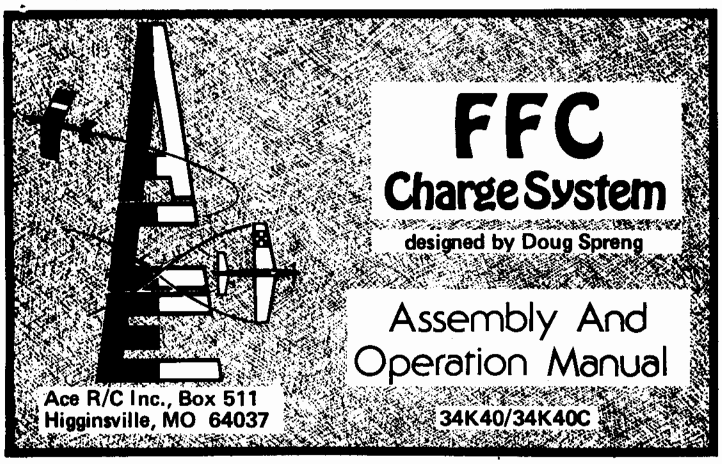
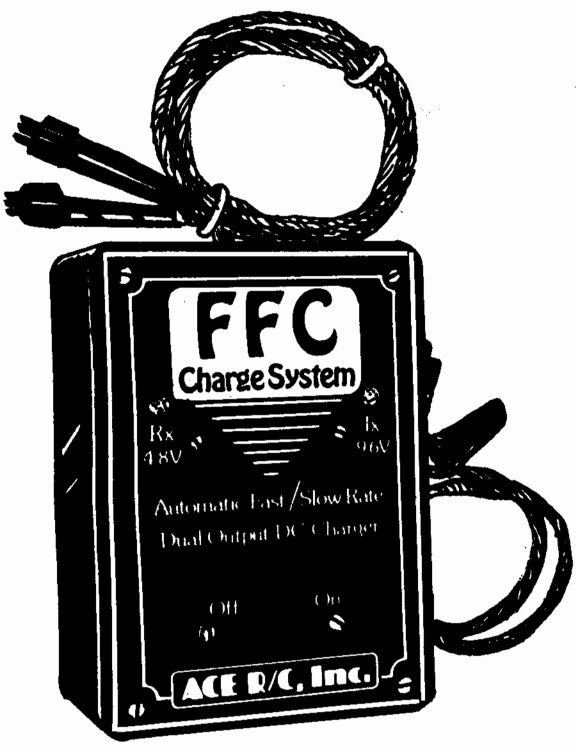




I. INTRODUCTION

Truly a versatile piece of equipment, the Ace FFC charge system fills a variety of needs. If you forgot to charge and the weather turns nice, the FFC will top off the batteries in a short time. If you've done alot of flying and are concerned about battery life left, the FFC will keep you going safely. Since, after Fast Charging, the FFC cuts back to an overnight rate, it's an ideal unit for slow charging batteries in your van, RV, at the contest site, or wherever there is a 12V source...the Fast Charge mode doesn't have to be activated when charging in this manner.

NOTE: The FFC Charge System works only with 4.8V (4 cell) receiver and 9.6V (8 cell) transmitter ni-cad batteries. If your radio system is other than this, please return the unit to place of purchase for refund before proceeding.

Rugged, dependable, state-of-the-art design makes the FFC something you'll never do without!

If you have purchased a kit, read through the Specification and Operation section and proceed to the Construction instructions, referring back to the Operation section when construction and calibration is complete. If you have an assembled unit, wire in the connectors and follow the procedures outlined in the Operation section after reading the specification section.

II. SPECIFICATIONS

Input Voltage: 12-14 Volts DC

Receiver Charge Output:	Fast=	500 ma
	Slow=	35 ma
Transmitter Charge Output:	Fast=	500 ma
	Slow=	35 ma
Receiver Charge Cutoff:	Fast=	85% of Full Charge
	Slow=	100% of Full Charge
Transmitter Charge Cutoff:	Fast=	50% of Full Charge*
	Slow=	100% of Full Charge
Polarity:	Copper Colored Leads=	Positive (+, Red)
	Silver Colored Leads=	Negative (-, Black)

Note: Duration of Fast Charge for 500 mah batteries is less that one hour. For the slow charge, it is 12 - 14 hours. Adjust accordingly up or down for smaller or larger batteries.

* This limitation is due to the 12V source; normally, for most purposes, 50% charge at the field is sufficient to keep flying.

CAUTION: If the source voltage is less than 12V, the percent of charge into the transmitter will be less than 50% at cutoff.

NOTE: A fully charged 5 ampere/hour battery or bigger is recommended for the power source to insure maximum efficiency from your FFC.

