CBP500-V1
Manual

Power Backup Module
For
HESC & HPSC Series Power Supplies

Manufactured by
Tri-M Technologies Inc.
Engineered Solutions for Embedded Applications

Technical Manual

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This manual is for integrators of applications of embedded systems. It contains information on hardware requirements and interconnection to other embedded electronics.

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GENERAL DESCRIPTION

The CBP500-V1 creates a complete UPS system when connected to an HESC/HPSC power supply battery charging port. The CBP500-V1 has six 3000 farad 2.7V ultracapacitors wired in series for a total of 500 farads up to 16.2 volts (maximum recommended operating voltage is 15V). The CBP500-V1 can supply backup power for over an hour for a 10 watt load.

Two Voltage Monitoring Controllers (VMCs) per capacitor are employed, one is used to shunt (bypass) current around the capacitor when the capacitor voltage approaches the maximum charge voltage and the second is used to activate the Charge Isolation Mosfets (CIMs) when the capacitor voltage is at the maximum charge voltage. Note: The CBP500-V1 is able to supply backup energy even when the CIMs are in isolation mode.

A set of Discharge Isolation Mosfets (DIMs) on the CBP500-V1 allow the HESC/HPSC power supply to put the CBP500-V1 into isolation mode when the CBP500-V1 output voltage drops below the minimum backup voltage level of the HESC/HPSC power supply.

The CBP500-V1 has a field replaceable automotive style “MINI Blade” fuse is provided to prevent excessively large currents.

Installation and Operation

Installing the CBP500-V1

The CBP500-V1 is mounted remotely from the HESC/HPSC and cabled together. Connectors CN3 provides the control signals and CN1 the power connectors for remotely connection.

Field Plug and Fuse Part Numbers

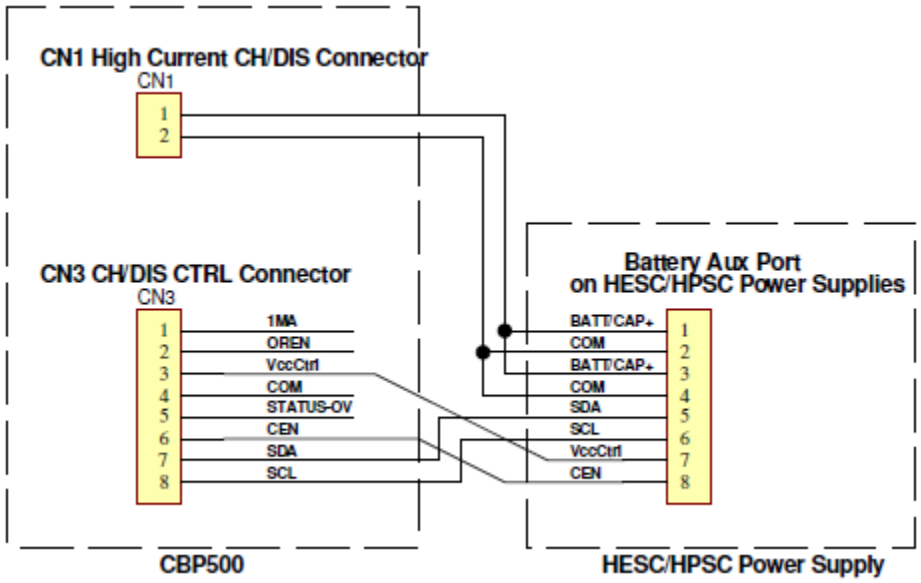
Tri-M Part No.	Qty	Description	Part Number	Manufacturer	Part Location
FUSE-MINI-15A	1	Fuse 15A/32V MINI Blade Fast-act	0297015.WXNV	Littelfuse Inc	Plugs into F1
CON-PLUG2-10mm*	1	2 Position Connector Plug	42816-0212	Molex	Plug for CN1
CON-PLUG-LOC8*	1	8 Position Locking Plug	50-57-9408	Molex	Plug for CN3
HW-CRMP-22-24	8	Connector Term Female 22-24 AWG	16-02-0102	Molex	Crimps for plugs for CN3
HW-CRMP-10-12*	2	Conn Term Male 10-12AWG Gold	42815-0012-C	Molex	Crimps for plugs CN1

