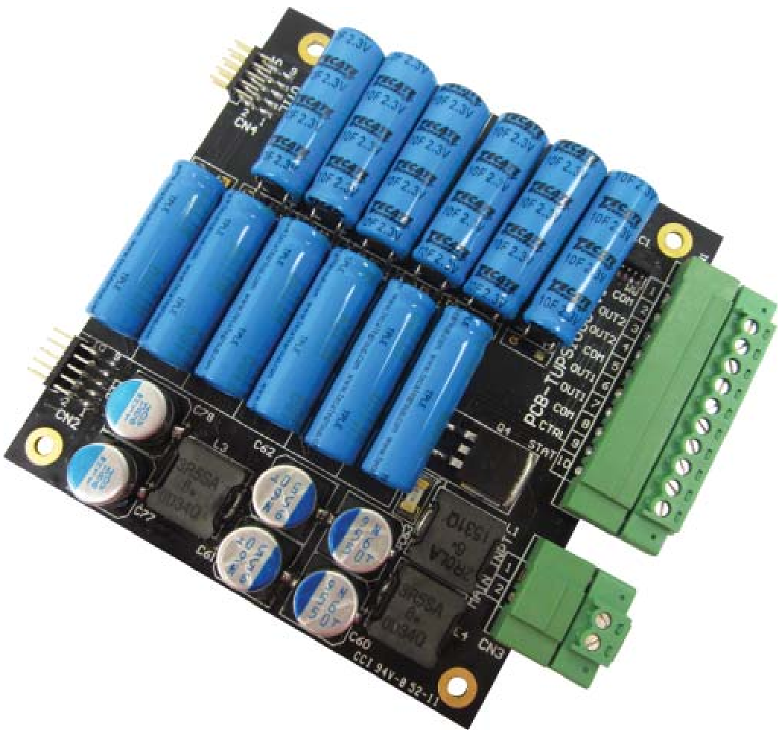
TUP1000

User Guide



Ultra Capacitors SFF Power Solution

Tri-M Technologies Inc.

Toll Free: 1.800.665.5600

Direct: +1.604.945.9565

Email: info@tri-m.com

Web: www.tri-m.com

Important Notes

About Tri-M Technologies Inc.

Tri-M Technologies Inc. specialises in embedded computing for rugged environments. Tri-M's innovative solutions are the premiere choice for off-highway vehicles, industrial controls, robotics, military equipment, aerospace technologies, undersea and advanced security products. We offer a wide range of DC-DC converters, CPU boards, hardened enclosures, I/O modules, wireless communication devices, and customized systems. With over 28 years of industry experience, Tri-M is your embedded systems specialist.

Who this Guide is For

This user guide is intended for integrators of embedded system applications. It contains detailed information on hardware and software requirements to interconnect to other embedded devices. Carefully read this user guide before you begin installation. The user should be familiar with practicing safe techniques while making supply or pin connections.

User Guide Revision History

Revision	Date	Description
A	June 2012	New product release
B	December 2012	Updated command tables

Trademarks

Trademarks, registered trademarks, and product names are the property of their respective owners and are used herein for identification purposes only.

Contact Information

Tri-M Technologies Inc.
101–1530 Kingsway Avenue
Port Coquitlam, BC V3C 6N6 Canada

Telephone	Toll free North America: 1.800.665.5600 Direct: +1.604.945.9565	
Email	Technical Support	techsupport@tri-m.com
	Sales	sales@tri-m.com
	Information	info@tri-m.com
Website	www.tri-m.com To submit a request for technical support, please complete the online form at www.tri-m.com/support/contact.html To request an RMA, please complete the online form at www.tri-m.com/support/rma/index.html.	

Technical Support

Business hours: M–F, 8:30am to 5pm PST

Warranty

For warranty information, see "Tri-M Technologies Inc. (Limited Warranty)" on page 35.

Important Safety Instructions

Conventions Used in this Guide

Note

This note contains important or useful information in the use or installation of the product.

CAUTION

The caution provides information to prevent potential equipment damage or shock hazard.

Electrostatic Discharge (ESD) Precautions

To avoid electrostatic discharge or transient voltage damage to the board, observe the following procedures:

- Before touching the board, discharge your body and any tools you use from electricity.
- Ensure that the board or the unit you want to install the board on is de-engergized before installing.
- Do not touch any devices or components on the board.

CAUTION: Shock Hazard

As soon as the board is connected to a working power supply, touching the board may result in electrical shock, even if the board has not been switched on yet.

Contents

Figures

Tables

1 Introduction

TUP1000 is a Small Form Factor (SFF[1]) UPS DC-DC converter using ultra capacitors (versus batteries) to provide seamless UPS backup capabilities. As a high performance power supply, the TUP1000 can produce 35 watts @ +5VDC or 42 watts @ +12VDC.

The PC/104 footprint design supports many low power embedded systems requiring short-term power during a power loss.

TUP1000 has a fully programmable power output of +4.5VDC to +12.6VDC. The rugged design includes transient suppression and locking terminal mating plugs.

Key Specifications and Benefits

- Ultra capacitor backup—500K charge cycles, 10000W transient suppression
- Three on-board RGB LEDs display input, output power status, TUP1000 status; support for three off-board RGB LEDs or nine single color LEDs
- Wide input voltage range of +4.5V to +33V DC with reverse polarity protection
- Compatible with many industry standard form factors
- High efficiency maximum 96% for optimized power performance
- Locking terminal mating plugs for ease of installation
- Extended operating and storage temperature range -40°C to +85°C (-40°F to +85°F), suited for outstanding performance and reliability in harsh environments
- Tested to meet MIL-STD-810G[2], and surges and transients ISO 7637-2 pulse 5

Models

TUP1000-5	35 watts power supply and smart charging
TUP1000-12	42 watts power supply and smart charging

Options

- **Conformal Coating** (Acrylic CH, Acrylic higher voltage CH1, Silicone CS, Urethane CU)
  Ruggedized temperature, fungal resistance, humidity, and chemical protection against the elements
- **Lead-Tin Soldering** (LD)
  Tri-M is RoHS compliant. We offer lead-tin soldering for automotive and military aerospace applications.
- **Cables** To secure the cables to the board, latching cables are available.

For more information about the TUP1000, please call us at 1.800.665.5600 or +1.604.945.9565 or visit our website at www.tri-m.com.

1 SFF includes PC/104, PC/104-*Plus*, PC/104-Express™, EPIC, EBX, Mini-ITX, and SUMIT.
2 For more information, see the Certificate of Compliance available at www.tri-m.com.

