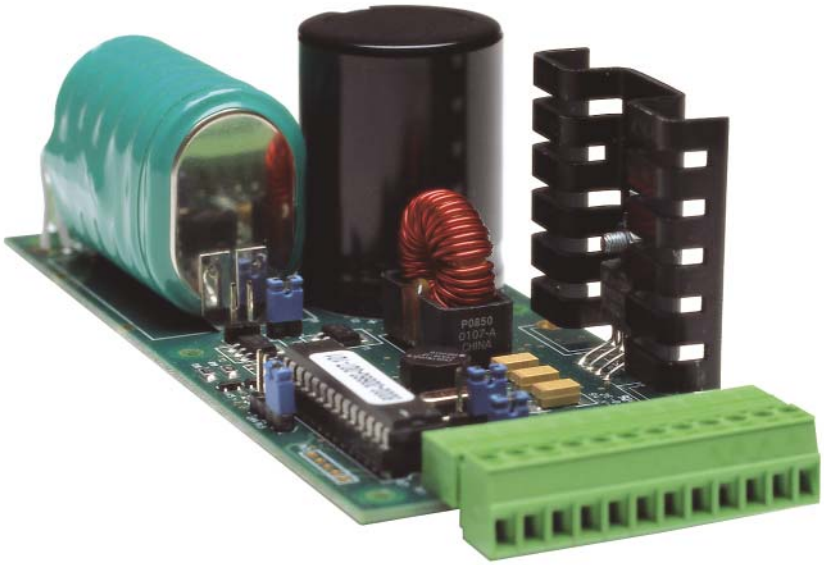
VIPER UPS

Uninterruptible Power Supply

Technical Manual



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Revision History

Manual	*PCB*	*Date*	*Comments*
Issue A	V1I2	11th June 2003	First full release of Manual.
Issue B	V1I3	27th June 2003	Updated for V1I3 issue board.
Issue C	V1I3 and V1I4	6th January 2005	Minor edits, updated layout.
Issue D	V1I4 Mod A	6th July 2006	LK6 removed, battery switching circuit modified, firmware upgraded.

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www.eurotech.com
For contact details, see page 24.

Arcom operates a company-wide quality management system, which has been certified by the British Standards Institution (BSI) as compliant with ISO9001:2000

Contents

Introduction

The VIPER Uninterruptible Power Supply (UPS) board is supplied both as part of the VIPER Development Kit and as a separate product. While primarily designed for use with a VIPER single board computer and to fit into the Arcom VIPER ICE, it can also be used with a number of other Arcom single board computers.

The board can be purchased in the following standard variants:

- VIPER UPS.
- VIPER UPS external battery.
- VIPER UPS automotive.

The VIPER Development Kit contains the VIPER UPS variant. This variant includes an on-board NiMH rechargeable battery.

The external battery variant is designed for use with an external (user supplied) battery, which must be either NiMH or lead acid ($PbSO_4$). The external battery board is rated up to 85°C (185°F), compared to the 65°C (149°F) rating of the VIPER UPS variant.

The automotive variant is a custom board available in OEM quantities with extra power supply filtering, designed to allow the board to be used in harsh EMC environments.

Please contact the Arcom sales team (see Appendix A – Contacting Arcom, page 24) for pricing and availability.

Handling your board safely

Anti-static handling

The VIPER UPS board contains CMOS devices that could be damaged in the event of static electricity being discharged through them. At all times, please observe anti-static precautions when handling the board. This includes storing the board in appropriate anti-static packaging and wearing a wrist strap when handling the board.

Environmental

The battery fitted to the VIPER UPS is a 7 cell battery pack containing Varta V500 HRT NiMH cells. These cells are highly environmentally compatible and contain 0% lead, 0% mercury and 0% cadmium.

Packaging

Please ensure that should a board need to be returned to Arcom it is adequately packed, preferably in the original packing material.

Safe battery use

The VIPER UPS (standard variant) is designed to operate between 0°C (32°F) and 65°C (149°F). Exposure to temperatures above 65°C (149°F) is dangerous and could cause the NiMH battery cells to vent, releasing hydrogen gas. For this reason, the VIPER UPS must not be fitted into airtight environments.

Do not dispose of the VIPER UPS or its NiMH battery in a fire or in an incinerator since this may rupture or dissemble the battery. The NiMH cells contain potassium hydroxide electrolyte, which can cause injury. In the event that electrolyte gets on skin or in eyes, flush immediately with water and seek medical advice.

For further information about VIPER UPS operating and storage temperatures, see Appendix C – Specification, page 27.

The VIPER UPS has a resettable thermal fuse designed to prevent continuous short circuit of the battery. In the event of a fault causing a prolonged battery short circuit, the thermal fuse breaks before the battery generates excessive heat and starts venting.

Hot diode bridge surface

The surface of the diode bridge (component reference D5) can get extremely hot (over 100°C or 212°F). Care should be taken to avoid contact with this device during operation of the VIPER-UPS.

Using an external battery

If using an external battery, it must conform to the requirements specified in the External battery selection section on page 12.

If you use an external lead acid battery, it must have a rating of at least 800mAh. A lower rated battery could be overcharged during recharging.

Jumper settings

It is extremely important that the user selectable jumpers are set correctly for the type of battery fitted to the VIPER UPS. Ensure that the jumpers are set as detailed in the Jumper settings section, page 9, before powering up or connecting a battery. Operating the VIPER UPS with incorrect jumper settings is dangerous, could cause serious injury and will invalidate the warranty of the VIPER UPS.

