Battery Boss
User Manual

Power Control Module including Battery Charger, Gas Gauge, Clock/Calendar, Alarm Function, Watch Dog Timer and EMI Filters.

Index Designs • 410-821-1315 • www.indexdesigns.com

Table of Contents

Introducing the Battery Boss

1

Overview

The Battery Boss is a complete microprocessor based power system for instrumentation, data collection and portable equipment. Integrated into a 2.15 x 4.5 x 0.75 inch encapsulated package is a switching regulator, real time clock, serial interface, battery charger and EMI filters. Software logic executing on an internal microprocessor provides Auto-Power On Alarm functions, On/Off switch control, under/over charge protection, Watch Dog Timer and date/time clock functions.

All connections to the Battery Boss are through a single 25 pin D connector. Various connector termination styles are available for this connector. Solder cup connectors allow single wire solder termination. Mass termination connectors simplify connection to PC boards via ribbon cable and mass termination headers. Assigning multiple connector pins to high current connections reduces connector losses and simplifies distribution of regulated voltages to multiple target service points.

The Battery Boss operates with a 9.6 Volt 700 mahr battery with internal current protection devices and a temperature monitoring thermistor. This NiCd battery pack is specifically designed to operate with the Battery Boss. Using other battery packs is not recommended. Since battery operating characteristics are modeled in processor software, other battery sizes and chemistries can be supported. These optional battery types include Nickel Metal Hydride, Lead Acid and Lithium Ion. Please consult the factory for custom battery support.

> *USE OF NON-APPROVED BATTERY PACKS CAN RESULT IN DAMAGE OR FIRE.*

Battery Boss interfaces can be divided into four sections.

- Primary Power Input
- Battery Connection
- Target Power Output
- Control Logic

Primary Power Input

Unregulated DC power is applied to the Battery Boss through the Primary Power Input. This input is the primary power source for both target operation, battery charging and internal operation. A low cost wall mounting transformer is the most common source for primary power. Note that these “Transformers” also include the rectifier and filter capacitor required for a DC output. These transformers provide line isolation, noise reduction, simplify the “Internationalization” of a product and keep hazardous voltages outside the target equipment.

A major requirement for the primary power source is the ability to maintain proper input voltages during both target operation and battery charging. A transformer must maintain the primary power input voltage at a level greater than the peak battery charging voltage. Using an 8 cell NiCd battery pack as an example the corresponding minimum primary input voltage must be greater than 12.8 volts. (A 12 volt charging voltage and 0.8 volt “Overhead.") Note that this 12.8 volt figure includes any ripple voltages. If the input voltage is ever less than 12.8 volts battery charging will halt. If the input voltage continues to drop the battery will discharge during target operation. During periods of “Brown Out” when the primary power drops in voltage, battery power will be used to maintain target operation. Use of a high output voltage transformer will reduce or eliminate battery usage during brown out. Saving battery power during brownout conditions reserves battery capacity for complete loss of primary power.

A major source of failure in microprocessor based systems is the intermittent application of power. Rapid application and removal of power to a system will, at best, hang the system with a worst case being damage to power supplies or processing equipment. Hardware circuits and software logic within the Battery Boss isolate the target from input variations and apply power to the target in a controlled manner.

Software logic will not allow the power converter to start if the input voltage in less than 10 volts. (Operation without battery.) Once started the inverter will continue to operate down to 8.5 volts. Additional hardware logic monitors inrush currents and allows powering of highly capacitive loads in a controlled manner.

Battery Operation

Battery operating characteristics have been factory configured within Battery Boss software for a specific battery type. Proper charging requires the use of only factory supplied battery packs. Support is available for NiCd, NiH and Lithium type rechargeable batteries.

Optimization of battery life was a primary goal in software design. Major logic functions include the limit of over discharge during battery usage and the limit of over charging during charge cycles. Charge limit is a particularly difficult task given the desire for 100% charge at a maximum rate. Internal software logic adjusts the charge cutoff point depending on total charge, cell voltage and temperature. Additional logic provides for peak charge maintenance without the overcharge associated with constant current trickle charging.

While the Battery Boss controls all phases of battery charging and provides remaining charge information via the serial interface, it is important that a user have an understanding of battery basics. A greater understanding of battery operation will help with the selection of the proper battery pack for a specific load and will enhance system operation.

Batteries are complex chemical systems which convert energy between electrical and chemical forms. Power, or the rate of energy transfer, requires a corresponding chemical reaction rate. Batteries do not maintain a constant ability to react chemicals as their chemical composition changes. A fully charged battery contains a large amount of active material allowing delivery of energy at a high rate. Given fixed output voltages on Battery Boss regulated outputs, this translates into high peak output currents. A battery with a low charge does not contain the same supply of active chemicals. A partially discharged battery can not provide the high peak currents possible with a fully charged battery.

