HCS II UPS

Technical Manual, version 1.0

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Description:

This Uninterruptible Power Supply (UPS) is designed to provide HCS II equipment with main and back-up power.

Specifications:

- Simple design uses commonly available parts and is easy to build.
- Main regulator can provide 14Vdc at currents up to 5A.
- Secondary regulator provides battery charging currents up to 1.5A.
- Charger accommodates variable size gel or wet-cell lead-acid batteries.
- Automatic float-charging allows for the battery not to be overcharged.
- Battery power is automatically switched-in when AC power is lost.
- Can also supply power to equipment that doesn't require battery backup.

Current revision: 1998-07-29

Theory of operation:

Please refer to the schematic diagram of the UPS found at the end of this manual.

The design uses an LM338K main regulator (IC1) to provide 14Vdc to the load at currents up to 5A. A secondary regulator, LM317 (IC2), is used as a dual level battery charger.

When recharging the battery, the charger starts off in a constant-current (bulk) mode. The battery is charged at its maximum charging current as set by R3. The charger remains in this mode until the battery voltage reaches 13.8V (about 80% fully charged) then the charger switches to a constant-voltage (float) mode to finish charging and to maintain the battery. LED1 will then light up to indicate the end of charge.

Choosing a battery:

Before you build the circuit, you should consider the type of battery you will be using. You can use any type of lead-acid battery with this circuit but Gel-cell batteries will provide you with the most cost-effective source of backup power. They are readily available, fairly cheap and easy to maintain.

Selecting the maximum amount of current delivered to the battery is important. Most manufacturers suggest that the current should not exceed 10% of the amp-hour (Ah) rating of the battery (this is called a C/10 rate). For example, a 5 Ah battery should not be charged with a current over 500 mA. Some batteries, particularly car and motorcycle lead-acid types, can take a quick charge, but this effectively shortens the life of the battery and should not be done often.

Resistor R3 determines the maximum current flow to the battery. Its value can be found by using the following formula:

R3 = 1.25 / I where I is the desired charging current in amps.

For example, to recharge a battery at 500 mA (0.5 A), the calculation for R3 yields 1.25/0.5 or 2.5 ohms. For currents under 500 mA, you can use a one watt resistor and for currents above 500 mA, a two watt resistor should be used.

The following table shows various values of R3 for different charging current levels:

Maximum charging current:	Value of R3:
100 mA	12.5 ohms
200 mA	6.25 ohms
400 mA	3.13 ohms
500 mA	2.5 ohms
700 mA	1.79 ohms
800 mA	1.56 ohms
1 A	1.25 ohms

Parts list:

U1	LM338K	5 A adjustable voltage regulator
U2	LM317	1.5 A adjustable voltage regulator
Q1	2N5064	800 mA, 200 V SCR
BR1		6 A, 200 PIV rectifier bridge
D1		6 A, 200 PIV diode
D2	1N5402	3 A, 200 PIV diode
D3		6 A schottky diode

LED1		Green LED
R1	1 K ohms	1/4 W, 5 % resistor
R2	240 ohms	1/4 W, 5 % resistor
R3	see text	1 W or 2 W, 5 % resistor
R4	220 ohms	1/4 W, 5 % resistor
R5	470 ohms	1/4 W, 5 % resistor
P1	2 K ohms	potentiometer
P2	5 K ohms	potentiometer
P3	5 K ohms	potentiometer
R6	330 ohms	1/4 W, 5 % resistor
C1	3500 uF	35 V electrolytic capacitor
C2	10 uF	25 V electrolytic capacitor
C3	0.1 uF	35 V ceramic capacitor
C4	10 uF	25 V electrolytic capacitor
J1	1 x 2	screw terminal
J2	1 x 2	screw terminal
J3	1 x 2	screw terminal
SW1	SPST	switch
SW2	SPST	switch
F1	4 A	fuse
B1		12 V Gel-cell battery

Assembly instructions:

I used a wall-mount transformer rated at 12.5 Vac, 40 VA, but any type of transformer can be used as long as it can supply the current required for your application.

The circuit should be assembled on a piece of perf-board. The wire you use to connect all components will have to be of a gauge large enough to handle the required currents.

Operation:

The circuit must be calibrated before use. You must first set P2, the end-of-charge voltage adjust. Then you must set the mode-switching trip-point which is adjusted by P3. P1 is adjusted last and sets the primary regulator's voltage level.

1. Before attaching a battery to the terminals and turning the circuit on, set potentiometer P2 using a ohmmeter according to the following table and P3 to its mid range.

Chosen value of R3:	Adust P2 to:
12.5 ohms	2799 ohms
6.25 ohms	2724 ohms
3.13 ohms	2686 ohms
2.5 ohms	2679 ohms
1.79 ohms	2670 ohms
1.56 ohms	2668 ohms
1.25 ohms	2664 ohms

2. Connect a 4.7 K ohms, five watt resistor across the terminals where the battery would normally be connected. Apply power to the circuit and measure the voltage across the resistor; the output should be approximately 13.8 V. If you don't get a reading, or if it is low, adjust the P3. If you still don't get a reading, or if it is off from the desired 13.8 V, turn P2 in either direction.

3. Connect a voltmeter between the wiper of trip-point potentiometer P3 and ground. Adjust P3 until the voltmeter reads zero. Turn the power off.

4. Remove the 4.7 K ohms resistor and connect a partially discharged battery. Be sure to use a discharged battery since we want to exercise the charger circuit. Turn the power on. LED1 should not light.

5. Connect a voltmeter across the battery terminals and monitor the voltage until it reaches 13.8 V. When that battery voltage is reached, adjust P3 so that LED1 glows, this is the end-of-charge indicator. At this point the constant current source is removed and the battery is float charged at 13.8 V.

6. Connect the 4.7 K ohms resistor and a voltmeter to the output terminal J3 and adjust P1 to 14 V, this makes the main regulator's voltage just above the charger's maximum voltage.

7. Turn SW1 off, the voltage should drop to about 13 V, this shows that the battery now supplies power to the load. Turn SW2 off, this will disconnect the battery and power to the load. Turn SW1 and SW2 back on and the load voltage should be 14 V again.

8. Connect any HCS equipment that doesn't require battery backup to J2 (ie: RBUF-Term...) and the ones that require backup to J3 (ie: the SC et al) and enjoy!

Credits:

Excerpts taken by permission from "The Robot Builder's Bonanza" by Gordon McComb, 1987 (ISBN 0-8306-0800-1)