About this manual

This manual provides detailed information about the VIPER Uninterruptible Power Supply (UPS) board.

Related documents

Further information can be found in the Documentation folder on the User CD, including:

- VIPER Technical Manual (PDF).
- VIPER ICE Technical Manual (PDF).
- Information about other items included in the Development Kit.

Conventions

The following symbols are used in this guide:

Symbol	Explanation
	Note - information that requires your attention.
	Tip - a handy hint that may provide a useful alternative or save time.
	Caution - proceeding with a course of action may damage your equipment or result in loss of data.
	Jumper is fitted.
	Jumper is not fitted.

Getting started with your VIPER UPS

The VIPER UPS is shipped with the board in shutdown mode. However, the battery could be fully discharged when shipped. To start using the board to power a VIPER or another suitable Arcom single board computer, follow these steps:

1. Ensure the jumpers are set correctly for your application. (See Jumper settings, page 9.)
2. Connect a suitable power supply to PL3 (see below).
3. Connect the VIPER (or other load) to the +5V and 0V supply output on PL1.

See Appendix B – Connector details, page 25, for connection details.

It is likely that the NiMH battery fitted to the standard variant is completely discharged. The VIPER UPS must be powered for a minimum of 4 hours to ensure that the battery reaches full capacity.

You can manually force the VIPER-UPS to shut down when running from the battery by removing the following link for 10 seconds:

LK1 for standard variant or external battery variant with a NiMH battery

LK2 for external battery variant with a lead acid battery

Power input requirements

The power input must be:

- 10-36V DC or 12-36V DC[1].

-or-

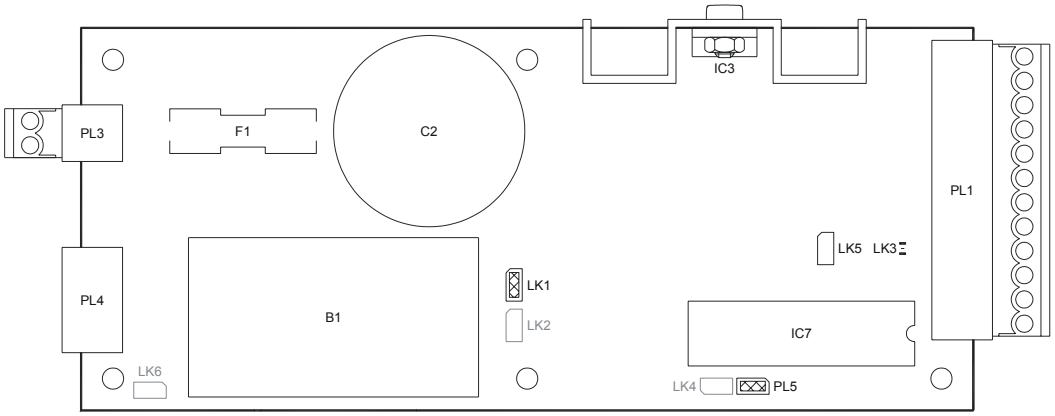
- 10-25V AC (not AUTOMOTIVE variant).

The minimum power requirements of the main input power supply you use are determined by the maximum load that may be connected. If the VIPER is the only board connected to the VIPER UPS, the maximum current drain is 280mA at +5V. The power supply connected to the VIPER UPS should be capable of at least 2W to allow for VIPER UPS losses and derating.

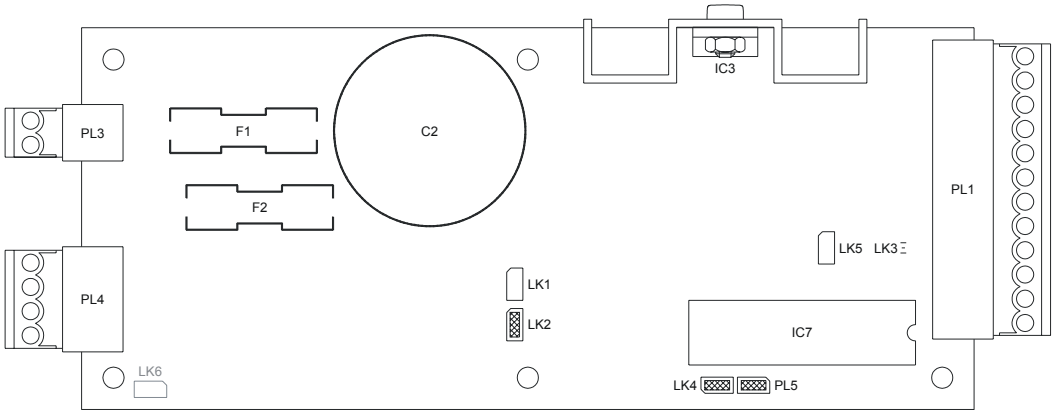
[1] Applicable to the v1i4 Mod A board only: If the main input voltage is not at least 1.6V above the battery voltage, then the system runs from the battery. This discharges the battery even if the main power supply is present (between 10V and 12V).

Jumper settings

The default jumper positions for VIPER UPS standard variant are as follows:



The default jumper positions for VIPER UPS external battery variant are as follows:



LK1, LK2 and LK4

The positions of jumpers LK1, LK2 and LK4 specify the type of battery you are using. If you are using a VIPER UPS standard variant or a VIPER UPS external battery variant with a NiMH battery, the jumpers should be connected as in the top diagram above. If you are using a VIPER UPS external battery with a lead acid battery, the jumpers should be connected as in the bottom diagram.