When selecting a battery it is important to consider peak load currents in addition to the total mahr capacity. A good example is a portable instrument using a thermal print head. Print heads draw more than 2 amps during brief printing cycles while the remaining system might draw only 100ma. Selecting a 1 Amp Hour battery for 10 hours of operation will result in failure after 5 hours of operation. Failures take place when the print head energizes, battery voltage drops, the system loses power resetting the processor and jamming the printer. The key to a successful system is knowing the remaining battery capacity and disabling the printing process. The Battery Boss maintains this information and makes it available to the target system.

Software logic within the Battery Boss and non-volatile memory locations prevent operating the battery into a cell reversal condition. Detection of a minimum battery voltage will abort the discharge process and shut off target power. At this point the battery is considered FAILED and battery usage will not resume. Restoring primary power will not clear the FAILED condition. If primary power again fails while the battery is FAILED the target is turned off and the battery is not used for power. Only after the battery is partially recharged will the FAILED condition be cleared and the battery made available for target operation.

Target Power Outputs

A 100Khz flyback converter accepts energy from the primary input/batter and delivers this energy to 4 output windings. Since one of the flyback outputs (either the +5 or +3.3 outputs) controls flyback currents, and given the nature of the coupled secondaries, all 4 outputs remain at constant output voltage while the primary input voltage changes (Line Regulation). Battery Boss line regulation is < 2%. As the target load changes the 3 none monitored outputs do change voltage slightly, typically less than 5%. The single monitored output is very stable with load variations affecting output voltage less than 2%.

Digital systems require the greatest regulation on the main logic supply voltage with less regulation required on analog processing supplies. The Battery Boss provides two such outputs, +5 and +3.3 volts, and one of these outputs is directly regulated. Some systems require both +5 and +3.3 supplies. Strapping options on the Battery Boss connector allow selection of the most variable load, or the most heavily loaded output, for direct regulation. Construction techniques used in manufacturing the main flyback inductor provide a high degree of regulation between the +5 and +3.3 sections.

Voltage for analog processes consist of two outputs, +13 and -13 volts. These outputs are never directly regulated but are highly filtered to reduce noise. Flyback operation maintains the load regulation of these outputs to within 10%. All output voltages are adjustable via a 10K potentiometer connected to the 25 pin connector. All voltages are adjusted proportionally.

All target output voltages pass through a sequence of output filters. High current common mode chokes provide a high degree of isolation for high frequency signals between the Battery Boss and the target. This high level of filter isolation make the Battery Boss an ideal power source for sensitive analog processing and measurement instruments. High frequency noise on digital power lines is also blocked by these chokes simplifying system EMI filtering and regulatory compliance.

Control Logic

A single On/Off control signal and internal Battery Boss software provide the target with a number of possible power control options. These options include:

- Push On - Push Off Operations
- Push On - Release Off Operation
- Continuous Operation (UPS Mode)
- Push On - Target Software Hold and Release

Control of the Battery Boss ON/OFF status is through a signal on the 25 pin connector. A 4 volt signal applied to this ON/OFF circuit (> 10K ohm input impedance) will cause the switching regulator to start if power conditions permit. Software logic will not permit the inverter to start if the primary voltage is less than 10 volts or if pervious operation has left the battery in a FAILED condition. When the converter starts hardware circuits limit inrush current and temporarily disable primary input voltage monitors. A two second delay allows the target power to stabilize then normal operating limits are re-established.

Once power conversion has started the Battery Boss will maintain target power for a minimum of 5 seconds. During this initial 5 seconds period target software has the option to either Lock or Hold the power using commands over the serial link. If the target issues a Hold command then power will remain On even after removal of the On/Off signal. However, using the Hold command allows another assertion and removal of the On/Off signal to turn the target Off. Together these actions provide Push ON / Push Off operation. If the target issues a Lock command then another assertion of the On/Off signal will not cause the target to lose power. Once Locked only the target can release power thought use of the serial link OFF command.

If after 5 seconds the target processor does not Hold or Lock the power into the ON state, Battery Boss operation follows the ON/OFF signal. A mechanical Push ON / Push Off switch will toggle will On/Off state without support from target software.

A major feature of the Battery Boss is an internal Real Time Clock with time and date counters. The contents of this clock provide the target with real time clock and date functions. Additional serial link commands allow the target to set a “Auto Wake Up Time.” Using this timer and the OFF command a target can set a future wake up time then turn the power off. When the wakeup timer expires power is restored. Wakeup time is expressed in seconds, and can range up to 2^{31}- 1 seconds (68 Years) with 1 second resolution.