III. CONNECTOR WIRING

CAUTION: PROPER POLARITY <u>MUST</u> BE MAINTAINED at all times. If it is reversed at the Source battery or at the batteries being charged, severe damage can result to the FFC and/or the batteries.

Copper Colored Wires = Positive (+,Red)
Silver Colored Wires = Negative (-,Black)

A. Wire Identification & Preparation

As you face the FFC, the cable coming out of the left of the case is the Receiver Output cable, the one on the right is the Transmitter Output cable and the one out the bottom hooks to the 12V Power Source.

Make a cut between wires at the end of the Receiver, Transmitter, and Power cables. Pull the wires apart for about 3/4" from the end and strip 1/8" of insulation off each wire and tin. (Apply a small bit of solder.) Take the two pieces of 1/8" Heat Shrink tube and cut into 8 1/2" pieces to use as insulation for the connectors.

B. Power Source Hookup

The power cable can be hooked up directly to the Power Source battery if you are installing the FFC in a Flite Box. Or, you may install alligator clips, banana plugs, or a cigarette lighter cord on the end of the power cable to hook and unhook the FFC to the power source. Another set of connectors can be installed between the FFC and the end connectors to allow "patch cords" for flexibility in hookup. IN ANY EVENT, always make sure proper polarity is maintained and all joints are secure and well insulated.

C. Receiver Connector Hookup

CAUTION: Connector wiring shown is for current Ace Silver Seven only. Check your Receiver and Transmitter wiring and maintain proper polarity and connector wiring.

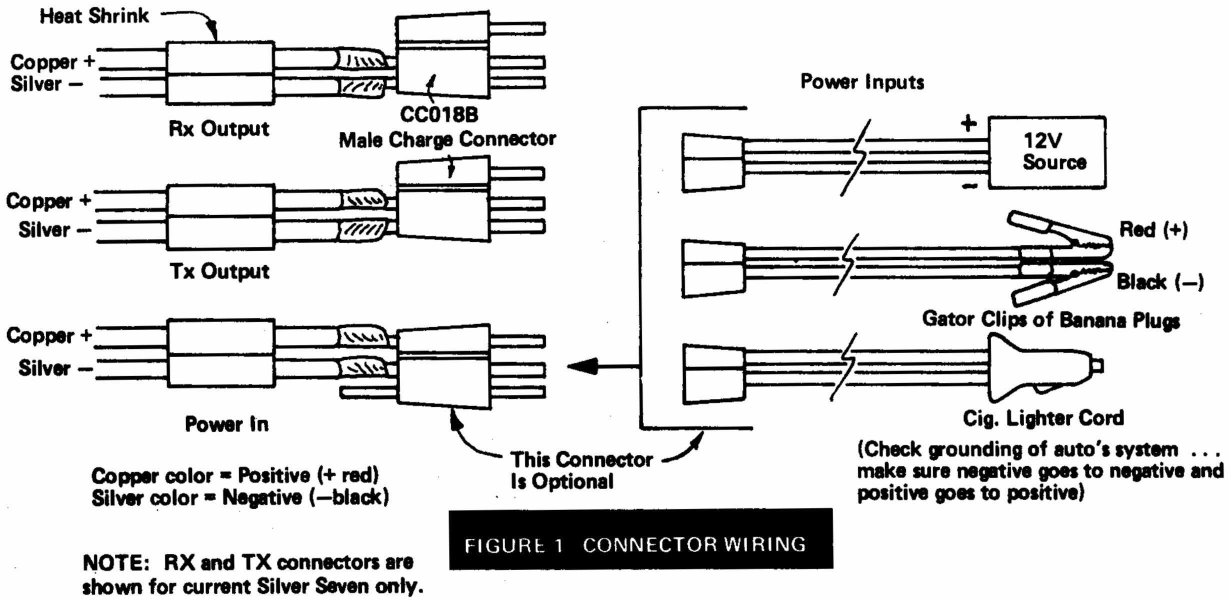


FIGURE 1 CONNECTOR WIRING

Solder the appropriate male charge connector to mate with your receiver charge receptical onto the Receiver Output cable. If the connector is not the solderable type, it will be necessary to splice it on...keep the distance between the end of the Receiver Output cable and the connector less than 2" to prevent any excess voltage drop thru the wires. ALWAYS MAKE SURE proper polarity is maintained: Copper colored wire to positive (+,red) and Silver colored wire to negative (-,black). Make sure the joints are secure and well insulated.

D. Transmitter Connector Hookup (9.6V Transmitters only)

As with the receiver, solder the appropriate male charge connector to mate with your transmitter's charge receptical. If you splice, keep the extra wire length to less than 2". Watch for proper polarity and solid, insulated joints.