The differences in the jumper settings for the different battery options are summarized in the following table:

Variant/battery	LK1	LK2	LK4
VIPER UPS standard			
VIPER UPS external battery with NiMH battery			
VIPER UPS external battery with lead acid battery			

LK3 - Factory jumper (V1I1 and V1I2 boards only)

For factory use only. This jumper should always be fitted.

LK5 - Recharging temperature profile select

Applicable only if you are using a NiMH battery (i.e. you have the VIPER UPS standard variant or you are using the VIPER UPS external battery variant with a NiMH battery).

You can choose a different recharging temperature profile to allow the VIPER UPS to operate and keep the battery fully charged when used in environments outside a 10°C (50°F) to 45°C (113°F) range. See Recharging temperature profiles (NiMH battery only), page 21, for further details.

LK5	Description
	Standard temperature profile.
	Extended temperature profile.

Default setting: 

This jumper should not be fitted if using a lead acid battery.

LK6 - Battery connect jumper (not present on V1I1, V1I2 and V1I4 Mod A boards)

Applicable only if you are using the VIPER UPS standard variant. Used to isolate the on-board NiMH battery from the VIPER UPS circuits, allowing the battery to remain charged for longer periods.

LK6	Description
	Battery isolated.
	Battery connected.

Default setting: 

The NiMH battery discharges if the VIPER UPS is stored (un-powered) for long periods, due to self-discharge. It typically loses up to 20% in the first month and 40% if stored for 6 months (figures calculated for storage at 20°C (68°F)). Higher storage temperatures can dramatically accelerate self-discharge.

PL5 - Factory jumper (operating mode select)

For factory use only. This jumper should always be fitted.

Replaceable fuses

The VIPER UPS standard variant has one fuse that can be replaced by users; F1.This should be a 5A, 20mm, High Rupture Capacity (HRC) fuse. A suitable fuse is the Bussmann S505 series 5A fuse.

The VIPER UPS external battery variant has an additional fuse, F2. This protects the external battery against short circuit faults caused by the VIPER UPS. This should be a 3A, 20mm, HRC fuse. A suitable fuse is the Bussmann S505 series 3A fuse.

External battery variant

The external battery variant of the VIPER UPS is designed to use an external (user supplied) battery, which can be either a NiMH or a lead acid ($PbSO_4$) battery. The external battery board is rated to operate between -40°C (-40°F) and 85°C (185°F); the standard board is rated to operate within the range 0°C (32°F) to 65°C (149°F).

External battery selection

The external battery should be either:

- A NiMH battery, nominally 8.4V (7 cells at a nominal 1.2V each).

-or-

- A 12V lead acid battery.

The lead acid battery should have a rating of at least 800mAh. A lower mAh rated battery could be overcharged when the battery recharges.

It is only the VIPER UPS external battery board that is rated to operate between -40°C (-40°F) and 85°C (185°F), and not the external battery. The external battery selected should be rated for use in the environment in which it is to be fitted.

Thermistor selection

Regardless of which type of battery is used, the battery should be fitted with a thermistor to provide temperature feedback to the VIPER UPS external battery variant. This is essential for safe operation of the VIPER UPS. The VIPER UPS monitors the temperature and shuts down recharging circuits if the battery temperature is too high. The thermistor should have the following specification:

- Resistance at 25°C (77°F): 10 kΩ.
- Thermistor constant ‘B’: 3435.

A suitable thermistor is an ATC Semitec part 103AT-2.

If using a lead acid battery, if you do not wish to use a thermistor you can simply connect a 10 kΩ resistor instead. The default temperature of 25°C (77°F) is then reported.

External battery connection

The external battery and its thermistor are connected to the VIPER UPS external battery via the 4-way 2-part screw terminal connector, PL4. See Appendix B – Connector details, page 25, for pinout details.

The external battery connector, PL4, is fitted to all variants of the board. This is to provide compatibility between all the VIPER UPS variants and the design of the VIPER ICE (see VIPER ICE, page 23, for more details). However only on the external battery variant are the components fitted to interface an external battery with the VIPER UPS power supply circuitry.

High temperature recharging profile

If the external battery variant is to be used with a high temperature lead acid battery, a custom temperature profile may be needed to allow the VIPER UPS to charge the lead acid battery at temperatures higher than the standard programmed value (50°C/122°F). The required temperature profile must be added by Arcom into a custom software program and programmed into the microcontroller memory.

If the external battery variant is to be used with a NiMH battery, the jumper LK5 must not be fitted unless the NiMH battery is rated for charging at temperatures up to 65°C.

UPS operation

The VIPER UPS provides a regulated +5V to a load whenever there is a power supply or a charged battery backup source.

Whenever there is a main power input voltage of 10V (12V for V1I4 Mod A boards) or greater, the VIPER UPS always uses the main input power source, and not the battery, regardless of the absolute battery or main input voltage. It is not possible to shutdown the VIPER UPS when there is a valid input power source without first disconnecting the main power input.

Digital outputs

The VIPER UPS generates two active high TTL-level signals:

Signal	Explanation
POWER_FAIL	High signal if the input voltage falls below the acceptable minimum of 10V.
BATTERY_LOW	High signal if the battery is below the level required to power the VIPER UPS and external loads. The VIPER UPS shuts down 10 seconds after this output becomes active, unless main input power is restored before the 10 seconds elapses.