Target software failures can be detected and cleared through a Watch Dog Timer function built into Battery Boss software. Once the Watch Dog Timer has been enabled any failure of the Target to periodically refresh this timer will result in a power Off/On cycle. Continued failure of the target to respond will result in continuous On/Off cycles, one cycle every 60 seconds. Target hardware and software has 5 seconds to clear the Watch Dog Timeout error and regain control over power. Until a timeout is cleared all other power control signals are ignored.

Additional serial link commands allow the target to read the remaining battery capacity, monitor input and battery voltage and monitor inverter input current. Peak battery performance is maintained by occasionally forcing a battery discharge cycle. Battery Boss hardware and software allow the target to disconnect the Primary Power Input and force operation from battery reserves.

Power System Operation

2

Operating Modes

The Battery Boss operates in various configurations depending on application requirements. Variations include:

- Operation with both Battery and Serial Link
- Operation without Serial Link
- Operation without Battery or Serial Link

Operation with Battery and Serial Link

The most common application uses a battery for power backup while the Battery Boss provides DC power conversion and charge control. An On/Off switch on the system panel allows the user to apply target power and the Battery Boss serial link allows target software to control power removal. Additional serial link commands allow the target to disconnect/connect the Primary Power Input and force operation using battery power. Using this command allows cycling of battery cells and maximization of battery reserves.

Auto Power WakeUp function require use of serial link messages. Target software sets a Wake Up time using the Alarm command then typically turns off target power. While the target is powered down Battery Boss software counts down the number of seconds specified in the Alarm command. When the Alarm count hits zero an alarm flag is set and target power is restored. The target uses serial link commands to read Power Event status bits and determines the source of the power on cycle. Depending on the source, either a Wakeup Alarm or a user On/Off button press, the target takes the appropriate actions.

As previously mentioned the Battery Boss contains a power switch in series with the Primary Power Input. This switch enables the target to disconnect primary power and force operation from battery reserves.

While this feature allows the target to verify power system operation and conditions the external battery, target software must be careful not to force the battery into a FAILED condition. Running the battery into a failed condition disables operation from the battery. While Battery Boss software will automatically re-connect primary power, a subsequent loss of primary power will result in loss of target power. Only after a battery recharge will the Battery Boss again use battery power during primary power loss.

Additional serial link commands allow reading and writing of Battery Boss status, date and time. Twenty five bytes of status information including battery and input voltages, primary input current, status flags and event registers are available. A version code identifies the battery size and chemistry. Chapter 3 contains detail specifications on these commands. Both sample source code and MS-DOS executable binary files are available. These provide a detailed example of command usage and allow the Battery Boss to be configured and tested with a simple PC.

Operation with Battery Only

Many application exist where the Battery Boss provides only simple UPS (Uninterruptible Power Supply) operation. Serial link communications are not required if the target has access to primary power status or if the target operation does not require battery status or Gas Gauge information.

If the target has access to primary power status, and target current usage remains relatively constant, a target can approximate battery capacity using a simple elapse time counter. If the target remains continuously powered it can maintain battery status with minimal software. If the target is not continually powered then approximating battery status becomes more difficult. During periods when the target is powered off primary power status is not monitored. Further, non-volatile memory is required to maintain battery usage variables.

During periods when primary power is lost it is often desirable to conserve battery capacity for critical operations. While some of these operation can be managed without a serial link, the more complex applications are often simplified using Battery Boss resources and the serial link.

Operation Without Battery or Serial Port

While the Battery Boss was primarily designed to provide UPS and battery control functions, operation without a battery and serial link provides regulated outputs with a wide range of input voltages. Internal software continues to monitors input voltage and provide On/Off cycle control logic. Power filters simplify regulatory compliance and the 25 pin D connector provides ample wire termination points.

Without a backup battery loss of primary power always results in loss of target voltages. As input voltage drops through the minimum operating level Battery Boss software shuts down power converter operation. When primary input voltage is restored converter operation resumes when the input voltage exceeds the minimum starting voltage. The difference between the minimum input level and the minimum starting level helps prevent “Start Up Chatter.”

When the target is powered the load on the input source increases, typically resulting in a source voltage drop. If the source voltage drops below a minimum input level the Battery Boss shuts off power and removes load from the source. It is important that the source output impedance be sufficiently low to prevent a condition where power cycles on and off. This condition is typical of linear supplies operating with very low line voltages.