TRI-M

Specifications

Model	TUP1000-5	TUP1000-12
Main Input		
Input Voltage Range	+4.5V to +33V DC	
Ultra Capacitors		
Backup Capacity 12x10F ultra capacitors wired in series	0.833 farads	
Energy Capacity	260 joules	
Self-discharge Rate (see note 1)	1.67mV/sec	
Output 1		
Voltage Range	4.75 to 5.25V	11.4 to 12.6V
Current	7A	3.5A
Ripple Voltage	10 to 20mV	15 to 50mV
Load Regulation	100 to 120mV	80 to 100mV
Line Regulation	<10mV	
Output Temperature Drift	100mV	
Efficiency	92%	95%
Input/Output 2		
Voltage Range	6.5 to 25V	
Current (see note 2)	7A	
Ripple Voltage	80 to 100mV	
Load Regulation	<350mV	
Line Regulation	10 to 20mV	
Output Temperature Drift	150mV	
Efficiency	96%	
Mechanical Specifications		
PC/104 Standard		
Dimensions (see note 3)	90 × 96 ×11mm (3.55 × 3.775 × 0.43")	
Weight	80g (2.82oz)	
Environmental Specifications		
Storage Temperature Range	-40°C to +85°C (-40°F to +185°F)	
Operating Temperature Range	-40°C to +85°C (-40°F to +185°F)	
Communication		
USB	CDC and MSC	
LED Indicators	3 on-board RGB LEDs Off-board LEDs: 3 RGB LEDs or 9 single color LEDs	

Configuration	
OS Support	Linux
Certifications	Tested to MIL-STD-810G. For more information, see the Certificate of Compliance available at www.tri-m.com TRI-M RoHS compliant Manufactured in **ISO9001:2008** **ISO 14001:2004** & **ANSI/ESD S20.20** Environments

1) Based on an internal quiescent current of 1.4 mA when the TUP1000 is in "deep power down " mode.
2) The on-board microcontroller will set the current limit of 3.5A or 7A, depending on the input supply capability and whether the output 2 converter is working in buck or boost switching mode.

Block Diagram

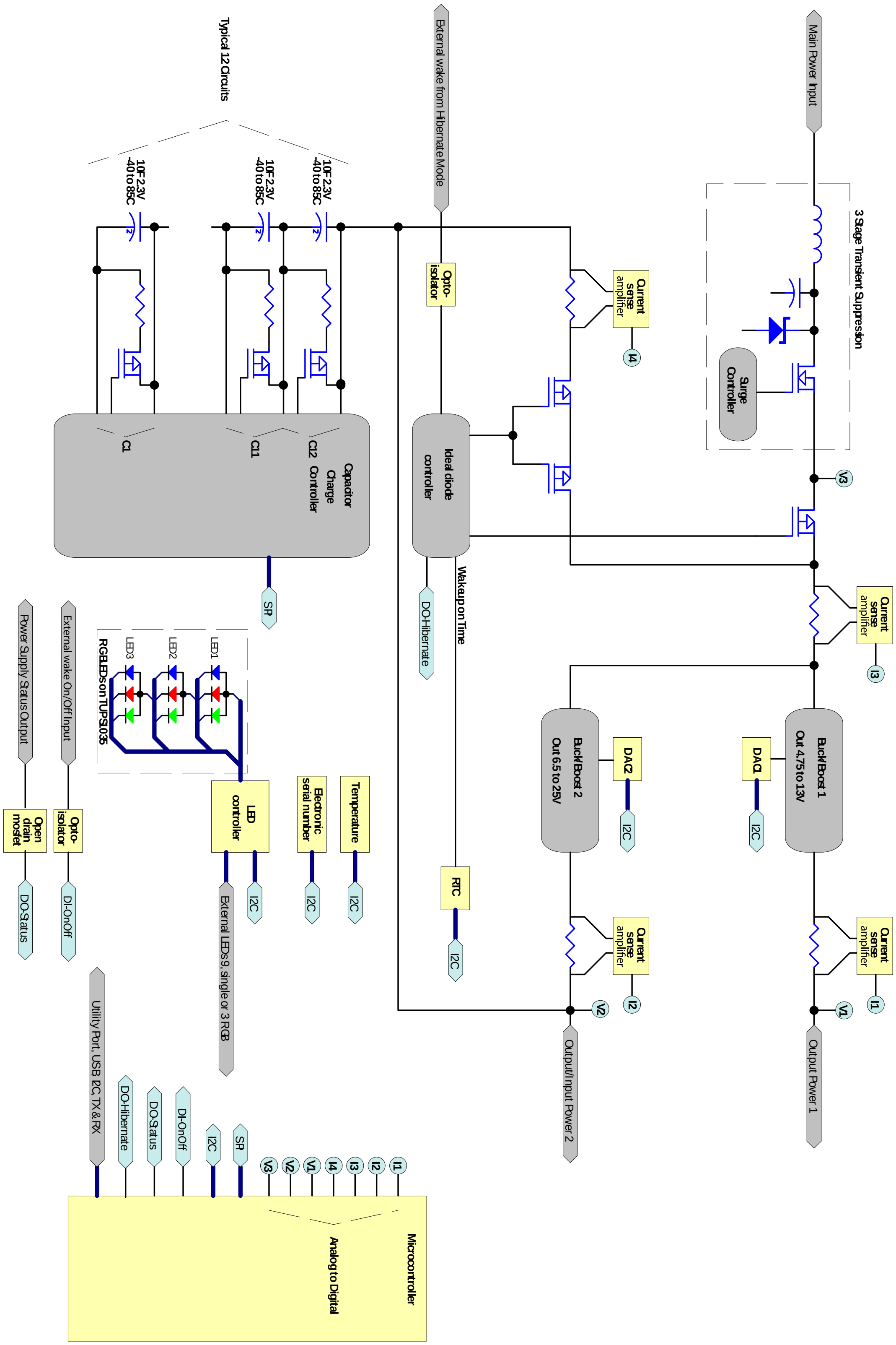
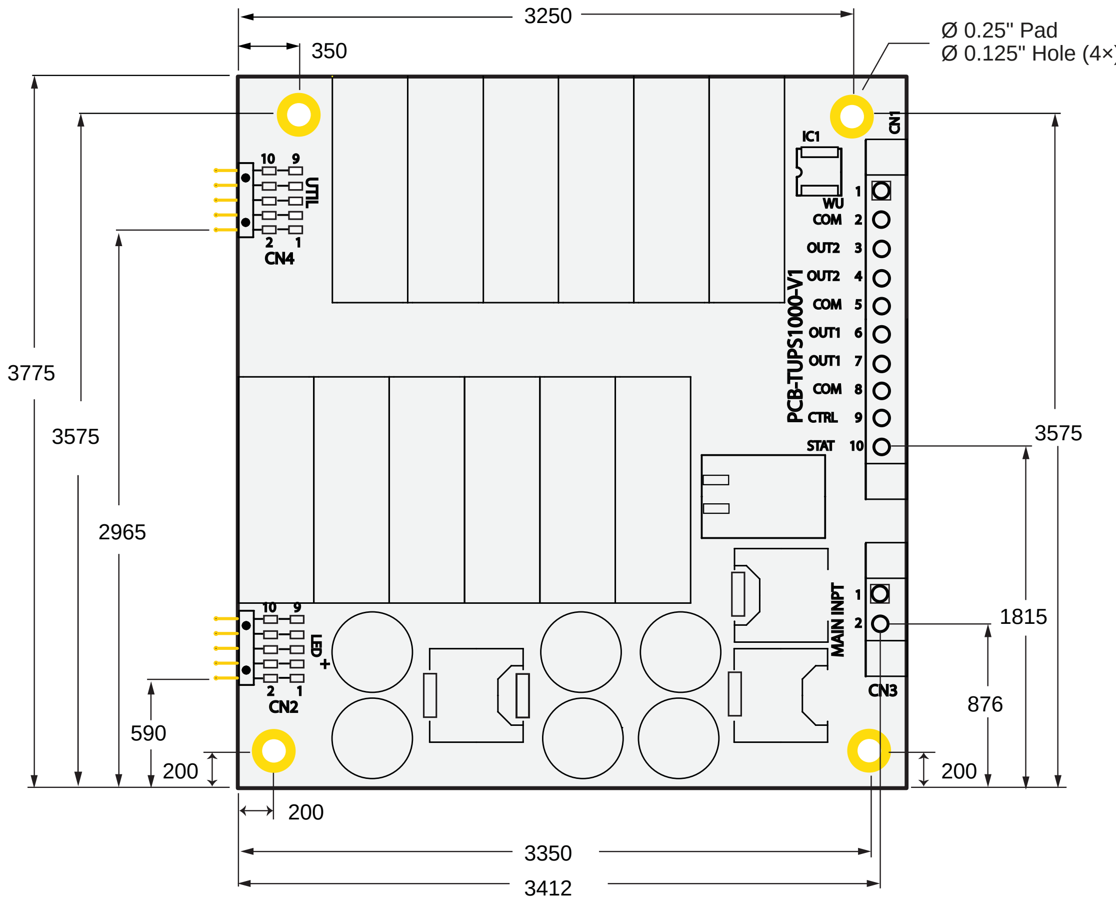


Figure 1: TUP1000 Detailed Block Diagram

Dimensions

Figure 2: TUP1000 Dimensions



Note

Dimensions are in mils. 1000 mils = 1 inch.