The table below summarizes the output signal state with the UPS mode of operation:

UPS state	POWER_FAIL	BATTERY_LOW
Normal (main power on)	Low signal	Low signal
Battery on / battery good	High signal	Low signal
Battery on / battery failing	High signal	High signal
Main power on / battery in 'highly discharged state'	Low signal	High signal
UPS Error [1]	Low signal	High signal

Fault conditions that could lead to an error state are:

- No battery connected.
- The battery failing to recharge.
- No thermistor connected.

[1] If the POWER_FAIL output is low and the BATTERY_LOW output is high for more than two minutes, the VIPER UPS indicates that it has detected an error state. Completely powering down the VIPER UPS (removing main input power and then pulling '/POWER_DOWN' low) clears the fault. However, the fault condition will be re-established if the same fault condition exists.

Digital input

There is one TTL-level active low input to the VIPER UPS:

Input	Explanation
/POWER_DOWN	This input, normally from a VIPER single board computer, instructs the VIPER UPS to shutdown when running from a battery source. The input has no effect when there is a valid main input supply.

Example of an interrupted power scenario

A typical VIPER/VIPER UPS scenario may be:

1. Main power to VIPER UPS fails. VIPER UPS switches to battery source and sets POWER_FAIL high.
2. VIPER waits two minutes to ensure the power disruption is ‘permanent’.
3. VIPER powers down external interfaces to reduce power and then enters power down mode.
4. 18 hours later, still with no main input source, the VIPER UPS BATTERY_LOW signal goes high.
5. VIPER UPS shuts down after 10 seconds. The VIPER, in this instance, saves any necessary data to non-volatile memory and then instructs VIPER UPS to power down by driving /POWER_DOWN low before 10 seconds elapse.
6. VIPER UPS shuts down completely.
7. Main power source returns. VIPER UPS and VIPER come back up. The battery immediately begins to be recharged.
8. One minute later, BATTERY_LOW is set low. While still mainly discharged, the battery voltage is high enough to switch off the BATTERY_LOW indication, and to briefly power the VIPER UPS and VIPER in the event of another main power failure.

Battery recharging

The VIPER UPS constantly monitors the state of the battery. While there is a valid main input power source, the VIPER UPS ensures that the battery (NiMH or lead acid) is maintained with 100% charge.

Trickle charging

When the battery is fully charged, the VIPER UPS keeps it at full charge by trickle charging. NiMH batteries are charged with a constant trickle charge current, lead acid batteries with a constant voltage of 13.65V at 25°C (77°F). The trickle charge compensates for internal battery discharge losses, which would discharge the battery over time.

The trickle charge voltage for lead acid batteries is temperature-compensated by the VIPER UPS. The greater the battery temperature, the lower the trickle charge voltage that is generated. This ensures that the lead acid battery lifetime is kept to a maximum.

If the battery (NiMH or lead acid) temperature exceeds the temperature limits (see Appendix C – Specification, page 27), trickle charging is switched off and the VIPER UPS enters a ‘cool down’ mode.

Trickle charging is also used whenever the NiMH battery is below 7.0V (1.0V per cell) until this voltage level is achieved, whereupon the VIPER UPS enters fast charge mode.

Fast charging

If the battery has been used to power the VIPER UPS (and external loads) for a period of time, it is likely to need a significant recharge. In its fast recharge mode, the VIPER UPS NiMH battery can be recharged in 2 hours. If the battery has been fully discharged (requiring an initial trickle charge stage) the battery may take 4 hours to charge fully.

The length of time taken to recharge an external lead acid battery depends upon the capacity of the battery.

Fast charge mode is terminated when one of the following occur:

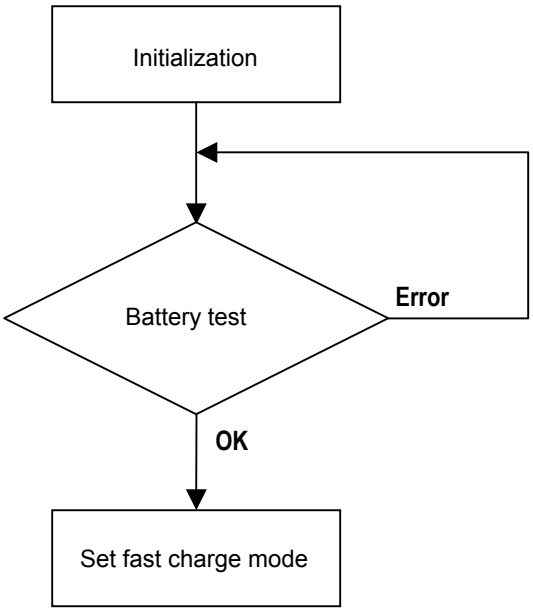
- The battery is considered fully charged.
- The battery temperature goes outside of the allowable range.
- The fast charge time period exceeds safe limits.
- Main power input is removed.

If an external battery is used and no thermistor is connected, the VIPER UPS will not recharge the battery. In such a case, the VIPER UPS sets its digital outputs to indicate a ‘UPS error’ state (see Digital outputs, page 14).

