3.0 Power Supply

3.1 Power Supply Specifications

An internal DC power supply provides power to the main system board and LCD. All power levels are regulated for over-voltage and over-current protection. The following are minimal power supply specifications:

VCC:

Input 8 to 20V
Output 5V +/-1%, 1A maximum steady-state; peaks to 3A

MTR:

Input 8 to 20V
Output 5V +/-1%, 1A maximum steady-state; peaks to 3A

LCD BIAS:

Input 8 to 20V
Output -12 to -17V (User adjustable), 50MA.

3.2 STBook Power Controls

The STBook incorporates a number of new sub-systems to allow tight control of the power usage of the machine. The operating system uses all of these to extend battery life of the machine; these functions will also be directly available to developers, so that they may customize the functions for any particular application. The various functions/topics are grouped as follows:

- Multiple Main Power Sources
- Multiple Regulated Power Outputs
- Software Control of the various Power Outputs
- Hardware Source Level Detectors/Interrupts
- User Input and Control Signals
- Power Source Level Direct Read
- Referenced Registers

3.2.1 Multiple Main Power Sources

The STBook can get its main power from various internal/external sources. These sources include:

- Replaceable battery pack (either NiCad or Alkaline)
- External AC adapter/charger, and internal rechargeable Lithium cells.

The first two are designed to run the machine in normal operation, and when "off" (i.e. only retaining the RAM contents and the Real-Time Clock, referred to herein as "back-up"); the last is only for back-up. The Battery Pack and AC Adapter supply power to a common

point to feed to the various regulators; this point is henceforth referred to as the "Common Power Source."

3.2.1.1 Battery Pack

The battery packs available are an eight-cell Nicad pack, or a7-cell Alkaline pack. The Nicad pack can be charged from the AC adapter/charger while in the unit, and while the machine is in operation. A full charge should operate the machine for 5 to 10 hours, and should retain the RAM and Real-Time Clock for approximately 100 days; a new Alkaline pack, somewhat less.

3.2.1.2 AC Adapter/Charger

The supplied AC Adapter charger has input circuitry that automatically adjusts for 120/220V, 50/60Hz AC inputs, and both a Power and Recharge output. It is capable of fully recharging the NiCad cells in under two hours,while the machine is in use. It uses a "Delta-V Peak Detect" control circuit on the recharging output, to allow for the quick charge of the cells without overcharging them.

3.2.1.3 Lithium Cells

Under normal conditions, the small amount of power needed to retain the data in the RAM and to run the Real-Time Clock is derived from Common Power Source. If, for some reason, there is no power available from this source, power for the Back-up system is derived from the internal Lithium cells, which can maintain the RAM and RTC integrity for approximately 40 hours. The Back-up system also takes power from the Lithium cells when the Battery pack is being changed. When the Common Power Source is available, it recharges the Lithium cells.

3.2.2 Multiple Regulated Power Outputs

The STBook has various regulated power sources built in, all of which derive their power from the Common Power Source. These are:

VCC (main 5V logic supply)
MTR (5V supply for Hard Disk Motor)
LCD BIAS (-15V generator for LCD contrast/bias)
VBAK (3V backup for RAM and Real-Time Clock)
Lithium Recharge

3.2.2.1 VCC

The main 5V logic supply comes from a switching regulator built-in to the STBook. It converts from the voltage level at the Common Power Source (AC adaptor, NiCad, or Alkaline) to the +5V needed for the logic. It is capable of supplying up to 1A @ 5V out with an input voltage as low as 8V. In includes current limiting on the input such that no more than 1.5A @ 5V is

available at any input voltage, and short-circuit current is limited to 3A. The VCC regulator can be started by either the momentary-ON switch, or by the Real-Time Clock Alarm output. To stay on, the POWERGOOD level-detect circuit must be active before the turn-on signal is released. If at anytime the POWERGOOD signal fails, the VCC supply turns itself off.

3.2.2.2 MTR

The Hard Disk motor has a separate +5V supply, which also derives power from the Common Power Source. It is capable of supplying 1A @ 5V steady-state, and short peaks up to 3A. It does not have the level-detect circuitry that the VCC supply does; it is turned on/off by a software-controlled signal MTR_PWR_ON.

3.2.2.3 LCD BIAS

The LCD requires a bias voltage at a level between -12 and -16V. A third switching regulator creates this voltage, also from the Common Power Source. It has a user control (CONTRAST) that sets the actual voltage level. It can supply up to 50mA @ -16V. It does not have the level-detect circuitry of the VCC supply, and is turned on/off by a software-controlled switch, /22ON.