The four mounting holes are per the PC/104 specification. Pads are 0.25" and holes are 0.125".

Connector Locations

Figure 3: Connector Locations

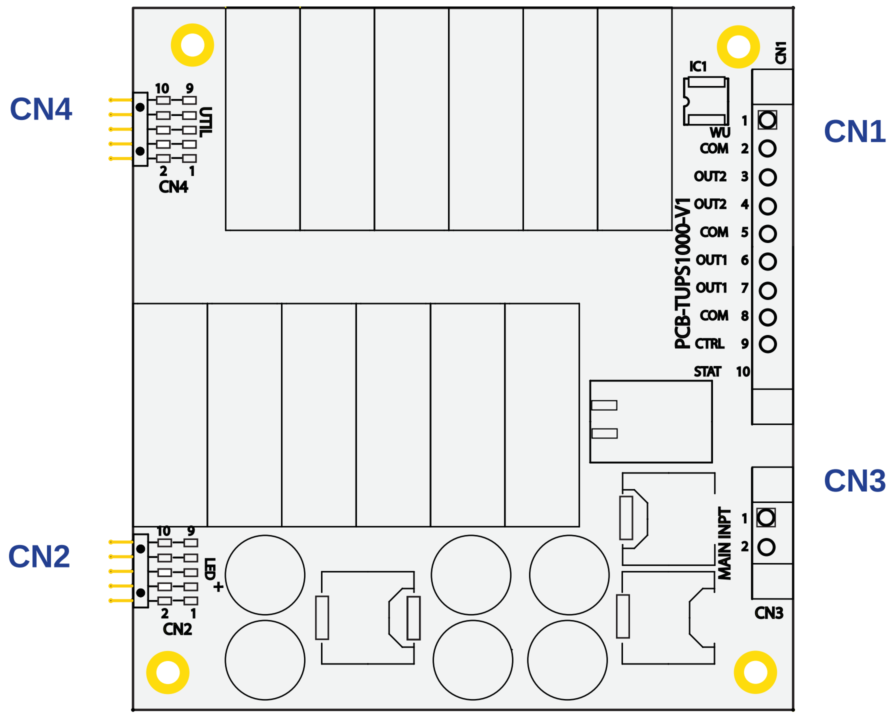


Table 1: CN1 to CN4 Connectors

Label	Description	Mechanical and Wire Specifications	Page
CN1	Power and control signals	• 10 position socket, 3.81 mm, right angle • Locking terminal mating plug, Phoenix Contact 1827787, 14 to 30 AWG (UL), 8A	See page 13.
CN2	LED	• 10 position shrouded pin header, 2x5 right angle • Locking mating plug FCI 90311-010LF • Female wire crimps FCI 77138-101LF	See page 16.
CN3	Main input power, +9V to +33V DC	• 2 position socket, 3.81 mm, right angle • Locking terminal mating plug Phoenix Contact 1827703, 14 to 30 AWG (UL), 8A	See page 19.
CN4	UTIL	• 10 position shrouded pin header, 2x5 right angle • Locking mating plug FCI 90311-010LF • Female wire crimps FCI 77138-101LF	See page 20.

2 Connectors

Output Power Connector (CN1)

CN1 provides terminal socket connections for the output voltages and signals. The outputs offer +5VDC @ 7A maximum and +12VDC @ 3.5A maximum. The screw terminal plugs for CN1 and CN3 connectors accept 16 to 28 AWG wires.

Figure 4: Output Power Connector (CN1)

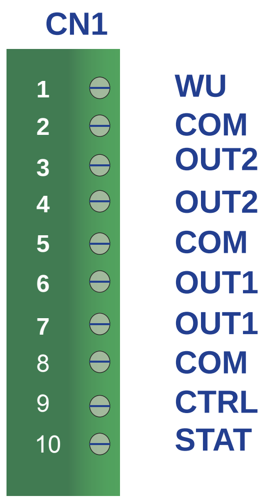


Table 2: Outputs & Signals for CN1

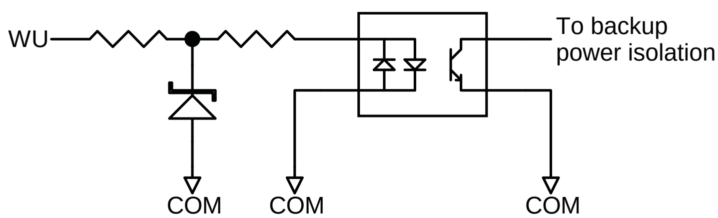
Outputs & Signals (CN1)			Page
Pin	**Signal**	**Description**	
CN1-1	WU	WU is an active high optocoupled input that wakes up the TUP1000 from hibernate mode.	See page 14.
CN1-2	COM (Common)	TUP1000 electrical common	
CN1-3	INPUT/OUT2	INPUT/OUT2 is directly connected to the TUP1000 ultra capacitors which are charging the Output2 regulator.	See page 14.
CN1-4	INPUT/OUT2		
CN1-5	COM (Common)	TUP1000 electrical common	
CN1-6	OUT1	Output from the Output1 regulator.	See page 14
CN1-7	OUT1		
CN1-8	COM (Common)	TUP1000 electrical common	
CN1-9	CTRL	CTRL is an optocoupled input that provides remote On/Off control.	See page 14.
CN1-10	STAT	STAT is an open drain FET with a series 1.24KΩ series resistor.	See page 15.

WU (CN1-1)

WU is an active high optocoupled input that wakes up the TUP1000 from hibernate mode. The WU signal must be a momentary pulse long enough (TBD) to initialize the microprocessor on the TPU1000.

CAUTION
Failure to remove the WU signal after the microprocessor is initialized prevents the TUP1000 from going into hibernate mode.

Figure 5: Wu Signal



INPUT/OUT2 (CN1-3, CN1-4)

INPUT/OUT2 is directly connected to the TUP1000 ultra capacitors which are charging the Output2 regulator. An external bank of ultra capacitors can be connected to the TUP1000 to provide additional storage to extend the holdup time.

CAUTION
Ensure the Output2 regulator is configured to supply no more than the maximum voltage rating of any connected external ultra capacitors.

OUT1 (CN1-6, CN1-7)

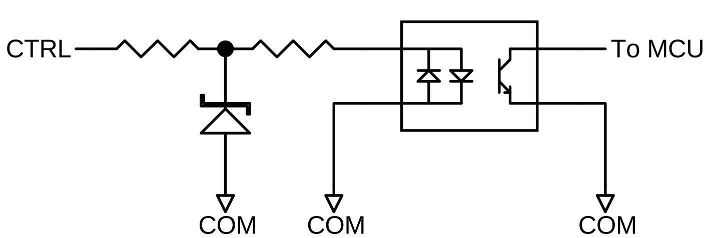
Output from the Output1 regulator. The Output1 can be configured to provide from 4.5 to 12.6V.