Connector Pin Outs

8-Pin Battery Aux port on HESC/HPSC Power Supplies (Provided for reference)			
Pin#	**Signal**	**Description**	**Range**
1,3	BATT/CAP+	Positive connection for charge & discharge.	0 to 15VDC *See Note “Operational Voltage”
2, 4	Com	Electrical common	0VDC
5	SDA	I^2C Bidirectional Data Signal to/from HESC/HPSC or remote charger.	Open collector signal pulled to Vcc by HESC/HPSC or remote charger.
6	SCL	I^2C Clock from HESC/HPSC or remote charger.	Open collector signal pulled to Vcc by HESC/HPSC or remote charger.
7	VccCtrl	Control power supplied by HESC/HPSC or remote charger.	5VDC
8	CEN	Low active enable signal.	0V = activate, Vcc = de-activate

CN1 High Current CH/DIS Connector			
Pin#	**Signal**	**Description**	**Range**
1	CAP+	Positive connection for charge & discharge.	0 to 15VDC *See Note “Operational Voltage”
2	Com	Electrical common	0VDC

Note: Operational Voltage – To increase the MTBF the recommended maximum voltage is 15V with a temperature compensation of 10mV/°C above 25°C. At 55°C the maximum recommended voltage would therefore be 14.7V.



CBP500 to HESC/HPSC Interconnect Wiring

CN3 CH/DIS CTRL Connector			
Pin#	**Signal**	**Description**	**Range**
1	1MA	1mA current limited supply directly from positive of capacitors.	1mA via current limiting diode.
2	OREN	Enables the DIMs (Discharge Isolation Mosfets) thus turning on the CBP500-V1. This signal should be by a momentary "contact" so that the HESC/HPSC can de-activate the CBP500-V1 when not required.	1mA current limited. A dry contact between the 1mA signal and OREN can be used.
3	VccCtrl	Control power supplied by HESC/HPSC or remote charger.	5VDC
4	Com	Electrical common	0VDC
5	OVR	Opto-isolated open collector status of any capacitor detected in an overvoltage condition.	Hi-impedance = normal operation. 0V = overvoltage condition exists on one of more capacitors.
6	CEN	Low active enable signal.	0V = activate, VccCtrl = de-activate
7	SDA	I^2C Bidirectional Data Signal to/from HESC/HPSC or remote charger.	Open collector signal pulled to VccCtrl by HESC/HPSC or remote charger.
8	SCL	I^2C Clock from HESC/HPSC or remote charger.	Open collector signal pulled to VccCtrl by HESC/HPSC or remote charger.

I^2C Temperature Sensor

The CBP500-V1 includes an I^2C temperature sensor at address 0x4F. The temperature sensor readings can be accessed over the I^2C port through connector CN3. The temperature readings can be used to decrease the charging voltage as the ambient temperature of the CBP500-V1 increases and to halt all charging if the temperature increases past the maximum (65°C). A negative compensation of 10mV/K (based on starting @ 25°C) will lower the maximum charging voltage 400mV @ 65°C but will extend the life expectancy of operation. The "10" mV/K value can be set into the HESC/HPSC "Temperature Compensation Applied to BattVDef" field in the charge "Cycle 1" settings using the SCU.exe utility. Note that the "Enable compensate the BattVDef voltage for the temperature" radio button must also be enabled for the temperature compensation to be applied (located under the "Cycle 1 – Charge Termination" settings.

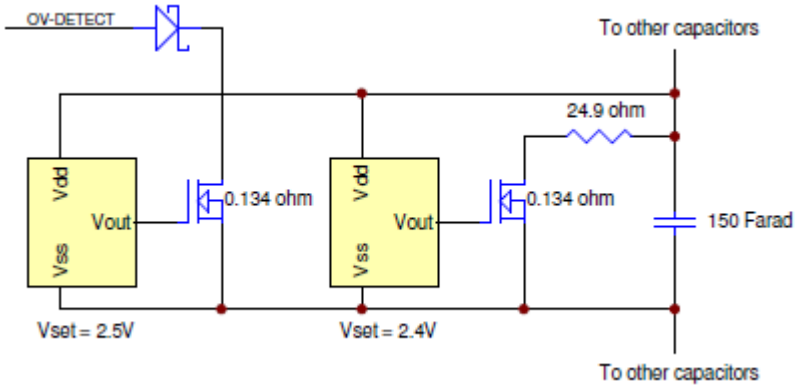
When using the SCU.exe utility to configure an HESC/HPSC type of power supply to read the I^2C temperature sensor set the "I2C Temperature Sensor Address" to 79 (decimal) and enable the "Address R/W, Enable for Read, Disable For Write" check box (located in the "Temperature Sensor Control" settings).