A small zener diode can be connected between the Primary Power Input and the On/Off control signal to prevent unwanted converter operation. Selecting a zener voltage equal to the minimum operating voltage, minus 3, inhibits converter operation below the minimum voltage. A small resistor from the On/Off control signal to VIN- we be required to insure zener bias current.

Gas Gauge Operation

Basic Operation

Basic operation of the Gas Gauge is quite simple, read the Battery Boss status and unpack the number of milliampere hours (mahr) remaining. Also available from the block of status information is a reading of the primary input current. Dividing the mahr reading by the current value gives approximate time remaining. Additional serial link commands are available to directly or indirectly affect gas gauge status. A Gas Gauge Initialize command allows target software to write a mahr value directly into the gas gauge accumulator. A Top Off Charge command allows the target process to “Top Off” a battery after the normal charging process.

While Battery Boss software does a good job of monitoring remaining battery charge, target software must be careful when operating a battery at less than 20% capacity. There are several conditions that affect battery capacity thereby limiting gas gauge accuracy. These are:

- High Current from Small Batteries
- High Peak Currents
- Battery Temperature
- Battery Aging

The high operating currents and peak currents qre, to some degree, compensated for in Battery Boss software. Any level of current that exceeds the battery mahr rating (1C Rate) should be considered high. A 10 watt Battery Boss is capable of drawing over 2 amps from a 8 cell NiCd battery. Using a 700 mahr battery pack this represents almost a 3C discharge rate. Experience has shown the useful battery capacity of a 700mahr battery at a 10 watt target load to be about 500mahr. At a primary current of 100ma (<.2C) the expected capacity of 700mahr is realistic.

Additional margin should be reserved by the target software for battery aging. This aging take two forms. Simple aging in terms of years and cycle aging in terms of discharge/charge cycles. During the equipment lifetime it is likely that the battery pack might be replaced. Target software should support this event. Highly accurate charge tracking must also consider battery temperature. Temperatures above or below 20°C reduce the charge a battery will accept. High temperatures increase the rate of self discharge.

The simple solution is to use a larger battery than required. Add Top Off charging once a day for 5 percent of capacity depending on temperature. If load characteristics result in peak currents over 50% of average current, disable operation below 20% capacity. Never plan on operation below 10%. After a battery has been declared “FULL” allow the battery to cool to 25°C and apply an additional 10% Top Off charge.

Battery Conditioning

Included in Battery Boss circuits is a power switch in series with the Primary Power Input. This switch, which is controlled by the target through the serial link, allows the target to disconnect the primary input source. Keeping the battery in top operating condition requires that the battery occasionally be discharged. This power switch can be used to force a battery discharge cycle. While the number of charge/discharge cycles affect battery life, a discharge frequency of once per month has minimal impact on battery life. If normal operation results in a discharge to 20% capacity then self discharge is not required.

When forcing a self discharge the target should terminate the cycle as close to total capacity as possible. This is most easily accomplished by monitoring battery voltage during discharge. Depending on the specific battery pack, self discharge should be stopped when the battery voltage reaches a voltage 0.25 volts above the Battery Boss battery FAIL cutoff. For a 700 mahr NiCd batter which has a FAIL cutoff of 8.0 volts, self discharge should be terminated at 8.25 volts. At discharge currents above 1.5C the 0.25 volt margin should be increased to 0.50 volts.

A problem with battery conditioning is that a real primary power failure could occur as the battery reaches the discharged condition. The advantage of power conditioning must be weighted with battery capacity and the likelihood of a power failure during a conditioning cycle. The trade off of not conditioning a battery is a possible 20% capacity drop after long periods of time with no discharge cycles. However if the primary power seldom fails, or the failures are of short duration, the probability of failure during a condition cycle becomes very small.

Battery Replacement

When the battery is replaced Battery Boss software must be forced to reset internal charge accumulators. This process requires that the battery be discharged to the FAILED condition then recharged. Target software can control this process using the power switch which is in series with the Primary Power Input. Manual removal of the Primary Power Input along with target operation until the battery reaches FAILED will also reset charge accumulators.

While the Gas Gauge Initialize command can be used force the charge accumulator too a know level, a complete charge/discharge cycle is recommended. Once the new battery reaches the FULL condition an additional discharge/charge cycle is recommended.

Serial Port Commands

3

Command Overview

Battery Boss commands are composed of text strings which are generated by the target processor. Operation of the serial link is half duplex, master / slave where the target is the master and the Battery Boss the slave. After sending a command the target must wait for a Battery Boss response before sending an additional command. Data is transferred at 1200 baud. Serial format settings are 8 data, no parity, 2 stops.