CAUTION
Ensure the Output1 regulator is configured to supply the correct voltage to any connected equipment.

CTRL (CN1-9)

CTRL is an active high optocoupled input that provides remote On/Off control. CTRL can be configured for maintained contacts (such as ignition switches) or momentary contracts (such as push buttons). CTRL can also be configured for polarity of operation. The input range is 4.5V to 33V.

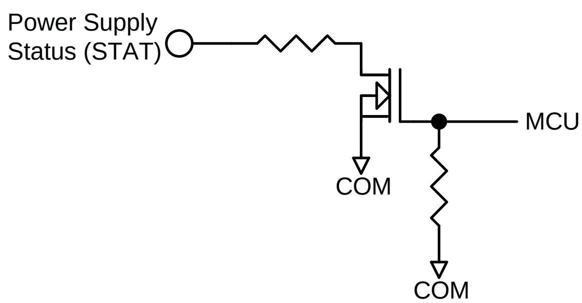
Figure 6: CTRL Signal



STAT (CN1-10)

STAT is an open drain FET with a 1.24KΩ series resistor. STAT is active low when OUT1 is On and no shutdown is pending. A pending shutdown may occur for many reasons including (but not limited to) main power loss, host generated request, CTRL and low backup power. When a shutdown is pending (for any reason) the STAT will go into high impedance and remain in that condition until the OUT1 turns On again.

Figure 7: Power Supply Status Signal



LED (CN2)

Three RGB status LEDs are located on TUP1000. The LEDs provide signal activity for

- power failure
- micro-controller (MCU) heartbeat
- input power status
- output power status.

TUP1000 supports three off-board RGB LEDs or nine single colour LEDs.

Table 3: Off-board RGB LEDs

Off-board RGB LEDs			
Pin	**Signal**	**Pin**	**Signal**
1	VccLED (Connect to anode of LEDs)	2	LED 4 Green cathode
3	LED 4 Red cathode	4	LED 4 Blue cathode
5	LED 5 Green cathode	6	LED 5 Red cathode
7	LED 5 Blue cathode	8	LED 6 Green cathode
9	LED 6 Red cathode	10	LED 6 Blue cathode

Table 4: Auto Mode Function

LED#	Auto Mode Function
LED1	Input Power Status
LED2	TUP1000 Status
LED3	Output Power Status
LED4	Input Power Status
LED5	TUP1000 Status
LED6	Output Power Status

Table 5: TUP1000 Status

LED Colour	TUP1000 Status	LED Duty Cycle Percent
Blinking Green	The ultra capacitor bank is at full charge status.	10
Blinking Yellow	The ultra capacitors are being charged.	10
Blinking Red	An internal alarm condition exists.	90
The LED blinks at a steady 1 Hz as a heart beat indicator. If no alarm condition exists the LED will blink Green or Yellow with a duty cycle of 10 percent on 90 percent off. If an alarm condition exists the LED will blink with a duty cycle 90 percent Red with the 10 percent displaying the ultra capacitor status.		

Table 6: Input Power Status

LED Colour	Input Power Status	LED Duty Cycle Percent
Steady Green	The input voltage and temperature are within operating range.	100
Blinking Red	The input voltage is too high.	90
Blinking Blue	The input voltage is too low.	90
Blinking Red	The temperature is too high.	10
Blinking Blue	The temperature is too low.	10
Steady Red	Both the input voltage and temperature are too high.	100
Example: If the input voltage is too low but the temperature is too high the LED will blink 90 percent Blue and 10 percent Red.		

Table 7: Output Power Status

LED Colour	Output Power Status	LED Duty Cycle Percent
Steady Green	The output voltage is within range.	100
Blinking Green	The output voltage is within range, but the TUP1000 is in shutdown, and the output will turn off after the programmed delay interval.	90
Blinking Green	TUP1000 is in start up mode and will turn on the output after the programmed delay interval.	10
Steady Red	The output is On and outside the calibration range.	100
Steady Orange	The output is On, not in range but can be calibrated.	100
Black (Off)	The output is off and the TUP1000 is not in start up mode.	100

Each RGB LED consists of three color diodes (Red, Green and Blue). A specific color is created by adjusting the ratios of current through the three color diodes. The brightness of the RGB LED is varied by increasing or decreasing the current through the color diodes but maintaining the ratios of the current. The current for each color diode is controlled a 32bit register mapped as 00.RR.GG.BB. The current for each color diode can be varied from 0 to 20ma in 65 steps (0x00 to 0x3F).

Table 8: RGB Color Mappings

RGB Color	32bit color control register mapped as 00.RR.GG.BB	Current through each color diode (ma)		
		Red	Green	Blue
Red	0x001F0000	9.84	0.00	0.00
Green	0x00000F00	0.00	4.76	0.00
Blue	0x0000000F	0.00	0.00	4.76
Yellow	0x000C0500	3.81	1.59	0.00
Orange	0x00180200	7.62	0.63	0.00

Off-board LEDs are supported as either three RGB or nine single color LEDs. This allows the remote mounting of LEDs on the enclosure to indicate either the power supply status or status of the host CPU functions.

The three on-board RGB LEDs and the three off-board LEDs (or nine single colour LEDs) can by controlled by the host software through the USB port.

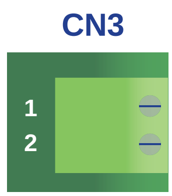
Table 9: Off-board Single Color LEDs

Off-board Single Color LEDs	
Pin	**Signal**
1	VccLED (Connect to anode of LEDs)
2	LED 4 cathode
3	LED 5 cathode
4	LED 6 cathode
5	LED 7 cathode
6	LED 8 cathode
7	LED 9 cathode
8	LED 10 cathode
9	LED 11 cathode
10	LED 12 cathode

Input Power Connector (CN3)

The CN3 connector provides terminal socket connections for input power.

For enhanced protection, the TUP1000 provides transient suppressors, active input clamping, reverse polarity protection, and current limiting. For more information, see the "Protection Features" on page 33.



Input Power (CN3)	
Pin	**Signal**
CN3-1	+5V to +33V DC
CN3-2	COM

CAUTION: Equipment Damage

Although the TUP1000 has reverse polarity protection, make sure that the polarities are correct in order to avoid damaging the input power supply. The supply must be correctly fused.

UTIL (CN4)

The UTIL connector CN4 provides access to the I2C (SDA & SCL), asynchronous (TX & RX) and USB (USB D- and D+) serial signals.

- The I2C serial signals can be used to expand the functionality and monitoring of the TUP1000.
- The USB serial signals can be used to reprogram and update the firmware and profile and provides a command-line communications port (USB CDC mode) to read and set operating values and parameters in the TUP1000.
- The TX and RX port operates as a command-line communications port (USB CDC mode) to read and set operating values and parameters in the TUP1000. NOTE: TX & RX signals are TTL level (SV) and require a RS232 buffer before they can be safely connected to an RS232 port.

Table 10: Util CN4 Connector

Util (CN4)			
Top		Bottom	
Pin	Signal	Pin	Signal
1	SDA	2	SCL
3	TX (3.3V TTL)	4	ISPX*
5	RX (3.3V TTL)	6	USB D-
7	INPUT/OUT2 Power (Limit to maximum 1A)	8	USB D+
9	COM (Common)	10	USB Vcc

*Connecting ISPX to ground puts the USB port in firmware replacement mode.