I^2C Address Byte							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	0	1	1	1	1	R/W
0x4F, (79 dec)							R=1

Note: The I^2C temperature readings are only available when VccCtrl power is applied. When using the HESC/HPSC the VccCtrl power is applied whenever the HESC/HPSC has power either from its main input or from the CBP500-V1. Therefore if the CBP500-V1 was enabled through OREN, backup power from the CBP500-V1 would flow to the HESC/HPSC which would in return supply the VccCtrl to the CBP500-V1.

Capacitor Voltage Monitoring

Each capacitor has two Voltage Monitoring Controllers (VMCs). One VMC with a setting of 2.4V is used to shunt (bypass) current around the capacitor through a 24 ohm resistor. The other VMC with a setting of 2.5V generates the OV-DETECT signal which activates the Charge Isolation Mosfets (CIMs) preventing additional charging of the CBP500-V1. The CBP500-V1 can still provide backup power even when the CIMs are activated. To prevent repeated overcharging of the capacitors, the CIMs can only be reset to normal operation by the removal of the charging voltage.



An opto-isolated open collector status (OVR) is available on pin 5 of CN3 (CH/DIS CTRL Connector) of any capacitor activating this OV-DETECT signal.

Fuse Replacement

Each Ultra Capacitor has a rated ESR of 0.3mohm, and the series ESR of the six of them is less than 2mohm. The application of unregulated charging power or the shorting of the CBP500-V1 output can result in excessive current. An automotive style MINI Blade 15A fuse (F1) allows for field replacing in case of fuse activation. The factory installation of this fuse includes a little RTV on the fuse blades for shock and vibration purposes.

Start up of an HESC/HPSC and CBP500-V1 without Main Power available.

An HESC/HPSC with CBP500-V1 can be powered up without main power available. Connect a momentary dry contact between the 1MA signal (pin 1) and OREN (pin 2) of CN3 (CH/DIS CTRL Connector). The HESC/HPSC with the HESC-UPS18 firmware can be configured to start on capacitor (battery) backup power so that when the momentary dry contact closes and backup power from the CBP500-V1 flows into the HESC/HPSC, the HESC/HPSC recognizes this as a start up request.

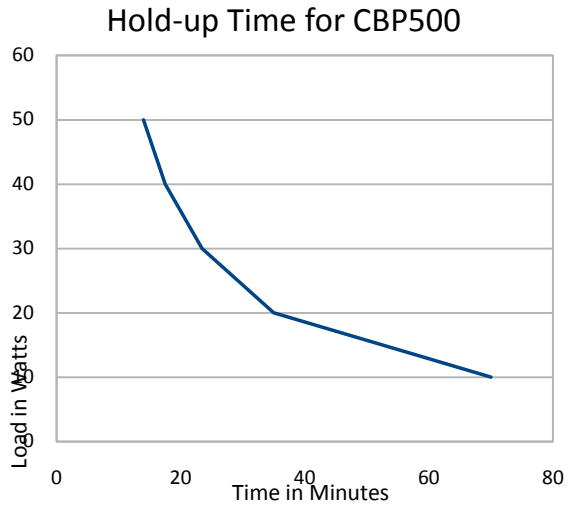
Determining Power Hold-Up Time

Energy decrease in capacitor: $\Delta E = \frac{1}{2} C(V_{max}^2 - V_{min}^2)$

Where:

- C is the capacitance in farads.
- V_{max} is the maximum voltage.
- V_{min} is the cutoff voltage.
- E is energy in joules (watt-seconds)

Therefore for the CBP500-V1, total energy available is $\Delta E = 0.5 * 25 (14.7^{2} - 7^{2}) = 2089$ joules. (Based on recommended maximum voltage of 14.7V and a cut off voltage of 7V).