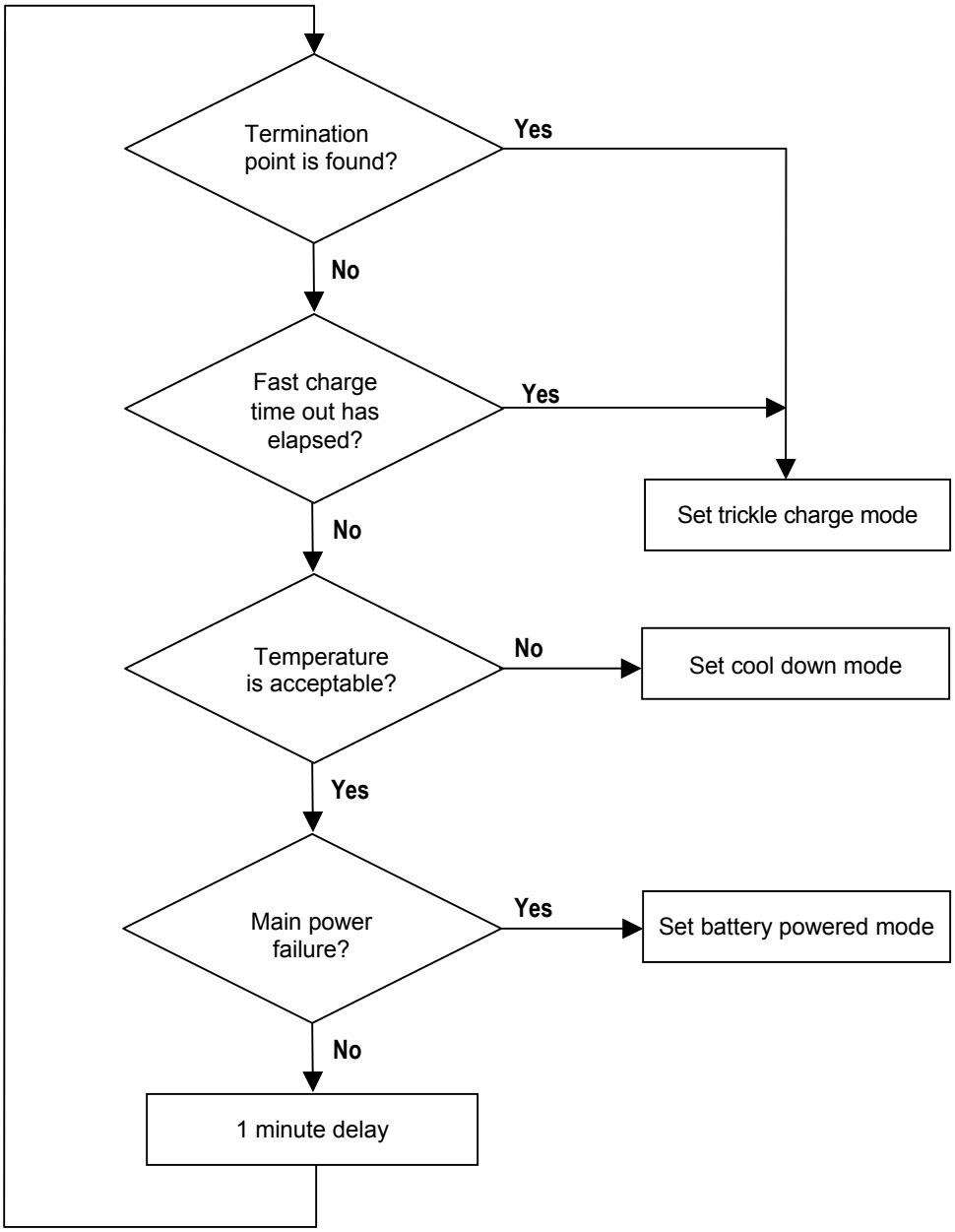
UPS operation flowcharts

The following flowcharts show the sequence of operations carried out by the VIPER UPS microcontroller program.