Command Structure

All command strings consist of a <CR> character (\r, ^M, or Char (0x0d)) followed immediately by a single character command letter. Following the command letter are possible command parameters. Following the parameters is a checksum. Both parameters and checksum consist of a space character (Char(0x20)) followed by 2 ASCII hex characters (0..9,A..F) which form an 8 bit value. The last checksum ASCII hex character is followed by an EOT (Char(4)). Once the target sends the EOT character NO ADDITIONAL CHARACTER MAY BE SENT.

A checksum is formed by adding together the command letter and parameters. Command letters are added as their ASCII code (Example A = 0x41) while each parameter is added before conversion to ASCII hex characters. A 2’s complement is taken and the result is send as a space followed by 2 ASCII hex characters. When the Battery Boss receives the string it adds together the command letter, decoded parameters and checksum. A zero sum is expected. Values are returned to the target in the same manner except there is no command letter is returned.

Depending on the command the Battery Boss responds with a number of returned values followed by a checksum. After the checksum the Battery Boss sends either an ACK (Char(6)) or NACK (Char(0x15)). ACK is send as an indication that the command has been processed with no errors. NACK infers that an error has been detected. If an error is detected with either the command structure or checksum NACK will be returned immediately. If the target receives a NACK during the transmission of a command then that command should be aborted. The target should wait for the following LF and resend the command string.

After sending the ACK or NACK the Battery Boss sends a CR character (Char(0x0d)) followed by a LF character (Char(0x0a)). The target MUST NOT send any additional command until AFTER the LF has been received by the target. Once the LF character has been received the target may send another command.

Sending and receiving characters takes a significant portion of Battery Boss processor bandwidth. The STATUS command, which returns a large number of parameters, takes a significant amount of processing time. STATUS commands should not be repeated at a rate greater than once every 10 seconds.

The following is a list of all Battery Boss Commands.

Command Name	Cmd Letter	Command Description	Parameters to Battery Boss	Values From Battery Boss
Alarm	A	Set Wakeup Alarm Timer	4	0
Connect	C	Connect Primary Power	0	0
Disconnect	D	Disconnect Primary Power	0	0
Event	E	Clear Event Flags	0	0
Gas	G	Gas Gauge Initialize	2	0
Hold	H	Set Hold Mode Operation	0	0
Lock	L	Set Lock Mode Operation	0	0
Off	F	Turn Off Converter	0	0
Reset	R	Execute Soft Reset	0	0
Status	S	Read Status from Battery Boss	0	25
TopOff	T	Start Top Off Charging	1	0
Update	U	Write Status to Battery Boss	25	0
Watch Dog	W	Set Watch Dog Timer	1	0

Detailed Command Description

Alarm

The Alarm command is used to set the Wakeup alarm counter. Four parameters are passed to the Battery Boss forming a single 32 bit alarm count. The LSB is the first parameter, the MSB is the fourth parameter. This 32 bit count represents the number of seconds that need to pass before the Wakeup Alarm expires. When the Alarm expires power is applied to the target. Power will continue to be applied to the target until the Alarm Expired flag in the Power Event register is cleared. Refer to the Event Command.

Connect

The Connect command turns the primary power switch ON. If the switch is already ON it will stay ON. If the switch is OFF it is turned ON.

Disconnect

The Disconnect command turns the primary power switch OFF. If the switch is already OFF it will stay OFF. If the switch is ON it will turn OFF.

Event

The Event command is used to clear Power Events as read by the Status command. Each time the target uses the Status command a copy of the Power Events register is saved. The Event command uses this saved copy to clear events from the event register. This insures that Battery Boss events between Status and Event commands are not lost.

Gas

The Gas command is used to set the Battery Boss Gas Gauge Accumulator. This command is used to compensate for replacement of external battery packs. Four parameters are passed to form a 16 bit value in mahr units. The first parameter is the LSB the second is the MSB. This command supports a 64,000 mahr accumulator.

Hold

The Hold command is used to set the operating mode of the external On/Off control signal. After the Hold command is issued the On/Off control signal operates in a Push On - Push Off mode. The Hold command clears the Lock mode as set by the Lock Command.

Lock

The Lock command forces the Battery Boss to turn on the converter at all times, power conditions permitting. Lock status is maintained in non-volatile memory. A Lock command clears the Hold operating mode as set by the Hold command. Lock mode is cleared by the Off command.

Off

The Off command turns off the converter. A 2 second delay is provided between receiving the Off command and actual power off. The Off command clears the Lock mode as set by the Lock Command. Hold mode is not affected by the Off command. If the Hold mode is set and the Off command is issued target power will turn Off but another Off to On transition of the On/Off signal will turn target power back on.

