



VPM-402

User Guide

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PROTONEX TECHNOLOGY CORPORATION
A wholly- Owned Subsidiary of BALLARD POWER SYSTEMS
153 NORTHBORO ROAD
SOUTHBOROUGH, MA 01772-1034
T 508.490.9960 | F 508.490.8575
WWW.ptxnomad.com
PTX IS A TRADEMARK OF PROTONEX TECHNOLOGY CORPORATION

1 Introduction

The Protonex VPM-402 Vest Power Manager is a universal power converter and charger: The four-port device can charge virtually any rechargeable battery from any energy source, and can also power any man-portable suite of equipment from any battery.

The VPM-402 automatically recognizes what device is plugged into each of its ports, and configures itself to “do the right thing” with no help from the user. For example, if a solar panel and two batteries are plugged in, clearly the intent of the user is to charge the batteries from solar power, and so that is what the VPM-402 will do. Similarly, if two batteries and two radios are connected, then clearly the user wants to power the radios from the two batteries. Again, the VPM-402 recognizes this, and performs the conversions automatically.

2 User Guide Overview

This guide will introduce you to the VPM-402, and will show you all of the basic features and functions of the power manager.

Sections a to b show the locations and functions of all the connectors, buttons, and the display. Section c introduces you to basic operations: charging a military battery. Section d adds to this powering equipment from your battery.

Section e details the display and keypad, and what you can do with them to enhance your mission SA and also how to react when something goes wrong.

Sections f to g outline combination cases where you are charging batteries and powering equipment at the same time. In addition, using vehicles as energy sources, and also charging dead vehicle batteries with the VPM-402 are covered here.

3 General Description

The VPM-402 power manager intelligently prioritizes and powers all soldier-worn or carried equipment from one or more military batteries, providing voltage conversion where necessary. In addition, the power manager provides a prioritized recharge to those batteries should an energy source be available – while continuing to power the attached load devices.

3.1 Soldier/Marine Benefit

The VPM-402 permits the soldier to share any standard military battery among his entire suite of equipment – a potentially significant reduction in battery weight. In addition, the weight of a large bulk charger is eliminated completely, since the power manager can be used in both discharge and charge operations.

Because the VPM-402 prioritizes discharge of multiple attached batteries, using one battery to completion before cycling to the other (with no interruption in power to the load suite), the soldier or Marine gains a significant amount of energy: The energy typically left in a battery that is discarded before it is completely drained. This ability to discharge all batteries completely has the same effect as increasing the battery energy density by 30-50% - the number of batteries carried and used is dramatically reduced.

3.2 The VPM-402 Kit

The VPM-402 comes with a soft case which holds cables enabling it to be used in virtually any situation. Each case typically contains cables which can be attached to a BB-2590 battery, a cigarette lighter plug, and alligator scavenger clips. Each kit should also contain a map of where each cable goes, allowing for easy inventory after use.

4 Getting Started

This section will get you up and running with your VPM-402 and associated cables.

4.1 The VPM-402 Ports

The VPM-402 has four ports, which all use identical connectors. Any cable can be connected to any port, although some will behave differently depending upon which port to which they are connected.

The L1 and L2 ports are designed primarily for Load devices, or equipment which receives power. Examples of Loads include radios, laptop computers, and the cigarette receptacle. These ports can also be used for rechargeable batteries, which will be charged if an energy source is available.

The B port is for a rechargeable Battery. The VPM requires that at least one battery be connected, and in most cases it will be connected to this port.

The S port is the energy scavenger. Energy sources such as solar panels, AC power adapters, and vehicle adapters should normally be connected to this port.

Keep in mind that the port assignments are only suggestions, and in many cases the VPM can use the ports for other functions if needed. For example, if you need to power three radios from a battery, the radios can be connected to ports L1, L2, and S (with the battery connected to B). The VPM will detect that a radio is attached to S, rather than an energy source, and it will power the radio from the battery. Similarly radios could be attached to ports L1, L2, and B, and battery connected to S, and the VPM will power the radios from the battery.

Some devices are port-specific, however. If you connect a solar panel (which requires a Peak Power Point Tracking algorithm which is only available at port S) to any port other than

S, the VPM display will indicate that this cable must be used in the S port – remove the cable and plug it into the indicated port.

4.2 Attaching a Battery

For most applications, the VPM-402 must be used with a rechargeable battery. This is most often a conformal battery such as those provided by Palladium or Ultralife, or a common radio battery like the BB-2590. Typically the battery will be the first device you plug into the VPM, and assuming the battery is not completely discharged, the VPM will power up as soon as it is connected.