Leaving the ISPX pin unconnected lets you edit the settings using the config.txt file.

The ‘config.txt’ files will be overwritten if the ‘firmware.bin’ is entirely rewritten, and the disk containing the config.txt resides in the upper 4KB of the ‘firmware.bin’

Installation

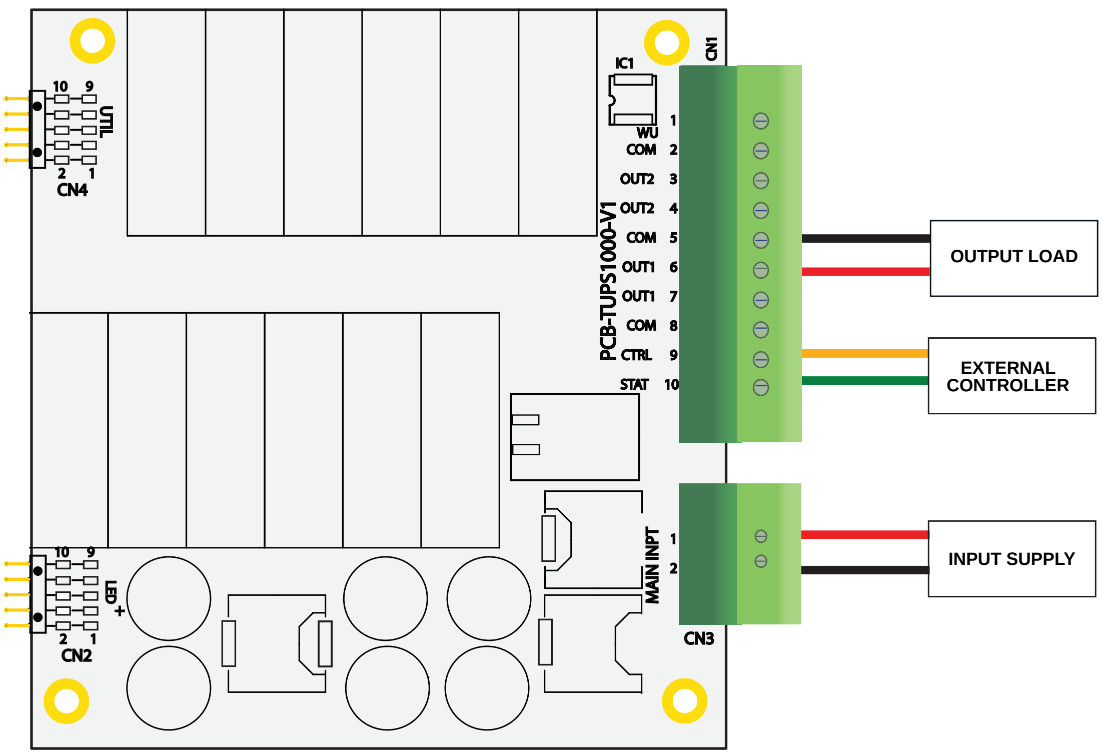
TUP1000 features locking terminal mating plugs for easy installation. The screw terminal plugs for CN1 and CN3 connectors accept 16 to 28 AWG wires.

Connection Diagram

CAUTION: Equipment Damage

Although the TUP1000 has reverse polarity protection, make sure that the polarities are correct in order to avoid damaging the input power supply. The supply must be correctly fused.

Figure 8: Connection Diagram



3 Configuration

The configuration setup uses a jumperless embedded design to access the board without having to dissemble and reassemble the stack. The TUP1000 also features a configuration lock to secure your settings from undesirable changes.

There are three methods to configure the TUP1000, command-line configuration setup and mass storage configuration setup via the USB port or the command-line configuration configuration through the asynchronous serial port. Please refer to the UTIL connector CN4 details on connecting to the USB and asynchronous serial ports."

Command-line Configuration Setup

Connect via USB CDC mode (communication device class) to enable a USB virtual COM Port, as shown Figure 9. A terminal command-line application is used to configure the device.

Figure 9: TUP1000 accessed using a USB cable as a Virtual COM Port

Figure 10: TUP1000 accessed via an asynchronous serial port

CAUTION

Locked configuration settings can only be unlocked by accessing the USB virtual COM port in USB CDC (communication device class) mode.

WARNING

Asynchronous serial TX & RX signals available on the UTIL port are TTL level (SV). Connecting the UTIL port directly to a COM port using RS232 will damage the board.

Command-line Configuration FAQ

1. What are the basic steps and commands to configure a TUP1000-5 for my application? My application has an ignition switch and I want the outputs to turn on after the power is stable (allow 5 seconds for cranking). I require a little more output voltage (5.15V) due to voltage drop on the wires to the CPU board. Shutdown should occur 30 seconds after main power is lost.

- Step a) Configure the CTRL input (CN1-9)
  - The TUP1000 can be configured using a terminal on the USB CDC port or on the TX/RX serial port.
  - The CTRL input can be configured for a maintained action switch such as an ignition with "SDA=Ignition".
  - The polarity of the CTRL input can be set for ignition switch operation with "SDP=Positive".
- Step b) Configure the 5 second delay on delay
  - Output 1 can be delayed from turning on for 5 seconds by "SUDL=5000".
  - Note: Other conditions must be met for Output 1 to turn on such as Vin in range, temperature in range ultracapacitors charged to BMIN.
- Step c) Calibrate the output voltage to 5.15 volts
  - Output 1 voltage can be calibrated to 5.15V by "VSET=5150".
- Step d) Set Output 1 to turn off after 30 seconds when main power is lost
  - The 30 second delay to turn off is set with "SDDL=30000".
  - Note: The 30 second delay off delay will occur when any of the shut down conditions occur such as Vin not in range, temperature out of range, ultracapacitors discharged below BMIN or ignition turns off.

2. How does my application determine when and why the TUP1000 will turn off Output 1?

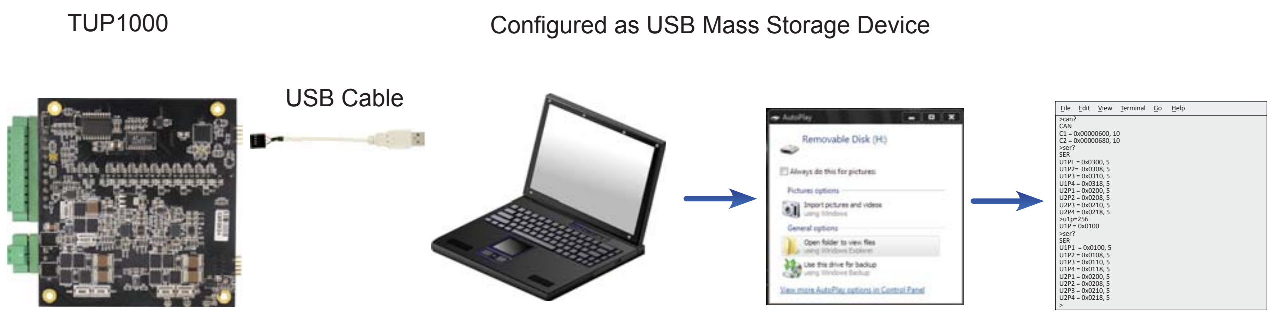
- Step a) Determine if Output 1 is in the process of turning off:
  - The TUP1000 can be polled to determine if Output 1 is in a timed shut down mode with "SDST?" When Output 1 is in the timed shut down mode the TUP1000 will return "SDST=ENABLE" to that query.
- Step b) Determine the length of time before Output 1 turns off:
  - The remaining time before Output 1 turns off can be determined with "SDDC?". The TUP1000 will respond with the remaining time in msec (ex SDDC=15000 for 15 seconds left to turning off Output 1).
- Step c) Determine why Output 1 is turning off:
  - The condition that initiated the shut down can be determined with "SDFL?". Possible responses are:
  - "SDFL=SD" cause is CTRL input
  - "SDFL=MV" cause is Main Voltage
  - "SDFL=BV" cause is Battery Voltage
  - "SDFL=TP" cause is Temperature
  - "SDFL=HC" cause is Host Control
  - "SDFL=None", no shut down is in progress

Mass Storage Configuration Setup

Once you have configured the settings using the command-line configuration setup, lock your configuration profile settings and export to a ‘tup_XXv.cfg’ file, where XX is the nominal voltage (5 for 5V, 12 for 12V ..., AD for adjustable).