Reset

The Reset command clear a number of Battery Boss non-volatile memory locations. The Reset command should never be used, it is reserved for manufacturing initialization.

Status

The Status command returns to the target a number of Battery Boss operating parameters. These parameters allow target software to monitor voltages, currents, alarms, status flags and events. Due to the size of the returned array the use of this command should be limited to not more than once every 10 seconds. A definition of the returned values follows the command descriptions.

Top Off

The Top Off command allows the target to specify an additional battery charging period. A single parameter is passed which specifies the number of minutes for charging. Values range from 0 to 255 minutes.

Update

The Update command is used to load the Battery Boss with a complete set of operating parameters. Setting the real time clock and date is the main purpose of the Update command. The structure of the passed parameters is identical to the structure returned using the Status command. This structure contains a number of important, but not documented, variables. These variables must be properly setup. Before the Update command is issued this structure should be read from the Battery Boss using the Status command. Target software can modify the required documented variables then write the modified structure using the Update command.

Watch Dog Timer

The Watch Dog Timer command is used to enable and control the Battery Boss Watch Dog Timer. A single parameter is passed to the Battery Boss which specifies, in minutes, the timeout period. A timeout period of 0 disables Watch Dog Timer operation and logic. Parameters ranging from 1 to 254 are valid ranges. Timeout logic executes once per minute and the actual timeout period will be the passed parameter plus some fraction of a minute.

After setting the Watch Dog Timer target software MUST issue an additional Watch Dog Timer command BEFORE the previous period expires. Failure to do so causes drastic changes in Battery Boss operation. These changes are:

Power is turned OFF.

- All power ON commands are ignored.
- Alarm Auto Power On is ignored.
- External Power On/Off signals are ignored.
- Power Hold and Lock status are cleared.

Failures within target software or hardware are cleared by removal of target power. Further, sufficient time must be provides for target supplies and circuits to completely discharge. Complete discharge is required to release hardware latchups. The re-application of power is limited to 5 seconds minimizing damage due to hardware failures and to preserve battery power. If the target does not respond within 5 seconds power is again removed. The process of applying power for 5 seconds repeats every 60 seconds until the target responds.

Target applications using Watch Dog Timer functions MUST read the Battery Boss status at power on. An active Timeout flag must be cleared using a Watch Dog Timer command. Immediately after the Watch Dog Timer command a Hold or Lock command should be used to gain control of power. Failure to use the Hold or Lock command will result in a loss of power after 5 seconds. An Event command can be used to clear the Timeout event but the Watch Dog Timer command should be used BEFORE the Event command. Watch Dog Timer commands provide additional power on time which is important since timeout events clear Hold and Lock power control bits.

Battery Boss Main Data Structure

The following table defines the Battery Boss main data structure.

Offset	Variable	Description
0x00	Version	Battery Type and Code Version Control
0x01	Seconds	All date and Clock counters are BCD counters. Hours is a 24 Hour Clock. Day of Week is 1 to 7
0x02	Minutes	
0x03	Hours	
0x04	Day Of Week	
0x05	Day Of Month	
0x06	Month	
0x07	Year	
0x08	Gas Gauge LSB	Gas Gauge Accumulator
0x09	Gas Gauge MSB	
0x0A	Power Events	Bit 6 - Watch Dog Timer Timeout Bit 5 - Not Defined Bit 4 - On/Off Signal caused Power On Bit 3 - Wakeup Alarm caused Power On Bit 2 - Loss of On Board Lithium Battery (Real Bad) Bit 1 - Loss of External Battery (Just Plain Bad) Bit 0 - Internal Reset
0x0B	Power State	Bit 7 - Top Off Charging Active Bit 6 - Battery Charging Required Bit 5 - Charger Ready, Min Voltage OK Bit 4 - Hold Mode Bit 3 - Lock Mode Bit 2 - State of On/Off Signal Bit 2 - State of On/Off Signal Bit 1 - Not Defined Bit 0 - Converter is On
0x0C	Battery State	Bit 2 - Battery FAILED Bit 1 - Battery FULL Bit 0 - Running On Battery
0x0D	Battery Temp	Range = 0 - 8 for 0°C - 40°C
0x0E	VRun	Voltage to Converter in 0.156 volt steps.
0x0F	Not Defined	
0x10	VBattery	Battery Voltage in 0.156 volt steps.
0x11	IRun	Converter Primary Current in 10ma steps.
0x12	Not defined	Must be written with 116 (0x74) before Update.
0x13	Not Defined	
0x14	AlarmCntr0	Wakeup Alarm Counter - 32 Bit Counter that Decrements once every second ONLY IF Primary Power or the external Battery is connected.
0x15	AlarmCntr1	
0x16	AlarmCntr2	
0x17	AlarmCntr3	