CAUTION: If your transmitter has a built-in internal charger, it must be by-passed so the FFC hooks directly to the 9.6V pack.

If you have a pre-1982 Proline transmitter, it is recommended that you obtain a Proline Fast Charger to do your fast charging. (Ace part no. 70GPLFC).

IV. OPERATION

NOTE: Any fast charge system should not be used for routine charging. Batteries should be charged for 12 - 14 hours and the slow overnight rate at least once a month to prevent any "memory" buildup.

A. Fast Charging

Plug the FFC into your fully charged 12V source. Then plug the FFC into your radio system...the transmitter and receiver batteries can be charged either both at the same time or separately. Double check that polarity is correct on all hookups.

Turn the FFC on...both LED's should come on. When 85% charge for the receiver and 50% charge for the transmitter is reached, the LED's go out and the FFC switches to the slow charge rate (from 500 ma to 35 ma). The FFC can be left on indefinitely while the LED's are out.

If the LED's stay on for over 1 hour for 500 mah batteries, unhook and check for a battery problem.

If the LED's shut down quickly, the batteries could have already been at the percentage of charge for cutoff. Or, the source battery could be discharged below the cutoff voltage...this is particularly noticeable on the transmitter charger.

B. Slow Charging Only

If you only wish to charge your batteries at the slow rate (applicable if you're charging overnight at the field or in your van, RV, etc.), simply plug the transmitter and/or receiver batteries in after turning the unit on. Then the batteries will charge at 35 ma (the LED's won't be lit) until the FFC is turned off.

Note that a combination of either slow or fast charging between the receiver and transmitter can be accomplished by the order in which the FFC is turned on in relation to when the batteries are plugged in.

NOTE: Unhook the Receiver and Transmitter batteries after charging is complete. Do not leave the batteries plugged in with the FFC off. If you do, the transmitter will discharge into the receiver.

V. PARTS LIST

Resistors:
( ) 2 R1-05X .5 ohm 1W 5% Grn,Blk,Sil,Gld
( ) 2 R4-102B 1K 1/4W 1% Brn,Blk,Blk,Brn,Brn
( ) 2 R4-183C 18K 1/4W 1% Brn,Gry,Blk,Rd,Grn,
( ) 2 R4-202B 2K 1/4W 1% Rd,Blk,Blk,Brn,Brn
( ) 1 R4-221 220ohm 1/4W 5% Rd,Rd,Brn,Gld
( ) 2 R4-224 220K 1/4W 5% Rd,Rd,Yel,Gld
( ) 1 R4-332B 3.32K 1/4W 1% Or,Or,Rd,Brn,Brn
( ) 1 R4-353B 35.7K 1/4W 1% Or,Grn,Vio,Rd,Brn
( ) 2 R4-471 470ohm 1/4W 5% Yel,Vio,Brn,Gld
( ) 2 R4-472 4.7K 1/4W 5% Yel,Vio,Rd,Gld
( ) 1 R4-483B 48.7K 1/4W 1% Yel,Gry,Vio,Rd,Brn
( ) 1 R4-681B 681ohm1/4W 1% Blu,Gry,Brn,Blk,Brn
( ) 2 RV069 10K Trim Pot

Capacitors:
( ) 2 CE106AL 10 mfd Electrolytic
( ) 1 CE107AL 100 mfd Electrolytic
( ) 2 CO104 .1 mfd Monolytic (104)
( ) 2 CO472 .0047 mfd Monolythic (472)
(or Yel, Vio, Red)

Semiconductors:
( ) 1 SS042 LM335Z Precision Temp. Sensor
( ) 2 SS043 LM336Z 2.5V Ref. Diode
( ) 2 SS044 TIP32 Power Transistor 292 - ECG
( ) 2 SS075 Large Red LED
( ) 1 SS087 LM324N IC
( ) 1 SS119 1N5400 Diode

Hardware and Miscellaneous:

( ) 2 CC065 Fuse Holder Clips
( ) 2 HW002 4-40 Hex Nuts
( ) 2 HW010F 3mm x 10mm Pan Head Phillips Head bolts
( ) 6 HW082A 4-40 X 1/4" BH Bolts
( ) 2 HW139 Transistor Collector Insulator
( ) 2 HW197 Transistor Hole Insulator
( ) 1 HW205A 1.25A 3AG Fuse
( ) 1 LB064 Case Faceplate
( ) 1 PC152 PC Board
( ) 3 PLA022 Small Wrap 'N Ties
( ) 1 SW001 DPDT Slide Switch
( ) 2 TB027 1/8" X 1 1/2" Heat Shrink
( ) 2 CC026 7/16" Vinyl Sleeving

( ) 12" Twisted Red and Black Hookup Wire
( ) 60" Clear Covered Zip Cord
( ) 18" Solder
( ) 1 Black Plastic Case, Machined

VI. CONSTRUCTION

Read the "Kit Builder's Hints" before beginning construction.