Using the USB MSC (mass storage device class) mode, you can transfer the configuration profiles between your PC and the TUP1000, as shown in Figure 11.

Figure 11: TUP1000 configured as a Mass Storage Device



CAUTION

Although the device is recognized as a mass storage device, space is limited to approximately 4KB. The intended use is strictly for storing the configuration file, ‘tup_XXv.cfg. The mass storage memory should not be used for any other purpose; if any other files are present, those files will be lost when the system power cycles.

Using tup_5v.cfg

Typical example contents of the "tup_5v.cfg". Note: The TUP1000 firmware will accept abbreviated response values (as shown in file listing below). For example "I = Ignition", "E=Enable", "N=Negative", "D=Disable", "L=Locked" and "A=Auto". Note also that the same abbreviation can have different values for different commands, ex: "U=Unlocked" for LCK command and "U=Uart" for DBP command.

Note: The contents of "tup_5v.cfg" can be edited and saved back to the TUP1000 to implement configuration changes. To implement Example 1 as shown in the previous section the following changes to the file are shown in **red** below:

```
# Configuration
HBT=1000
HBD=10
LED1=00000000
LED2=00000000
LED3=00000000
LED4=00000000
LED5=00000000
LED6=00000000
SUTH=355650
SUTL=233650
SUVH=32500
SUVL=7050
BSUV=24850
BSDV=7000
VMIN=7000
VMAX=33000
BMIN=24600
BMAX=25000
VSET=5000
MVDB=1000
SUDL=1000
SDDL=10000
SDS=100
DBG=D
DBP=U
SDP=N
SDA=I
OUT=A
LED=A
LCK=U
```

Figure 12: tup_5v.cfg sample contents

```
# Configuration
HBT=1000
HBD=10
LED1=00000000
LED2=00000000
LED3=00000000
LED4=00000000
LED5=00000000
LED6=00000000
SUTH=355650
SUTL=233650
SUVH=32500
SUVL=7050
BSUV=24850
BSDV=7000
VMIN=7000
VMAX=33000
BMIN=24600
BMAX=25000
VSET=5150
MVDB=1000
SUDL=5000
SDDL=30000
SDS=100
DBG=D
DBP=U
SDP=P
SDA=I
OUT=A
LED=A
LCK=U
```

Figure 13: tup_5v.cfg sample configured for an ignition switch, 5 second startup delay, increased output voltage, and 30 seconds of UPS functionality.

Command-line Configuration

After a connection to the TUP1000 is established a terminal command-line application can be used to read and write values.

Table 11: User Commands

Command	Example Command ?	 TUP1000 Response	Units and Values	Description
VER	ver?	01.00 - Nov 2 2012	N/A	Code version
PN	pn?	TUP1000_5V (4747mV ~ 5253mV)	N/A	Product part number with the output 1 range
SN	sn?	F50000004EFE036D53360ABB03031B07	32 Hex characters	Serial number
RT	rt?	0:00:01:32	Days:HH:MM:SS	Runtime
TRD	trd?	TRD = 297524	mK (milli Kelvin)	Temperature
MLF	mlf?	MLF = 54413	Integer number	Number of times the main loop is executed per second
SDX	sdx?	SDX = high	low, high	SD Status
SUST	sust?	SUST = Disable	Enable, Disable	Startup state
SDST	sdst?	SDST = Disable	Enable, Disable	Shutdown state
PBST	pbst?	PBST = high	high, low	Push Button / Ignition input state
SUFL	sufl?	SUFL = SD	SD, MV,BV,TP, HC, None	Startup event (event that initiated the startup)
SDFL	sdfl?	SDFL = None	SD, MV,BV,TP, HC, None	Shutdown event (event that initiated the shutdown)
MAINV	mainv?	MAINV = 14995	mV	Main input Voltage
MAINI	maini?	MAINI = 98	mA	Main Input Current
OUTV	outv?	OUTV = 5000	mV	Output 1 Voltage
OUTI	outi?	OUTI = 27	mA	Output 1 Current
OMAX	omax?	OMAX = 5253	mV	Output 1 maximum voltage limit
OMIN	omin?	OMIN = 4747	mV	Output 1 minimum voltage limit
PSST	psst?	PSST = ON	ON, OFF	Output 1 state
BAKV	bakv?	BAKV = 14911	mV	Output 2 (Ultracapacitor charging) Voltage
BAKI	baki?	BAKI = 319	mA	Output 2 (Ultracapacitor charging) Current
CHST	chst?	CHST = OFF	ON, OFF	Output 2 (Ultracapacitor charger) state
SECI	seci?	SECI = 19	mA	Ultracapacitor discharge Current

Note

To enter a User Command using a terminal command-line application, type the command followed by a question mark **'?'**, then press the **Enter key** to return the value.

Command-line Configuration

After a connection to the TUP1000 is established a terminal command-line application can be used to read and write values.

Command	Example: Command ?	Example: TUP1000 Response	Units and Values	Description
CELV	celv?	CELV = 14918 Cell[0] = 1239 Cell[1] = 1255 Cell[2] = 1240 Cell[3] = 1251 Cell[4] = 1242 Cell[5] = 1242 Cell[6] = 1243 Cell[7] = 1239 Cell[8] = 1243 Cell[9] = 1240 Cell[10] = 1245 Cell[11] = 1239	mV	Ultracapacitor bank voltage and the voltage of each cell (only updated during charge)
CELT	celt?	CELT = 301000	mK (milli Kelvin)	Temperature of the ultracapacitor controller (only up-dated during charge)
CELF	celf?	CELF = 040A	hex character bit mapped Bit 0 = ultracapacitor 1 to Bit 11 = ultracapacitor 12 0 = OFF, 1 = ON	Is the same as BP except CELF retains the last state of the Discharge cell register

Note
To enter a User Command using a terminal command-line application, type the command followed by a question mark **'?'**, then press the **Enter key** to return the value.

Command-line Configuration

After a connection to the TUP1000 is established a terminal command-line application can be used to read and write values.

Command	Example Command ?	 TUP1000 Response	Units and Values	Description
CELS	cels?	CELS:	N/A	Status of each ultracapacitor (only updated during charge)
		Cell[0] = undervoltage Cell[1] = undervoltage Cell[2] = undervoltage Cell[3] = undervoltage Cell[4] = undervoltage Cell[5] = undervoltage Cell[6] = undervoltage Cell[7] = undervoltage Cell[8] = undervoltage Cell[9] = undervoltage Cell[10] = undervoltage Cell[11] = undervoltage	undervoltage, OK, overvolt-age	
		OV=000	hex character bit mapped Bit 0 = ultracapacitor 1 to Bit 11 = ultracapacitor 12 0 = OK, 1 = over voltage	Ultracapacitor controller over voltage register (only updated during charge)
		UV=FFF	hex character bit mapped Bit 0 = ultracapacitor 1 to Bit 11 = ultracapacitor 12 0 = OK, 1 = under voltage	Ultracapacitor controller under voltage register (only updated during charge)
		BP=000	hex character bit mapped Bit 0 = ultracapacitor 1 to Bit 11 = ultracapacitor 12 0 = OFF, 1 = ON	Ultracapacitor controller bypass register (updated ultra-capacitor bank voltage is above 7V)
		MM=10	10 = standby, 12 = normal	Ultracapacitor controller running mode

Note
To enter a User Command using a terminal command-line application, type the command followed by a question mark **'?'**, then press the **Enter key** to return the value.