3.2.2.4 VBAK

When the main VCC supply is off, the RAM and Real-Time Clock can be supplied a 3V data-retaining voltage from the VBAK regulator. It is a Linear (not switching) regulator, and derives power from either the Common Power Source, or from internal Lithium cells. If the voltage level of the Common Power Source is insufficient (for example, when the Battery pack is removed for replacement), then it derives power from the built-in rechargeable Lithium cells. It is the only load on these cells.

3.2.2.5 Lithium Charge

The lithium cells are constantly trickle-charged (when necessary) from the Common Power Source. The circuit is a Voltage-level Trickle charge circuit.

3.2.3 Hardware Level Detectors/Interrupts

To make battery level detection and warnings as automatic as possible, various fixed-voltage-level detectors are included. These are, specifically:

SOURCE LOW (/SRCLOW)
SOURCE DEAD (/SRCDEAD)
POWERGOOD

There is also a two-color LED which is driven off these signals, to allow a visual indication of the power levels/warnings.

3.2.3.1 SOURCE LOW

SOURCE LOW is set to signal when the "common source" voltage level drops below 8.8V. It is wire-ORed with the real-time clock alarm and the "Power On" switch into the MFP Input 7, which is normally configured to generate an interrupt when the signal goes low. /SRCLOW, /RTC_ALARM, and /POWERON can all be read separately via the Configuration/Signal register; it is the only mechanism provided to distinguish the source of the interrupt.

3.2.3.2 SOURCE DEAD

SOURCE DEAD is set to signal when the "common source" voltage level drops below 7.2V. It generates a Level 7 (NMI) Interrupt when the signal transitions from high-to-low; the interrupt request is cleared and re-enabled upon vector fetch. This signal can also be read directly through the Configuration/Signal register.

3.2.3.3 POWERGOOD

POWERGOOD is purely a hardware-level "safety-valve", and cannot be read or controlled by software. It is set to trigger when the regulated VCC (+5V) signal drops to below 4.55V. If this occurs, /RESET is asserted and the hardware is signalled to turn the system off. If this occurs, the VCC, MOTOR, and LCD power convertors are all disabled, and the system automatically switches to low-voltage backup for the RAM and Real-Time Clock. The logic behind this "brute-force" approach is that system integrity cannot be guaranteed at VCC's below 4.55V, and protection of the RAMDISK (if present) is considered to be of highest priority.

3.2.3.4 Power LED

Power LED The Power LED is a two-color LED (Green and Red) which visually indicates the source level state of the machine. The Green segment is lit when POWERGOOD is active and /SRCDEAD is not; the Red segment is lit when /SRCLOW is active. Thus, the LED has four states:

OFF When the STBook is turned off

GREEN When the STBook is on and the Common Power Source is above 8.8V (i.e. power level is good)

YELLOW When the STBook is on and the Common Power Source is between 8.8V and 7.2V (i.e. power level is low)

RED When the STBook is on and the Common Power Source is below 7.2V (i.e. power is about to expire).

This last will rarely be actually seen, as it signals the operating system to do an emergency shutdown, which should take only a few milliseconds.

3.2.4 Software Control of Power Sources

Most of the power systems are under software control so that the operating system can keep power use as efficient as possible. These controls can also be used by applications to customize power usage for particular situations. While the exact registers and bits involved will be described later in this document, the system includes the ability to:

Turn off the main VCC supply
Turn on/off the Hard Disk motor supply
Turn on/off the LCD Bias supply
Turn on/off the RS-232 +/-9V generator
Program the Real-Time Clock to turn on the main VCC supply.

3.2.4.1 Main VCC

The main VCC supply is controlled, in part, by a signal that, on a low-to-high transition of POWEROFF, turns it off. Since VCC drives all of the logic in the system, this also results in the Hard Disk and LCD Bias supplies being turned off, as well. It is recommended, however, that at least the LCD Bias be turned off before the main VCC is.

3.2.4.2 Hard Disk Motor Supply

The Motor supply is controlled directly by a signal MTR_PWR_ON, which must be high for the motor supply to be on. This signal is directly controlled by software. The intent of this control is two-fold:

To disable the switching regulator when it is known that the disk-drive motor is not spinning

To disable the motor when an attempt to spin-up the motor results in the power source level dropping too far.

3.2.4.3 LCD Bias

The LCD Bias supply is also controlled directly by software, in this case by the signal /22ON (the significance of this particular name is purely archaic). The intent of this control is, as previously stated, two-fold:

To sequence the voltages into the LCD circuitry properly.
To allow the system to save a bit of power when the system is not in use, by blanking the screen.