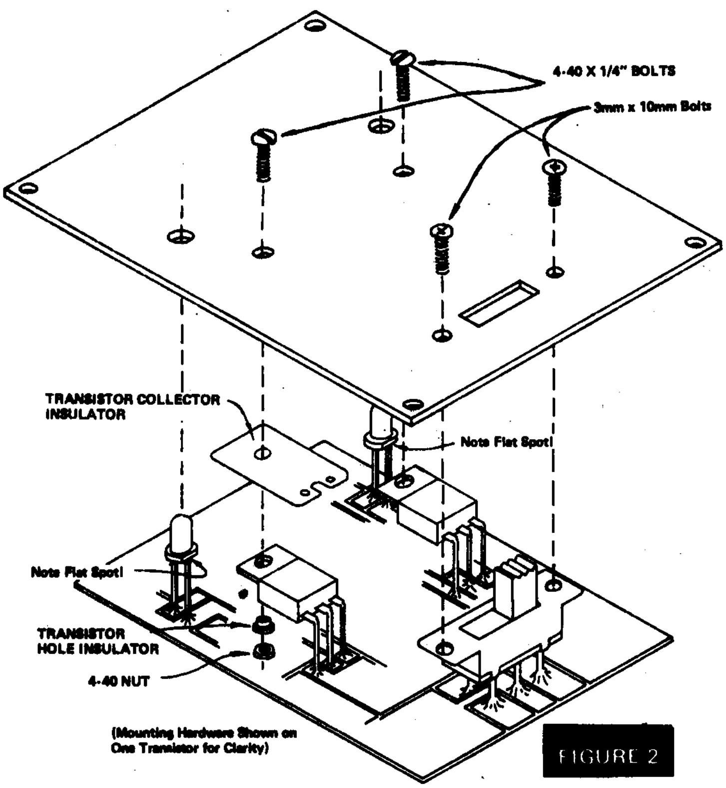


FIGURE 2

A. PC Board Assembly

( ) Using the Overlay Drawing and Parts ID Legend (Fig. 4), assemble the PC board following the suggested procedure. Always observe the special instructions in the Parts ID Legend concerning specific installation of parts.

( ) Referring to Figure 2, install switch by laying the PC board PC LAND side up on a flat surface and inserting switch lugs into slots. Make sure lugs are flush with opposite side of PC Board and the switch is perpendicular with the board before and during soldering.

( ) Referring to the Overlay, Fig. 4, install and solder IC1 noting the proper orientation of pin 1.
( ) Install and solder Capacitors C1R, C1T, C2R, & C2T.
( ) Install the remainder of the parts shown in Fig. 4 EXCEPT FOR R1R, R1T, D1P, C4, and both F2's. Observe the special instructions in the Parts ID for specific installation of parts. Work around the board from top to bottom, left to right, installing and soldering components a few at a time. Solder in the appropriate resistors, capacitors, and trim pots keeping them tight on the board. Leave the transistors 1/8" off the board.
( ) Using scrap resistors leads, install Jumpers J1, J2, and J3. Make sure jumpers are flat on the board before soldering.

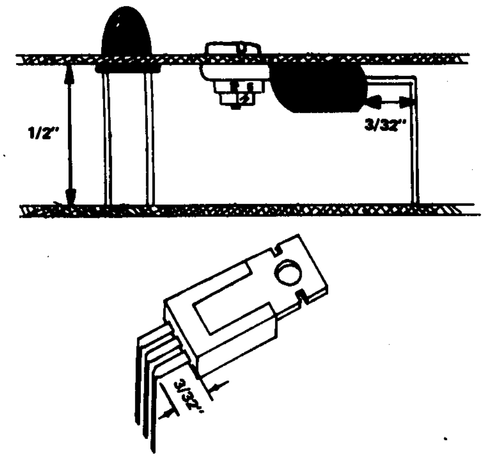


FIGURE 3 BENDING TRANSISTORS

( ) Referring to Fig. 3, bend the leads of Q1R and Q1T to the dimensions shown...failure to maintain these dimensions will result in misalignment of the faceplate.
( ) Install the transistors Q1R and Q1T on the PC LAND side of the PC board as shown in Fig. 2. Before soldering, trial fit the faceplate for proper lead bend and height off the board. Solder the transistors to the board, checking fit before clipping the leads flush with the component side of the board.
( ) Install LED's D2R and D2T on the PC LAND side of the board as shown in Fig. 2, maintaining proper orientation of the flat side on the LED. Check for the proper height off the board using the faceplate before soldering and clipping the excess leads off flush with the component side of the board.
( ) Install and solder R1R, R1T, D1P, and both F2's as shown in Fig. 4. Note the Parts ID for instructions for proper installation. Now install the 1.25A fuse.