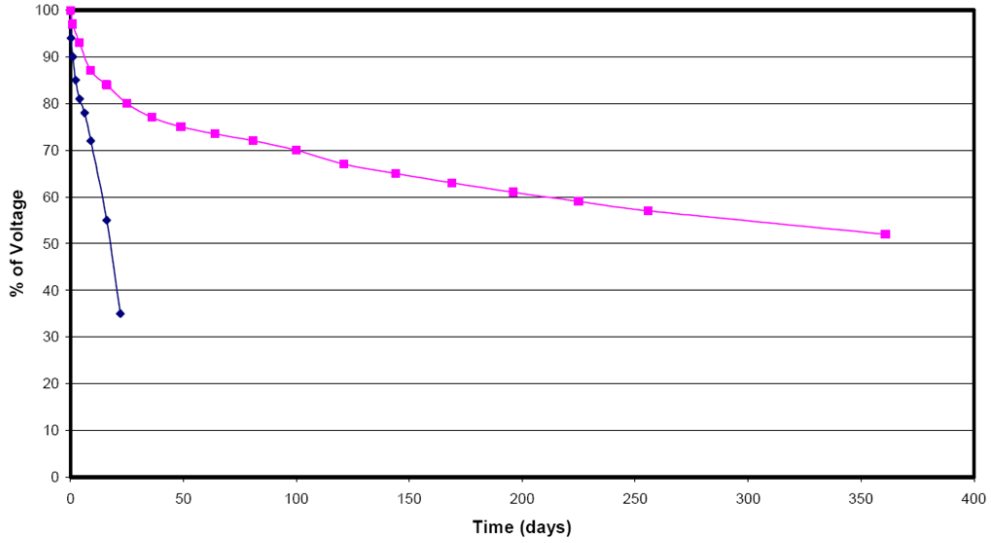


Load in Watts	Holdup Time in Minutes
10	70
20	35
30	23.4
40	17.5
50	14

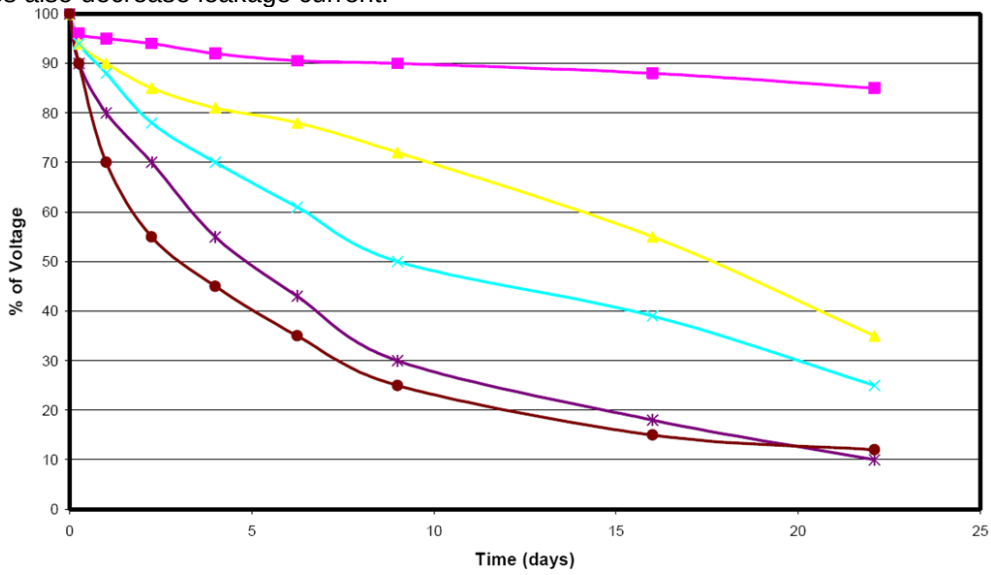
Self Discharge Rate

The self discharge of the CBP500-V1 is largely from leakage current of the ultracapacitors which can vary widely depending on the ambient temperature and the length of time charging was held on the ultracapacitors. The leakage current is a result of the dielectric between the plates passing a small amount of current which causes the voltage across a charged ultracapacitor to decay over time.

Due to the extremely large surface area of the electrode in the ultracapacitors the time constant of the last 0.5% of the electrode area is extremely long due to the pore size and geometry. The specified leakage current for the ultracapacitors in the CBP500-V1 is 0.3mA and is a measurement of the leakage current after holding the device at the rated voltage for 72 hours continuous at room temperature (25°C). The longer the ultracapacitor is held on charge the lower the leakage current of the device.



Lower temperatures also decrease leakage current.



A simple estimate of self discharge is if the ultracapacitors are charged for 72 hours or more and the ambient temperature is 25°C, then the self discharge rate is.

1. 1 percent daily for the first 25 days.
2. 0.1 percent daily after the 25 days.