3.2.4.4 RS232 Drive

The RS232 drive level is not actually a separate power supply; rather, it is a pair of voltages generated by the RS232 interface IC. This generation can be disabled by software when it is known that the serial port is not in use, saving a small amount of power.

3.2.4.5 Real-Time Clock Alarm

The VCC supply can also be turned on by the Real-Time Clock Alarm, which is set under software control. Thus, it can be used to schedule operations for a later time/date, and the system can be turned off until that time.

3.2.5 User Input Signals and Controls

The user controls and influences the power state of the STBook through a variety of controls and switches. Some of the controls have different functions, depending on the current state of the STBook. The switches/controls are:

Power switch
Reset
"Top Closed"
Contrast

3.2.5.1 Power Switch

The Power switch is a momentary, push-button switch, located on the lower part of the top half of the STBook, at the lower left of the LCD screen. When the STBook is turned "off" (only the RAM and Real-Time Clock powered), it is used to turn the system on. Since the signal it generates is "wire-ORed" with the VCC POWERGOOD signal, one or the other must be present for the system to remain on. To the user, this means holding the Power Switch until the power LED turns either green or yellow, which indicates that VCC has reached its proper level; yellow indicates that the system is on, but the source level is low.

Pushing the Power Switch when the STBook is already on sends a signal to the software, indicating that the user wishes the system to be turned off. If the function is enabled, the software with take a "snapshot" of the hardware state at that time and save it in the RAM. Since all of the RAM contents are retained by the VBAK supply when the system is off, the "snapshot" can be used when the system is turned back on to return the system to exactly the state it was in when the system was turned off, even to the extent of returning to the application that was running at the time.

3.2.5.2 RESET

The reset signal is not, of course, really a power control; it is

mentioned here for completeness. Its function is to reset the hardware and software state of the machine. It is also located at the lower left of the LCD display area, to the right of the Power Switch. It is deliberately recessed, so that it is unlikely to be pressed accidently.

3.2.5.3 Top Closed

The Top Closed switch is also not directly a power control; it is located between the Power Switch and the Reset Switch. The STBook housing is molded such that this switch is pressed when the top of the STBook is closed; this then generates a signal to the software, which can, for example, initiate the same power-down as the Power Switch. It also is used when the Real-Time Clock alarms turns on the system; the STBook then knows the top is closed, and that spinning-up the Hard drive would be inappropriate.

3.2.5.4 Contrast

The Contrast control is a potentiometer which allows the user to adjust the LCD Bias voltage level. Changing this level affects the LCD contrast; thus the user can set it to an appropriate level.

3.2.6 Power Source Level Direct Read

The current level of the Common Power Source can be read directly from an 8-bit A/D built into the STBook. It is designed such that each LSB change corresponds to 1/10V (100mV). Because of inaccuracies in the circuitry used, the built-in 2.5V reference level is converted at the same time as the Common Source level, and nominally converts to 1/2 full scale (i.e. 128 LSB's). This reference can then be used to scale the Power Source value; this is valid since the inaccuracies are only in the voltage ramp used to measure the levels; the scaling of the Common Source is done by 1% parts, and the reference is un-scaled. The level is read 2000 times/sec, and runs continuously while the VCC source is on.

3.2.7 Referenced Registers

This is a list of the specific registers and bits used to control all of the power system functions.

Address	Bit Positions	Register Name	Bit Name
FF 827E	0-5,7	LCD Control	
	Bit 0		Shadow Chip OFF
	Bit 1		/(SHIFTER OFF)
	Bit 2		POWEROFF
	Bit 3		/22ON
	Bit 4		RS-232_OFF
	Bit 5		(Unused in STBook)

Bit 7 MTR_PWR_ON

Address	Bit Positions	Register Name	Bit Name
FF 9200	0-15	Configuration/ Signals	
			Bit 0 /(POWER_SWITCH)
			Bit 1 /(TOP_CLOSED)
			Bit 2 /(RTC_ALARM)
			Bit 3 /(SRCDEAD)
			Bit 4 /(SRCLOW)
			Bit 5 /(MODEM_WAKE)
			Bit 6 Reserved
			Bit 7 /(EXPANSION_WAKE)
			Bit 8 Reserved
			Bit 9 Reserved
			Bit 10 Reserved
			Bit 11 Reserved
			Bit 12 Reserved
			Bit 13 Self Test Bypass
			Bit 14 Low Speed Floppy
			Bit 15 DMA Available
FF 9210	0-7		Common Power Source Level
		Power Source Voltage Level	
FF 9214	0-7		Reference Voltage Level
		Reference Voltage Level	