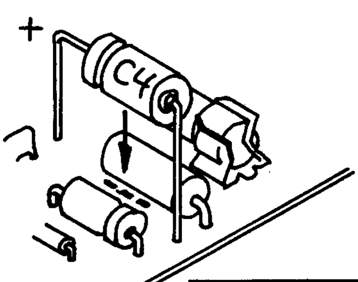
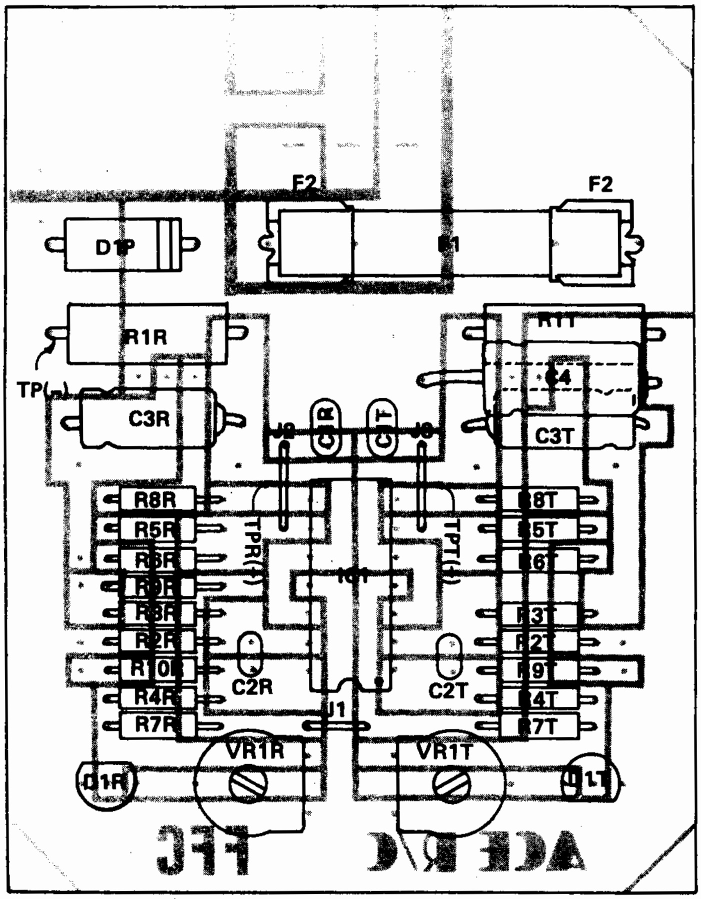


FIGURE 5 C4 INSTALLATION

( ) Referring to Fig. 5, install & solder C4. Note that the positive end goes to the inside of the board. Make sure it is down tight on top of R1T and C3T.



CALIBRATION TEST POINTS

Negative Probe: TP(-) [the left lead of R1R]

Trans. Cal. Pos. Probe: TPT(+) [J3]
Rec. Cal. Pos. Probe: TPR(+) [J2]

FIGURE 4 PC OVERLAY DRAWING

PARTS ID LEGEND

( ) C1R--.1 mfd Monolythic (104)
( ) C1T--.1 mfd Monolythic (104)
( ) C2R--.0047 mfd Monolythic (472 or Yel,Vio,Rd)
( ) C2T--.0047 mfd Monolythic (472 or Yel,Vio,Rd)
( ) C3R--10mfd Electrolytic (+ to outside of board)
( ) C3T--10 mfd Electrolytic (+ to outside of board)
( ) C4--100 mfd Electrolytic*

( ) D1P--1N5400 (Banded end to inside of board)*
( ) D1R--LM336Z (Flat side to inside of board)
( ) D1T--LM336Z (Flat side to outside of board)
( ) D2R--Large Red LED (Flat spot to inside)
( ) D2T--Large Red LED (Flat spot to inside)
( ) D3R--LM335Z (Mounted to Rx Cable)

( ) F1-- 1.25A 3AG Fuse
( ) F2-- Fuse Clips (Crimped Ends Out)*
( ) IC1--LM324

( ) Q1R--TIP32 (Mounted to Faceplate)
( ) Q1T--TIP32 (Mounted to Faceplate)