In most cases the battery will be connected to the B port on the VPM.

Once the power manager has booted up, it will display the number of hours of life remaining on the battery – this time will change as additional devices are plugged into the VPM, and the VPM calculates how fast those devices are using power.

Some battery cables are multi-function: For example, a common conformal battery cable also has a USB power receptacle on it. Note that usually when there is more than one connector on a cable, the VPM terminates all the connectors. This means that in the example just given, if the cable is plugged into a battery but not into the VPM, the USB power port will not be live, since it is driven by the VPM, not by the battery.

If the battery attached is fully discharged, and energy source must also be connected before the VPM will power up – see the following section.

4.3 Connecting an Energy Source

In many cases you will want to recharge the battery attached to port B, and simultaneously power devices connected to the L1 and L2 ports. To do this, simply connect an AC power brick, a cigarette plug, a NATO Slave plug, a solar panel, a zinc-air battery, or another energy source to the S port.

When an energy source is connected to the S port, the VPM will look for power to be available on this port, and when it is available will start to draw power from the port, powering devices or recharging batteries (or both) as appropriate.

4.4 Connecting Load Devices

Finally, it want to connect one or more laptops, radios, etc to the VPM. Simply plug them into ports L1 or L2 – the VP will detect the devices connected, and will power them up.

5 The User Interface

The VPM-402 uses a graphical control screen and four arrow buttons to permit you to examine status of each port and the power manager, and configure some settings. IN most cases configuration will not be needed, but may be desirable to change operation to match your mission requirements.



5.1 Control Buttons

The VPM-402 uses a four button interface to interact with the LCD display. The use of the buttons is outlined below:

- **Escape (left)** – This button exits the present menu to a level higher, or cancels any parameter selection in process without having the selection take effect.
- **Up and Down** – These buttons select the previous and next menu items, or if a configuration item is selected the previous and next available parameters. The highlighted item does not take effect until the “Enter” button (below) is pressed.
- **Enter (right)** – This button selects the highlighted menu item, or the highlighted configuration value. If a configuration value is selected, it will take effect immediately upon depressing the “Enter” button.

5.2 Graphical Display

VPM-402 has a graphical user interface (GUI) display which, with the arrow controls permits you to see extended information about the configuration and operation of the power manager, to monitor the power being generated and used by various components of your system, and to modify configurations and behaviors of the power manager while in the field.

5.2.1 About Screen

When the VPM-402 powers up, it first displays an “About” screen, that shows the product model, and the firmware revision code. You will need this revision code if you call Protonex for support.

5.2.2 Main Status Screen

When operating, the main status screen displays which ports on the device are in use, the remaining percentage of battery charge, and the amount of time until the battery is dead.

5.2.3 Port Information Screens

The port information screens can be seen by scrolling right from the main status screen, and can be navigated to see the details of any attachment with the up and down buttons.

5.2.4 The Main Menu

The main menu is found by scrolling all the way to the right while operating the VPM-402. By navigating the main menu a user can find assign priority overrides, put the power manager into sleep mode, look at data collected by the VPM-402, configure the user interface, and look at system information.

5.3 Usage Instructions

5.3.1 Charging Batteries

The VPM-402 power manager can intelligently charge a battery using power from one source, while simultaneously powering other equipment. To charge batteries:

- Connect the first battery to the B port
- Connect an energy source (solar, AC, vehicle, primary battery) to port S
- Connect additional batteries to be charged to ports L1 and L2.

Note that full batteries cannot be charged further – if the VPM fails to charge a connected battery, verify that an energy source is connected and recognized, and that the battery or batteries to be charged are not already fully charged.

5.3.2 Powering Equipment

The VPM-402 will automatically power any piece of equipment that is plugged into it so long as a power source is attached. The kit included with the power manager typically includes an AC wall plug adapter, scavenger clips and a solar blanket, which can only be attached to port S. These accessories will power any equipment attached, as well as charge batteries. Should the power source plugged into one of the main discharge ports fail or become insufficient the system will automatically begin to draw power from any attached batteries as is necessary.

5.2 Vehicle Use

The standard kit that comes with the VPM-402 contains two cables made to interact with vehicles, the standard cigarette lighter plug and the NATO vehicle power adapter. It is important to note that unlike other power sources, a vehicle's battery can be charged as well as discharged when attached to the power manager. Users must utilize the display in order to ensure the proper charging and discharging of equipment when using a vehicle. In order to use equipment with the vehicle as a power source plug the cable connected to the power source into port S. To charge the battery of the vehicle connect alternate power sources to ports S and the vehicle to ports L1 or L2.

