Mode 3 is initiated, the only event that can force the Einstein XL to Mode 2 is the complete discharge of a battery hooked to the channel in question. Once this event occurs on either channel, the long-range timer is activated, and nothing will prevent the unit from entering Mode 1 16 hours later. This means that if no pack, or a small to normal-sized pack is cycled on one channel, and a very large pack is cycled on the other channel, a charging error (Err1) indication will be given as described above, and a discharge error (Err2) indication will be given on the large pack. The discharge error is easy to detect. If the large pack has not reached full discharge by the time the long-range 16 hour timer expires, the final removed capacity will not be correct. Should this occur, when the unit reverts to Mode 1, the LCD alternately flashes between Err1 and Err2 to indicate that both a charge error and a discharge error have occurred during the cycle process for the given channel. The LCD will continue to alternately flash between Err1, Err2, and 00:00 (Trickle Timer) in Mode 1.

With this in mind, the only time a discharge error can occur is when the difference in final removed capacity between a pack connected to channel 1 and a pack connected to channel 2 is >4800 mAh or 16 hours. Err2 indications are provided to ensure that in those rare situations where a great discrepancy between battery capacities is involved, it can be handled.

#### HOW TO HANDLE BATTERY PACKS OF LARGE CAPACITY (>1500 mAh):

Einstein XL has the ability to charge large packs even if they cannot be charged by the system in one pass. The Err1 indication is provided to notify you when your battery will require additional charging. Furthermore Einstein XL has the ability to cycle large packs even if Err2 has been encountered. When a very large pack is cycled, the display is capable of counting up to 9999 mAh in one pass. If a battery is larger than 9999 mAh, the LCD will reset to 0000 and the UP ARROW indicator will light on the LCD. When the UP ARROW is lit on the LCD, add 10000 to the final removed capacity. Limitations described above mean that if only one channel were used at a time, the largest pack that could be successfully discharged without an Err2 message would be 4800 mAh = 16 hours. Should you wish to discharge very large batteries (> 4800 mAh), cycle two large packs on both channels and/or ensure that the difference in capacity between the two does not exceed 4800 mAh.