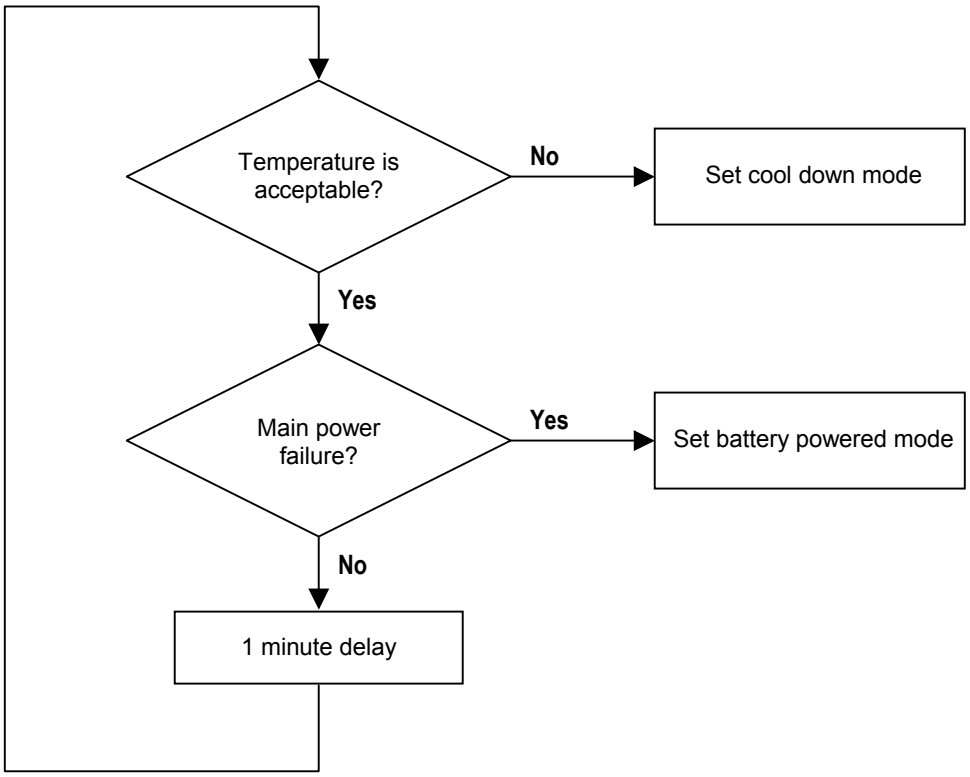
Main program entry



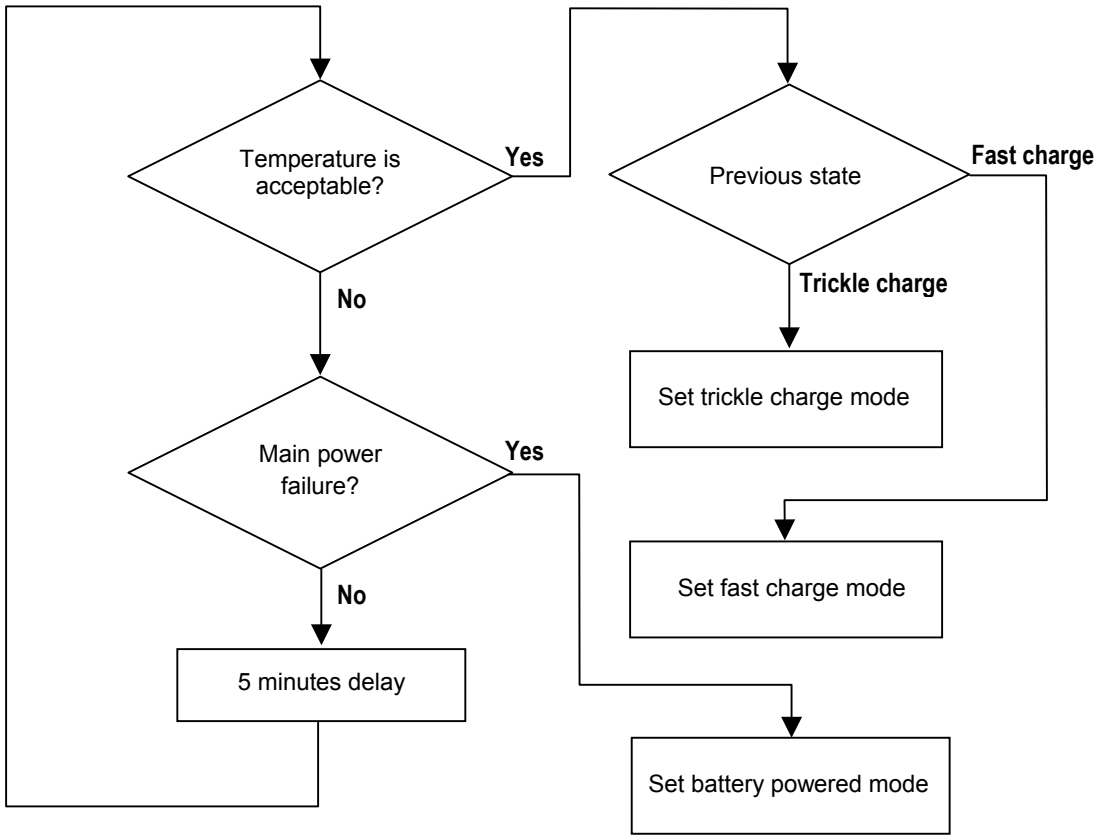
Fast charge mode



Trickle charge mode



Cool down mode



Operation at temperature extremes

The VIPER UPS is designed to operate between 0°C (32°F) and 65°C (149°F). Exposure to temperatures above 65°C (149°F) is dangerous and could cause the NiMH cells to vent, releasing hydrogen gas. For this reason, the VIPER UPS must not be fitted into airtight environments.

Do not dispose of the VIPER UPS or its NiMH battery in a fire or in an incinerator since this may rupture or dissemble the battery. The cells contain potassium hydroxide electrolyte, which can cause injury. In the event that electrolyte gets on skin or in eyes, flush immediately with water and seek medical advice.

The VIPER UPS may be stored in temperatures between -40°C (-40°F) and 65°C (149°F), although it is recommended that the board be kept below 45°C (113°F) during storage. Extended operation above 45°C (113°F) reduces the performance of the battery. Repeated discharging of the battery at the upper temperature extremes also reduces the life of the battery.

High temperature shutdown

The VIPER UPS automatically shuts down when running from a NiMH battery source if the battery temperature exceeds 65°C (149°F). The VIPER UPS first sets the BATTERY_LOW signal high for 10 seconds before shutting down to give the VIPER opportunity to safely shutdown.

When running from an external lead acid battery, the VIPER UPS external battery variant does not shut down, regardless of the temperature of the lead acid battery. Discharging the lead acid battery does not significantly increase the temperature of the battery and so shutting down does not directly prevent overheating. The VIPER UPS external battery variant only continues charging a lead acid battery if its temperature is between 10°C (50°F) and 50°C (122°F).