5.3 Possible Configurations

5.3.1 Two Batteries and a Radio

If you connect an LI-80 battery to port B, a PRC-119 radio to port L1, a BB-2590 battery to port S, the BB-2590 will charge the LI-80 and power the PRC-119 simultaneously, and once the BB-2590 is completely discharged the LI-80 will take over.

5.3.2 Battery, AC adapter, and Toughbook

Connecting a BB-2590 battery to port B, an AC wall plug to port S and a Toughbook computer to port L1 will cause the VPM-402 to charge the battery and power the computer simultaneously, with the battery as a backup should power from the AC wall plug lose power.

5.3.3 Possible Vehicle Configurations

Plugging a vehicle NATO attachment into port L2, a BB-2590 battery into port B and a PRC-119 radio into port L1 will cause the battery to charge both the vehicle and power the radio. However, by plugging the NATO power cable into port S and the BB-2590 into port B the vehicle will power the radio and charge the battery.

6 Safety

6.1 Hazardous Materials

6.1.1 Batteries

The VPM-402 units each contain a Panasonic BR1225-1HC button-size lithium battery for maintenance of the Real Time Clock (RTC). The cell has a 48 mAh capacity, and is not considered a hazardous material (no special handling or disposal requirements).

6.1.2 Fluids

None.

6.1.3 Lasers

Not applicable.

6.2 Safety and Human Factors Design Features

6.2.1 Battery Safety Feature Overview

One primary use of the Vest Power Manager is to recharge military lithium-ion batteries, such as the Li-80, Li-145, BB-2590, and BB-2557. Because of the potential for fire and injury from a damaged or overcharged Lithium-Ion battery, the VPM-402 units have several redundant safety features designed in.

The design philosophy used when creating the VPM-402 can be summarized:

At no time should the internal protections of any attached battery be triggered: The VPM-402 should provide protection superior to and slightly more conservative than that provided by the battery itself.

The VPM-402 protections must be only slightly more conservative, so that the user will see no discernible decreased performance from the batteries when using them in extreme conditions.

For example, the BB-2590 battery has a thermal cutout that occurs at 70°C. The VPM-402 constantly monitors the battery temperature of an attached BB-2590, and will disconnect the battery at a temperature of 65°C. As such, when using the VPM-402, the user's safety is slightly improved from using the BB-2590 alone.

6.2.2 Battery Over and Under Temperature

The VPM-402 monitors the internally reported temperature of each attached battery using the SMBus protocol. In addition, the Smart Cable which attaches each battery to the VPM-402 includes information on the highest rated charge and discharge temperatures permitted by the battery manufacturer. The VPM-402 then enforces these temperatures: It will not charge or discharge the battery when the battery's internal temperature (not the VPM-402's temperature, which is also monitored) falls outside the safe range.

When the VPM-402 disconnects a battery due to over temperature, or disables charge because of under-temperature, it reports this to the user on the graphic user interface.

6.2.3 Smart Battery Health

On a per-battery-type basis, the VPM-402 can be set to require a functional SMBus interface in order to use a battery. As such, a Smart Battery with a non-functional SMBus interface can be rejected so as to not provide a potentially unsafe use condition.

By default, most battery types are flagged “SMBus Optional”, and the VPM-402 will apply more conservative safety limits if the SMBus interface is non-functional: When the VPM-402 successfully polls the battery using SMBus, it widens the limits to those supported by the battery.

6.2.4 Battery Overcharge

A supervisor algorithm within the VPM-402 constantly monitors all attached batteries for an overcharge condition – even if the batteries are being charged by a device external to the VPM-402, such as a fuel cell. If an overcharge situation is detected, the VPM-402 disconnects the battery to eliminate the hazard, and reports the condition to the user on the graphic user interface.

6.2.5 Power Manager Surface Temperature

The VPM-402 monitors its own internal and case temperatures, and reduces activity when the case temperature reaches the limits specified by MIL-STD-1472F. If the VPM-402 is charging batteries when the surface temperature limit is reached, the rate of charge is decreased until the temperature stays within limit. If the VPM-402 is using internal converters to power equipment when the temperature limit is reached, the equipment is powered down.

If power is removed or adjusted due to case temperature, the user is notified on the graphic user interface.

6.2.6 Water Resistance

The VPM-402 is submersible while in operation to 3 foot depth for 30 minutes, without a functional or safety impact.

7 References

MSDS, Panasonic BR Type Button Lithium Battery
Safety Assessment Report – VPM-402 Revision 1-0