( ) R1R--.5 ohm 1W (Grn,Blk,Sil,Gld)*
( ) R1T--.5 ohm 1W (Grn,Blk,Sil,Gld)*
( ) R2R--1K 1% 1/4W (Brn,Blk,Blk,Brn,Brn)
( ) R2T--1K 1% 1/4W (Brn,Blk,Blk,Brn,Brn)
( ) R3R--35.7K 1% 1/4W (Or,Grn,Vio,Rd,Brn)
( ) R3T--48.7K 1% 1/4W (Yel,Gry,Vio,Rd,Brn)
( ) R4R--4.7K 5% 1/4W (Yel,Vio,Rd,Gld)
( ) R4T--4.7K 5% 1/4W (Yel,Vio,Rd,Gld)
( ) R5R--18K 1% 1/4W (**Brn,Gry,Blk,Rd,Grn**)
( ) R5T--18K 1% 1/4W (**Brn,Gry,Blk,Rd,Grn**)
( ) R6R--2K 1% 1/4W (Rd,Blk,Blk,Brn,Brn)
( ) R6T--2K 1% 1/4W (Rd,Blk,Blk,Brn,Brn)
( ) R7R--220K 5% 1/4W (Rd,Rd,Yel,Gld)
( ) R7T--220K 5% 1/4W (Rd,Rd,Yel,Gld)
( ) R8R--681ohm1% 1/4W (Blu,Gry,Brn,Blk,Brn)
( ) R8T--220ohm5% 1/4W (Rd,Rd,Brn,Gld)
( ) R9R--3.32K 1% 1/4W (Or,Or,Rd,Brn,Brn)
( ) R9T--470ohm5% 1/4W (Yel,Vio,Brn,Gld)
( ) R10R-470ohm5% 1/4W (Yel,Vio,Brn,Gld)

( ) S1--DPDT Slide Switch

( ) VR1R--10K Trim Pot
( ) VR1T--10K Trim Pot

*Install after Q1R and Q1T are soldered and clipped.

B. Wiring

( ) Referring to Fig. 6, prepare D3R by removing the lead shown and cutting the remaining leads to 3/16" long. (Note: the flat side of the LM335 is towards you.)

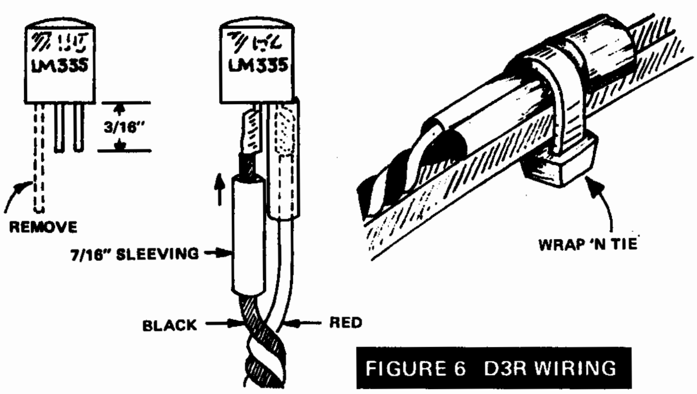


FIGURE 6 D3R WIRING

( ) Strip 1/8" insulation off both ends of the 12" piece of twisted red and black wire and tin. Solder the red and black wires to the leads of D3R as shown in Fig. 6 by untwisting the cable 1" and slipping the 7/16" vinyl sleeving over the wires and soldering as shown. Push the sleeving over the joint when complete. Orient the colors properly! Set the assembly aside.

( ) Measure and cut off two 18" pieces of the clear covered zip cord...this will leave you one 24" piece.
( ) Cut between the wires on one end of each of the three zip cord cables. Pull the wires apart about 3/4" and strip 3/16" insulation off and tin.

( ) Referring to Fig. 7, install and solder the appropriate cables in the PC board. The copper colored wire is postive and the silver wire is negative in each cable.

( ) Solder the D3R assembly to the PC board as shown ...make sure the colors are as indicated.

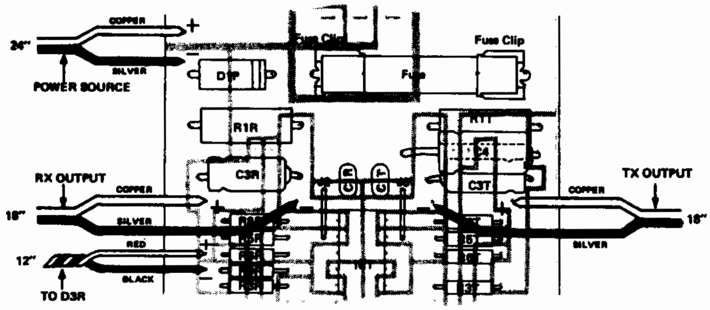


FIGURE 7 WIRING DIAGRAM

( ) Measure 1 1/4" along the the Receiver output cable from the PC board and hook the D3R cable to the Receiver cable with a Wrap 'N Tie. Stretch the D3R cable out along the length of the Receiver cable and install another Wrap 'N Tie to secure the assembly to the cable as shown in Fig. 6. About halfway between, install the third Wrap 'N Tie, keeping the cable neat.