Recharging temperature profiles (NiMH battery only)

The NiMH battery used on the VIPER UPS can be recharged and discharged at temperatures up to 65°C (149°F). However, the manufacturer recommends that maximum battery life can only be achieved if the battery is charged and discharged at temperatures between 10°C (50°F) and 45°C (113°F).

In order to maximize the life of the NiMH battery, the VIPER UPS has two recharging temperature profiles. These are set using jumper LK5 (see page 10). They are:

- **Standard recharging temperature profile** (jumper LK5 not fitted). The battery is only charged if its temperature is between 10°C (50°F) and 45°C (113°F). The VIPER UPS continues to operate at temperatures outside this range, but it does not attempt to recharge the battery until its temperature returns to a level within this range. This profile is recommended if the VIPER UPS is used in environments

where it is known that temperatures above 45°C (113°F) or below 10°C (50°F) are rare or only temporary.

- **Extended recharging temperature profile**. Use this to allow the VIPER UPS to operate and keep the battery fully charged when used in environments normally outside of a 10°C (50°F) to 45°C (113°F) range. To select this profile, fit jumper LK5. The battery is recharged if its temperature is within the range 0°C (32°F) to 65°C (149°F).

The VIPER UPS only reads jumper LK5 upon power-up or reset. Ensure that the board is fully powered down and not running from battery power. Insert a wire link between PL1 pins 9 and 12, or remove jumper LK1 (NiMH) / LK2 (lead acid) for 10 seconds, or remove jumper LK6 (if applicable) before changing the position of LK5.

VIPER ICE

The VIPER Industrial Compact Enclosure (ICE) is designed specifically to house the VIPER single board computer and the VIPER UPS. It provides easy connection to all the on-board VIPER devices. The enclosure can be optionally fitted with a 5.5" flat panel display and a touchscreen. The VIPER ICE has been designed to accommodate the Arcom touchscreen interface board (TSC1), an OEM V.34 modem, V.90 modem or wireless GPRS/GSM modem, and has space for up to two additional PC/104 expansion modules (only one PC/104 expansion module can be added if the flat panel display is fitted).

When the VIPER UPS is purchased as an individual item, the 5V regulator fitted to the board (IC3) is fitted with a suitable heatsink to enable the regulator to operate at up to 85°C (185°F). When the VIPER UPS is fitted into the VIPER ICE, the heatsink is removed and IC3 is mounted directly to the VIPER ICE metal enclosure, which acts as the heatsink.

The VIPER UPS has been designed to supply enough power for all the boards and devices that may be fitted inside a VIPER ICE, including the 5.5" flat panel display, touchscreen and modem (including GPRS modem option).

For further information, see the VIPER ICE Technical Manual.

Appendix A – Contacting Arcom

Arcom sales

Arcom's sales team is always available to assist you in choosing the board that best meets your requirements. Contact your local sales office or hotline.

Sales office US

Arcom
7500W 161st Street
Overland Park
Kansas
66085
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Tel: 913 549 1000
Fax: 913 549 1002
E-mail: us-sales@arcom.com

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E-mail: euro-sales@arcom.com

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Technical support

Arcom has a team of technical support engineers who can provide assistance if you have any problems with your VIPER UPS.

Technical support US

Tel: 913 549 1010
Fax: 913 549 1001
E-mail: us-support@arcom.com

Technical support Europe

Tel: +44 (0)1223 412 428
Fax: +44 (0)1223 403 409
E-mail: euro-support@arcom.com

Appendix B – Connector details

PL1 - Power output and digital I/O

12-way 0.2" MSTB 2-part screw terminal connector.

Pin	Signal
1	+5.0V
2	+5.0V
3	+5.0V
4	+5.0V
5	GND (0V)
6	GND (0V)
7	GND (0V)
8	GND (0V)
9	/POWER_DOWN (TTL Input)
10	POWER_FAIL (TTL Output)
11	BATTERY_LOW (TTL Output)
12	GND (0V)

PL2 - Debug header

5-way 0.1" header, not fitted. Factory use only.

PL3 - Power input

2-way 0.2" MSTB 2-part screw terminal connector.

Pin	Input (DC)	Input (AC)
1	10-36V DC[1]	10-25V AC (fused input)
2	GND (input 0V)	10-25V AC

[1] The V1I4 Mod A board requires a minimum input voltage of 12V to avoid draining the battery and to ensure that the VIPER-UPS fully runs from the main power input source.

PL4 - External battery and thermistor input (external battery variant only)

4-way 0.2" MSTB 2-part screw terminal connector.

Pin	Signal
1	Battery positive terminal
2	Battery negative terminal (GND)
3	Thermistor A
4	Thermistor B (GND)

Connect an external thermistor across thermistor inputs A and B, or a 10 kΩ resistor if you are using an external lead acid battery without thermistor.

PL5 - Diagnostic output (factory use only)

2-way 0.1" header.