Command-line Configuration

Assign Commands use "=" to enter a new value and "?" to request the current value.

Table 12: User Assign Commands

Command	Example Command ? Or =	TUP1000 Response	Units, Value and Range	Description
HBT	hbt?	HBT = 1000	ms Range 25 to 10000	LED flashing time period
HBD	hbd?	HBD = 10	Percent Range 10 to 35	LED flashing duty-cycle
LED1	led1? led1=0x00060201	LED1 = 00000000 LED1 = 00060201	32 bit hex 0x00RRGGBB	LED1 RGB color and brightness
LED2	led2? led2=0x00060201	LED2 = 00000000 LED2 = 00060201	32 bit hex 0x00RRGGBB	LED2 RGB color and brightness
LED3	led3? led3=0x00060201	LED3 = 00000000 LED3 = 00060201	32 bit hex 0x00RRGGBB	LED3 RGB color and brightness
LED4	led4? led4=0x00060201	LED4 = 00000000 LED4 = 00060201	32 bit hex 0x00RRGGBB	LED4 RGB color and brightness
LED5	led5? led5=0x00060201	LED5 = 00000000 LED5 = 00060201	32 bit hex 0x00RRGGBB	LED5 RGB color and brightness
LED6	led6? led6=0x00060201	LED6 = 00000000 LED6 = 00060201	32 bit hex 0x00RRGGBB	LED6 RGB color and brightness
SUDL	sudl?	SUDL = 1000	ms Range 0 to 0xFFFFFFFF 0 = Disable	Startup delay
SDDL	sddl?	SDDL = 500000	ms Range 0 to 0xFFFFFFFF 0 = Disable	Shutdown delay
SUDC	sudc?	SUDC = 0	ms Range 0 to 0xFFFFFFFF 0 = Disable	Startup Counter value
SDDC	sddc?	SDDC = 0	ms Range 0 to 0xFFFFFFFF 0 = Disable	Shutdown Counter value
SUTH	suth?	SUTH = 355650	mK (milli Kelvin) Range 233150 to 358150 0 = Disable	Temperature that initiates a startup when returning to normal temperature from an over temperature condition
SUTL	sutl?	SUTL = 233650	mK (milli Kelvin) Range 233150 to 358150 0 = Disable	Temperature that initiates a startup when returning to normal temperature from an under temperature condition
VSET	vset?	VSET = 5000	mV TUP1000-5: 4747 to 5253 TUP1000-12: 11393 to 12607	Output 1 voltage setpoint

Command-line Configuration

Assign Commands use "=" to enter a new value and "?" to request the current value.

Command	Example Command ? Or =	TUP1000 Response	Units, Value and Range	Description
MVDB	mvdb?	MVDB = 1000	ms Range 0 to 0xFFFFFFFF 0 = Disable	Main input Voltage debounce
SUVH	suvh?	SUVH = 32500	mV Range 7500 to 32500	Main input voltage that initiates a startup when returning to normal from an over voltage condition
SUVL	suvl?	SUVL = 7050	mV Range 7000 to 32000	Main input voltage that initiates a startup when returning to normal from an under voltage condition
VMIN	vmin?	VMIN = 7000	mV Range 7000 to 32000	Main input minimum voltage limit
VMAX	vmax?	VMAX = 33000	mV Range 7500 to 33000	Main input maximum voltage limit
BSUV	bsuv?	BSUV = 13500	mV Range 7100 to 25000	Ultracapacitor bank voltage that initiates a startup
BSDV	bsdv?	BSDV = 7000	mV Range 7000 to 24950	Ultracapacitor bank voltage that initiates a shutdown
BMIN	bmin?	BMIN = 14400	mV Range 7000 to 25000	Ultracapacitor bank minimum voltage (re-start charging)
BMAX	bmax?	BMAX = 14800	mV Range 7500 to 25100	Ultracapacitor bank maximum voltage (stop charging)
SDS	sds?	SDS = 100	ms Range 0 to 0xFFFFFFFF 0 = Disable	Time to validate STAT-SDX
CREG	creg?	CREG = 00000103	32bit hex bit mapped	Control register with bit mapped settings (refer to Control Register table for details).
EREG	ereg?	EREG = 00000000	32bit hex bit mapped	Error register with bit mapped flags (refer to Error Register table for details)., flags are reset by writing a 1 to the bit mapped location.
TIME	time?	TIME = 06:15:27	HH:MM:SS	RTC time
DATE	date?	DATE = 12/11/26	YY/MM/DD	RTC date
ATIME (future)	atime?	ATIME = 06:15:27	HH:MM:SS	RTC alarm time (TUP1000 wakeup from hibernation)
ADATE (future)	adate?	ADATE = 12/11/26	YY/MM/DD	RTC Alarm date (TUP1000 wakeup from hibernation)
PWD	pwd?	PWD = 00000000	32bit hex	Password to allow unlocking of profile

Command-line Configuration

Flag Commands use "=" to enter a new value and "?" to request the current value.

Table 13: User Flag Commands

Command	Example Command ? Or =	TUP1000 Response	Units and Values	Description
LCK	lck?	LCK = Unlocked	Unlocked, Locked	Lock, Unlock action. Valid password required before unlock
DBG	dbg?	DBG = Disable	Disable, Enable	Additional debug messages
DBP	dbp?	DBP = UART	Uart, Cdc	Debug port
SDP	sdp?	SDP = Negative	Positive, Negative	SD input polarity
SDA	sda?	SDA = Ignition	Ignition, Push button	SD input function
OUT	out?	OUT = Auto	Auto, ON	Output control
LED	led?	LED = Auto	Auto, Manual	LED control

Control Register Bits Details

Table 14: Control Register Bits Details

BIT#	Bit = 0	Bit = 1	Description
0	Negative	Positive	SD polarity
1	Ignition	Push Button	SD action
2	Auto	ON	OUTPUT 1 control
3	Auto	Manual	LED control
4 .. 28			Future
29	UART (TX/RX)	CDC (USB)	Debug port
30	Disable	Enable	Additional debug messages
31	Unlock	Lock	Lock/Unlock flag, Password has to be entered before Unlock.

Error Register Bits Details

Table 15: Error Register Bits Details

Bit #	Description
0	Serial number reading error
1	RTC registers initialization error
2	RTC reading error
3	RTC writing error
4	LED controller writing error
5 .. 15	Future
16	DAC1 (Output 1) initialization error (also set if max/min voltage limit is not defined)
17	DAC2 (Output 2) writing error
18	Temperature sensor registers initialization error
19	Temperature sensor reading error
20	Ultracapacitor controller registers initialization error
21	Ultracapacitor controller registers read error
22	Ultracapacitor controller registers write error
23	Future
24	Ultracapacitor voltage error
25	Ultracapacitor controller temperature error
26 .. 27	Future
28	Input Voltage configuration error
29	Ultracapacitor bank voltage configuration error
30	Temperature configuration error
31	Any configuration error

Protection Features

The TUP1000 has a number of enhanced protection features.