C. Installing the Faceplate

( ) Referring to Fig. 2, bolt transistors Q1R and Q1T to the faceplate using the mounting hardware illustrated. Make sure the transistor collector insulator is centered and the metal of the transistor is not contacting the faceplate. Note the shoulder of the hole insulator goes into the hole and lays flush on the transistor tab. Just snug down the nut for now.

( ) Making sure the switch tab is lined up with the square hole, secure the faceplate to the switch using 3mm x 10mm Phillips Head Bolts and tighten securely.

( ) Double checking collector insulator centering, tighten the transistor bolts. Note: LED leads will flex some but excessive pressure can cause cracking.

D. Calibration

( ) Refer to Section III on Connector Wiring and install the appropriate connectors on the ends of the Receiver, Transmitter, and Power outputs.

( ) For the following calibration, you must have an accurate Digital Voltmeter or a good Analog Voltmeter with a 0.5V range.

You will also need a receiver pack and a transmitter that is discharged below 85% and 50% respectively.

Make sure you are working in an area where nothing can short out the PC board.

( ) Connect your FFC to the 12V source and plug it into the transmitter and receiver packs.

( ) TRANSMITTER: Connect the negative probe to the resistor lead marked TP(-) on the overlay, Fig. 3. Connect the other lead to Jumper J3 marked TPT(+). Turn the FFC on. Check that both LED's lit indicating the Fast Charge mode. If not, make sure the batteries you are using are discharged below the cutoff level. If so, there is a problem...turn the unit off and refer to the Troubleshooting section. Now set the trim pot VR1T until the meter reads exactly 0.241 volts. A higher reading than that could result in an overcharge condition and thermal runaway which would damage the cells. If the reading is lower than that, the specified charge percentage would not be reached and a premature shutdown will occur.

( ) RECEIVER: Leave the negative probe on TP(-) and hook the positive probe to jumper J2, marked TPR(+). As with the transmitter, except using the pot VR1R, set the voltage to 0.253 volts.

( ) TESTING: Due to variations in setups and voltmeters, it is necessary to verify proper operation and recalibrate if necessary. Perform the following tests at room temperature and make sure you have a freshly charged 12V source and it measures at least 12V.

Keeping the receiver and transmitter plugged in, with the unit off, set the voltmeter on the lowest range which includes 6.5V and hook it up to monitor the voltage at the charge jack or plug which is on the end of the RECEIVER cable coming from the FFC. Be careful not to short the batteries out! Turn the FFC on to start a fast charge cycle (both LED's lit). Watch the voltage on the receiver side until the FFC goes into the slow charge mode (Receiver LED goes out) and record the voltage reading right before this occurs. (This is the Trip Voltage.) It should be 5.95 to 6.0 volts.

If it is lower or higher than this, it is necessary to re-calibrate the 0.253 volt setting previously done. Following the same procedure as before, re-calibrate the receiver side of the FFC...if you raise the calibration voltage by 0.002 volts, you will raise the trip voltage by about 0.10 volts and vice versa. For example, if your trip voltage is 5.8 volts, you need to raise it 0.15 volts to reach 5.95 volts (5.8 + 0.15 = 5.95). So, you should raise the calibration voltage by 0.003 volts (1.5 x 0.002 = 0.003) or from 0.253 volts to 0.256 volts. Recheck for proper trip voltage on the receiver side. Recalibrate again if necessary.

( ) Calibration is complete. Turn your FFC off and unhook everything.

E. Installing in the Case

( ) Position case with the slots on the right, left and bottom. Insert the FFC into the case, routing the Transmitter cable out the right slot and the Power cable out the bottom slot...route the Receiver cable out the left slot, keeping the Wrap 'N Tie inside of the case for strain relief.

( ) Bolt the faceplate to the case using 4-40 X 1/4" bolts.

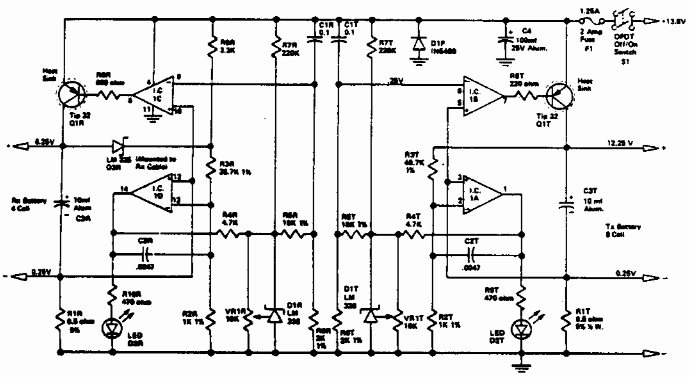
Your unit is now ready for operation. Refer to Section IV on procedures.