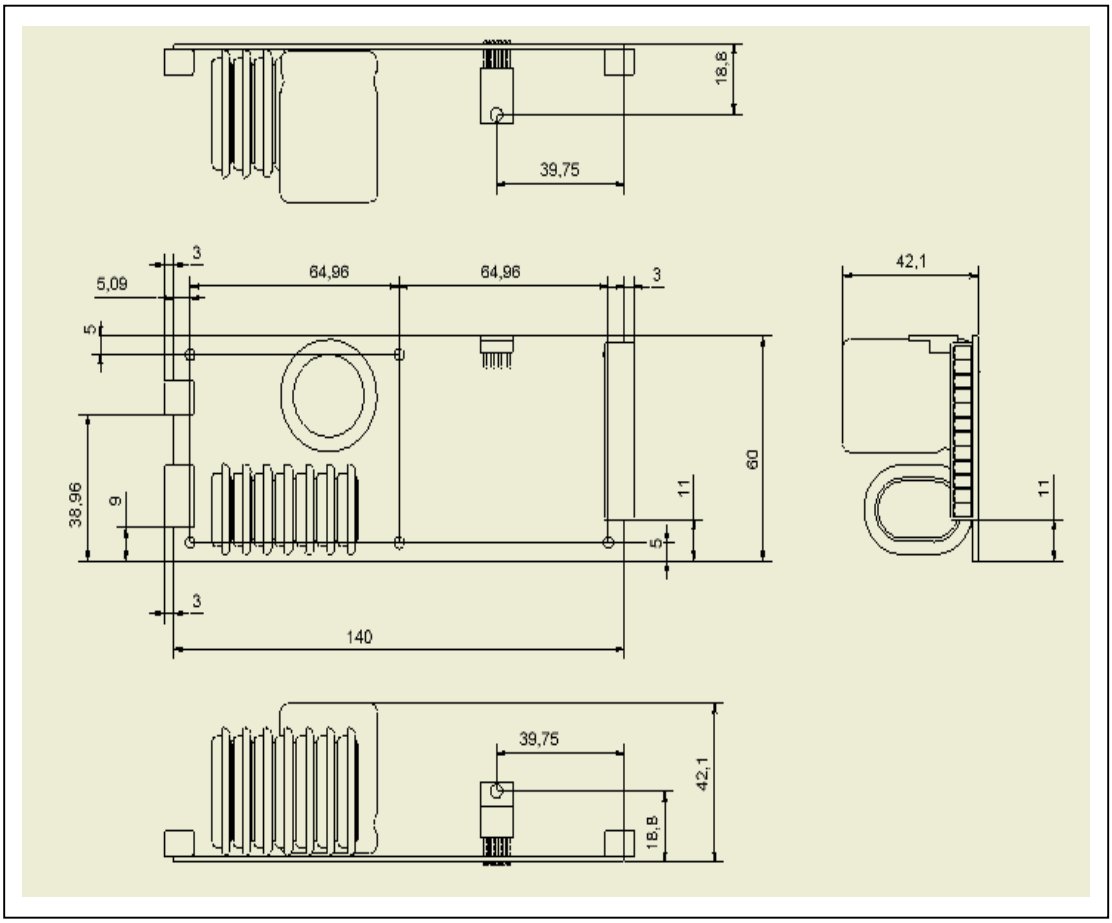
Pin	Signal
1	RX data (to VIPER UPS)
2	TX data (from VIPER UPS)

Appendix C – Specification

Power output	5.05V regulated DC. +/- 0.10V over full line and load conditions at 25°C (77°F). +/- 0.15V over full line and load conditions at temperature range -40°C (-40°F) to 85°C (185°F). 3.5A maximum output.
Power input requirements	10-36V DC (12-36V DC for V1I4 Mod A boards) or 10-25Vrms AC.
Operating temperature range	Standard variant: 0°C (32°F) to 65°C (149°F). External battery variant: -40°C (-40°F) to 85°C (185°F).
Storage temperature range	Standard variant: -40°C (-40°F) to 65°C (149°F). External battery variant: -40°C (-40°F) to 85°C (185°F).
Battery (standard variant)	500mAh, 8.4V (nominal) NiMH battery with thermistor. Uses 7 x Varta V500 HRT cells.
Battery requirements (external battery variant)	• 8.4V nominal (7 cell) NiMH battery, 500mAh or greater and thermistor. • 12V nominal lead acid ($PbSO_4$), 800mAh or greater and thermistor.
Charging battery temperature range	NiMH battery connected (jumper LK5 not fitted): • 10°C (50°F) to 45°C (113°F) NiMH battery connected (jumper LK5 fitted): • 0°C (32°F) to 65°C (176°F) Lead acid battery connected: • 10°C (50°F) to 50°C (113°F)
Backup capability	When on-board NiMH fully charged and at 25°C (77°F): • +5V at +3.5A for 12 minutes. • VIPER (board only) in full power mode for 2 hours. • VIPER (board only) in standby mode for 18 hours.
Intelligent battery charger	On-board Microcontroller carries out the following: • Monitors main input voltage. • Monitors battery voltage. • Monitors battery temperature. • Controls the efficient recharging of either NiMH or lead acid battery. • Switches between main input and battery as necessary. • Outputs status to VIPER.

Efficiency	75 - 80% (depending on power input voltage).
Digital I/O (TTL-level signals)	Main power failure indication output. Battery low warning output. Shutdown command input.
Serial communications port (TTL-level signals, not RS232)	Diagnostic information can be output via serial link.

Appendix D – Mechanical drawing



Appendix E – Reference information

Product information

Product notices, updated drivers, support material, 24hour-online ordering:

www.arcom.com

Varta Rechargeable Button Cell Information

V500 HRT button cell datasheet.

www.varta-microbattery.com

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