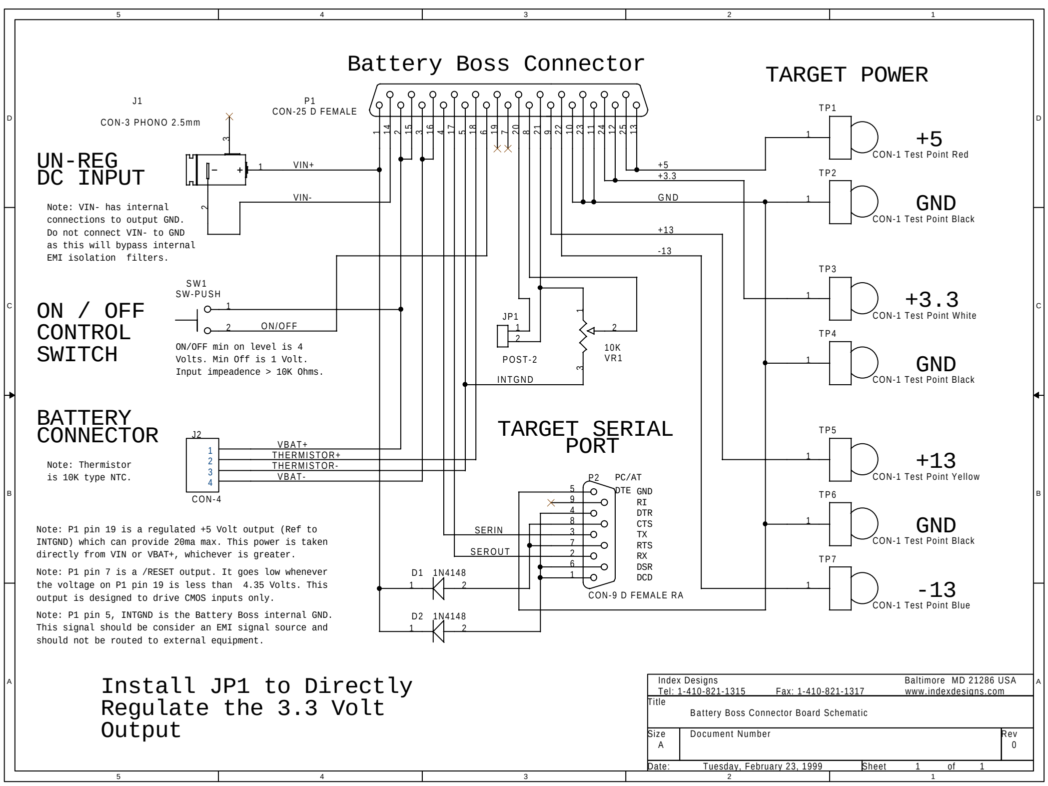
Reference

4

Application Examples

Connector Wiring Schematic

A schematic for the Battery Boss Connector Board follows. This schematic show the connections and functions of Battery Boss pins.



Connector Pinout

Pin Number	Function
1	VIN+ Primary Power Input +
2	VBAT + Battery Positive Terminal. Connect in Parallel with Pin 15
3	VBAT- Battery Negative Terminal. Connect in Parallel with Pin 16.
4	Serial Input RS-232 from Target Input
5	INTGND Internal Ground. DO NOT CONNECT TO OTHER GNDs.
6	ON/OFF Control Signal. High (+4V) is on, low (1.5V) is off.
7	/RESETOUT Goes low to indicate failed INT+5. CMOS inputs only.
8	VADJ Offset Adjust Input. (0-5V, 100K Ohm, Ok to leave open.)
9	+13 Volt Output
10	Target GND. Do Not Connect to Pin 14 or Pin 2 or Pin 15 or Pin 5.
11	Target GND. Do Not Connect to Pin 14 or Pin 2 or Pin 15 or Pin 5.
12	+3.3 Volt Output. Connect in Parallel with Pin 24.
13	+5 Volt Output. Connect in Parallel with Pin 25.
14	VIN- Primary Power Input -
15	VBAT + Battery Positive Terminal. Connect in Parallel with Pin 2
16	VBAT- Battery Negative Terminal. Connect in Parallel with Pin 3.
17	Serial Out RS-232 signal to Target.
18	Battery Thermistor. 10K Ohm NTC Battery Thermistor.
19	INT+5 Internal +5 Supply regulated from battery. 10 ma MAX.
20	Input Select. Connect to Pin 21 to Directly Regulate the 3.3V Output.
21	Unfiltered 3.3Volt Signal. DO NOT CONNECT TO TARGET.
22	-13 Volt Output
23	Target GND. Do Not Connect to Pin 14 or Pin 2 or Pin 15 or Pin 5.
24	+3.3 Volt Output. Connect in Parallel with Pin 12
25	+5 Volt Output. Connect in Parallel with Pin 25

Do not connect VIN- to either INTGND or Target GND. These three different ground circuits are connected internally through common mode EMI chokes. External connections would bypass ground currents and result in EMI choke saturation.