VII. TROUBLESHOOTING/SERVICE

If your FFC fails to operate, first check the fuse and replace if necessary. If the unit is still inoperable, double check the parts placement, wiring, and make sure there are no missed joints or solder bridges. This is about the only troubleshooting that is appropriate for the FFC, assuming you are sure it is hooked up properly to the 12V source and the batteries being charged. If all else fails, return the unit for repair.

Refer to the Service Policies and Procedures in the "Kit Builder's Hints" for Warrantee information and returning procedure.

FIGURE 8 SCHEMATIC DIAGRAM



VIII. CIRCUIT DESCRIPTION

A. Transmitter Section

Charging current is produced by the conduction of Q1T, and the amount of charge is measured by measuring the voltage developed across R1T. Using Ohm's Law, it turns out that 0.25V will be developed across a .5 ohm resistor when .5A (500 ma) flows through the battery. This voltage is compared to the voltage at pin 6 of IC1B, which is set to .25kV by the zener D1T and voltage divider R5T and R6T. IC1B turns on Q1T through R8T in such a manner to cause 500 ma to flow constantly, regardless of the battery voltage until the battery voltage approaches that of the charging source voltage. When the battery voltage increases to a value equal to the source voltage minus the transistor saturation voltage (approx. .1V) and the "IR" drop through the wiring, the constant current loop goes out of regulation and the loop shuts down by virtue of IC1A pin 1 going low and removing the bias voltage for the zener D1T. IC1A senses the battery and loop voltage (.25 across R1T) and continually compares them. As long as the voltage at pin 2, as determined by the precision divider R3T and R2T, is lower than the loop sense voltage at pin 3, the output of IC1A will remain high, thereby turning on the precision zener, D1T. It's output will be 2.5V and is adjustable by pot VR1T. This pot is adjusted to achieve the .25V reading at pin 6 of the IC. When the loop goes out of regulation, the voltage at R1T starts to drop. This causes pin 3 to go lower than pin 2 thereby causing the output of the IC to go low and remove the zener bias. At this time, R7T biases pin 6 ato the point that the loop will allow a current of 35 ma to flow through the battery. There is another shut down mechanism involved.

If the source voltage is a car battery and the engine is running, the voltage can approach 14.5 volts. This would cause the TX battery to overcharge if the loop shutdown were used exclusively. Therefore, the voltage divider R2T and R3T are set to shut down the high rate charge when the battery reaches about 12V. This will occur when the divided voltage at pin 2 exceeds the loop voltage at pin 3. This will cause the IC to go low, thereby shutting the loop down to the trickle, (35 ma) state. C1T is the "start up" cap, causing a spike to appear at pin 6 which forces the loop into the high current state. D2T LED lights when the loop in in the high current state through R9T. C2T is included to minimize the effects of voltage surges on the charging source battery.

B. Reciever Section

The transmitter and receiver chargers are almost identical in operation. The loop is the same, the only difference being in the temperature compensation. Since the transmitter charger normally doesn't charge over 50%, no compensation is needed. The reciever charger has an excess of voltage at the source, therefore it is capable of charging over 100% of capacity. Since Nickel Cadmium batteries have a negative coefficient, meaning that as the battery temperature rises, the battery terminal voltage lowers, there is a possibility that if the cut-off voltage is not temperature compensated and you try to charge the battery to near full capacity on a hot day, there is a possibility that a "thermal runaway" condition may develop. If this condition does occur and is allowed to continue for any length of time, the battery will vent causing damage or destruction. Because of this D3R and R9R have been added to circumvent this problem. The LM335 is a temperature sensitive zener diode, whose terminal voltage is directly proportional to the device temperature. It turns out that the 10 MV per degree centigrade positive coefficient matches the battery characteristics. The temperature diode is in the circuit in such a manner as to shut the charge down to the trickle state at a lower terminal voltage as the environment temperature increases. R2R biases the temperature zener to conduct by pulling it up toward the source voltage. This adds the zener voltage to the battery voltage. Now, as the battery voltage decreases due to temperature, the zener voltage will increase to compensate. R2R and R3R determine the shut-down voltage at a normal ambient temperature of 25 deg.C. This is set at very near 6V.

A bad cell could cause the charge to shut-down prematurely due to the high impedance cell's excessive "IR" drop. Conversely, a battery in which a cell has "reverse charged" due to excessive discharge would never shut down due the the effective lack of the voltage of the cell preventing the terminal voltage from ever reaching the shut-down voltage. If left on to charge over the 1C time, the remaining good cells could be damaged. This is not likely to occur in normal use.

ACE R/C

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