Thermal Shutdown

If the environmental conditions raise the internal temperature above the extended operating temperature range of -40°C to +85°C (-40°F to +185°F), the TUP1000 automatically shuts down until the internal temperature returns to a safe temperature.

Short Circuit

If a short circuit condition exists, the system will shut down for a specific time-out period until the short-circuit condition is removed. Short circuit protection prevents the internal temperature from rising to excessive levels while maintaining system integrity for an indefinite short circuit output condition.

Three Stage Transient Protection

TUP1000 is designed to meet ISO 7637-2:2011 pulse 5 load dump standards, which specifies the electrical transient protection of equipment installed on passenger cars and commercial vehicles fitted with 12V or 24V electrical systems.

Figure 14: Typical Load Dump Transient and Pulse 5 Waveform*

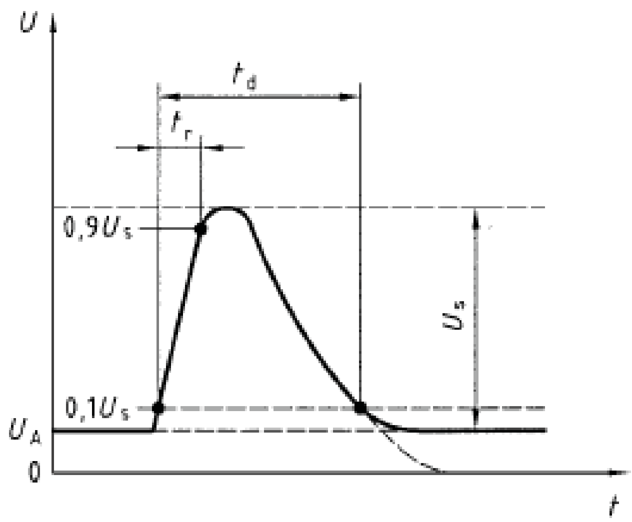


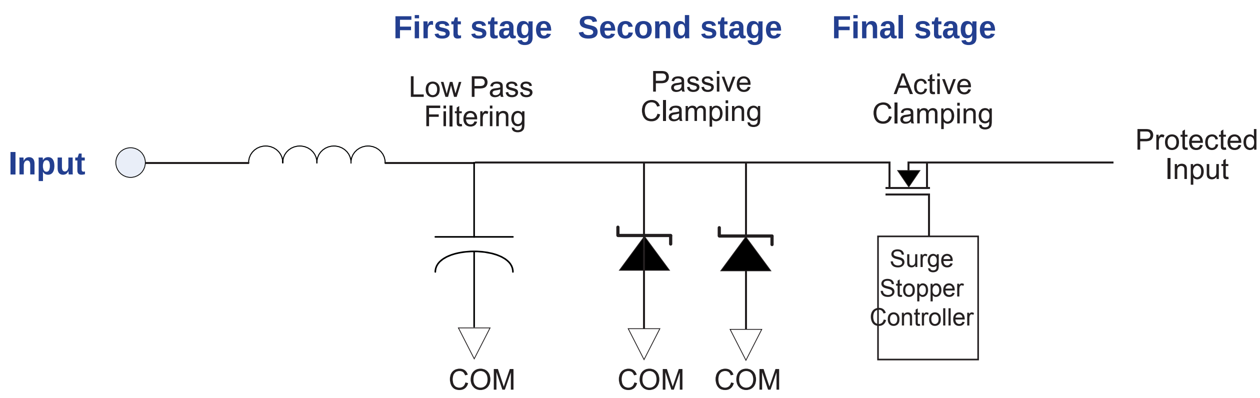
Table 16: Unsuppressed Load Dump Pulse

Unsuppressed Load Dump Pulse		
Parameter	**12V System**	**24V System**
U_s	65V – 87V	123V – 174V
R_i	0.5Ω – 4Ω	1Ω – 8Ω
t_d	40ms – 400ms	100ms – 350ms
t_r	(10_{-5})ms	

* Courtesy of the International Standards Organization

The TUP1000 offers a three-stage transient protection process: low-pass filtering, passive clamping, and active clamping.

Figure 15: Three-Stage Transient Protection



The first stage is a waveform modification that employs a low pass filter to eliminate unwanted high frequencies from entering the system.

The second stage incorporates two high power 5000W transorbs in parallel that work by diverting any energy in excess of 100V to the common ground thus limiting the voltage into the active clamping stage.

The final stage involves active clamping with a surge stopper controller (SSC). The SSC regulates the output to a maximum of 33V during a transient event by controlling the gate of a clamping N-channel MOSFET allowing the TUP1000 to continue regulating.

The SSC has a built in timer that starts when a transient is detected and times inversely proportional to the clamping stress on the clamping MOSFET. If the SSC timer expires it turns the clamping MOSFET off resulting in the TUP1000 drawing power from the backup ultra capacitors to maintain the output load. After a cool down period, the SSC re-enables the clamping MOSFET. If the input voltage is within normal operating levels then normal operation continues however if the input voltage remains above the maximum 33V the SSC timer starts timing again.

Warranty and Product Information

Tri-M Technologies Inc. (Limited Warranty)

Unless otherwise agreed to in writing, Tri-M Technologies Inc. (Tri-M) warrants to the original purchaser that its products will be free from defects in material and workmanship for a period of (1) one year from the date of shipment. Tri-M's obligation under this warranty is limited to replacement or repair at its option and its designated site. Any such products must be returned within the warranty period to Tri-M in Tri-M approved packaging with a Tri-M-assigned RMA (Return Material Authorization) number referenced on the shipping documents.

All warranties are void if there is evidence of misuse, tampering, or attempted repair of parts. Any returns must be accompanied by a return material authorization (RMA) number issued by Tri-M. Purchaser shall prepay transportation to Tri-M's designated site. If returned products are repaired or replaced under the terms of this warranty, Tri-M shall pay return transportation charges.

In no case will Tri-M be held liable for consequential damages arising out of its obligations under this warranty or the failure or incorrect use of any of its products. This warranty is in lieu of all warranties, either express or implied, including, without limitation, any implied warranty of merchantability or fitness for any particular purpose, and of any other obligation on the part of Tri-M.

Disclaimer

No part of this document may be reproduced, transmitted, transcribed, stored in a retrieval system, or translated into any language or computer language, in any form or by any means, electronic, mechanical, magnetic, optical, chemical, manual, or otherwise, without the express written permission of Tri-M Technologies Inc.

Tri-M Technologies Inc. (Tri-M) makes no representations or warranties with respect to the contents of this manual, and specifically disclaims any implied warranties of merchantability or fitness for any particular purpose. Tri-M shall under no circumstances be liable for incidental or consequential damages or related expenses resulting from the use of this product, even if it has been notified of the possibility of such damages. Tri-M reserves the right to revise this publication from time to time without obligation to notify any person of such revisions.

Frequently Asked Questions (FAQ)

1. **What is the mating connector for relay connectors (CN1, CN2)?**
2. **Is the TUP1000 RoHS Compliant?**

   All Tri-M's products are RoHs, and we also provide other customisable options depending on your requirements.
3. **What is the MTBF?**

   The TUP1000 MTBF is rated at xx,xxxx hours at 30°C (86°F) ambient temperature.
4. **How do I request an RMA or warranty issue?**

   To request an RMA, please fill out the online form on our website at www.tri-m.com/support .

   What if I have a technical or specific question?

   For technical support, please see "Contact Information" on page 2.