The internal +5 supply (INT+5) is internally bypassed to INTGND. Do not bypass to any other grounds. An external 10ufd Tantalum bypass cap is required (bypass to INTGND) if user circuits use this supply.

/RESETOUT is a high impedance output. Do not pull up. Connect only to CMOS inputs.

Several signals use multiple pins. These are Target GND, +3.3 Volt Output, +5 Volt Output, VBAT+ and VBAT-. The common pins on these circuits should be connected in parallel. See the Application Schematic for sample connections.

Serial Interface Sample Code

The following code fragment show Battery Boss command structure and command format. Complete listings are available at: www.indexdesigns.com.

```
/*
 *    Read bytes from serial port until a LF is seen
 */

void com_sync()
{
    char c = 0;
    do {
        if (dataReady(port)) {
            c = getByte(port);
        }
        if (c == 0x15) nak_count++;
    } while (c != ‘\n’);
}
/*
 *    Write string to serial port
 */
void com_write(char *string)
{
    do {
        sendByte(port, *string);
    } while (*string++);
}
/*
 *    Convert a number to binary coded decimal
 */
int to_bcd(long in_val)
{
    int i = 0;
    in_val = in_val % 10000;
    while (in_val >= 1000) {
        in_val -= 1000;
        i += 1000;
    }
    while (in_val >= 100) {
        in_val -= 100;
        i += 100;
    }
    while (in_val >= 10) {
        in_val -= 10;
        i += 10;
    }
    i += in_val;
    return i;
}
/*
 *  Convert a value into a 2 char hex number and send to serial port
 */
void pwr_out(int value)
{
    int i = ((value > 4) & 0x0f) + ‘0’;
    if (i > ‘9’) i = i - ‘9’ + ‘A’ - 1;
    sendByte(port, i);
    i = (value & 0x0f) + ‘0’;
    if (i > ‘9’) i = i - ‘9’ + ‘A’ - 1;
    sendByte(port, i);
```

```
}
/*
 *    Attempts to read a character, skipping spaces, and counting
 *    errors.  Characters read are stored in input_buffer global.
 */
char pwr_in()
{
    char c;
    do {
        c = 0;
        if (dataReady(port)) {
            c = getByte(port);
        }
        if (c == '\x15') nak_count++;
        if (c >= ' ' &&
            input_buffer_pos < input_buffer + MAX_INPUT_BUFFER ) {
            *input_buffer_pos++ = c;
            *input_buffer_pos = 0;
        }
    } while (c <= ' ');
    return c;
}
/*
 *    Read two bytes from the serial port representing a hexadecimal
 *    number, and convert them to decimal.
 */
int pwr_read_hex()
{
    char c;
    int i;
    c = pwr_in();
    if (c > '9') {
        i = c - 'A' + 10;
    } else {
        i = c - '0';
    }
    i = i * 16;
    c = pwr_in();
    if (c > '9') {
        i += c - 'A' + 10;
    } else {
        i += c - '0';
    }
    return i;
}
/*
 *    Clear event in the Battery Boss
 */

void pwr_clear_events()
{
    com_write("\rE BB\x4");
    com_sync();
}
/*
 *    Read the status, return the checksum
 */
int pwr_read()
{
    int checksum = 0;
    com_write("\rS AD\x4");
    input_buffer_pos = input_buffer;
    for (int i=0; i < 25; i++) {
        in_array[i] = pwr_read_hex();
```

```
        checksum = (checksum + in_array[i]) & 0xff;
    }
    if (checksum != 0 && !new_error) check_errors += 1;
    if (checksum != 0) new_error = TRUE;
    else new_error = FALSE;
    seconds = (in_array[1] > 4) * 10 + (in_array[1] & 0x0f);
    minutes = (in_array[2] > 4) * 10 + (in_array[2] & 0x0f);
    hours   = (in_array[3] > 4) * 10 + (in_array[3] & 0x0f);
    day     = (in_array[5] > 4) * 10 + (in_array[5] & 0x0f);
    month   = (in_array[6] > 4) * 10 + (in_array[6] & 0x0f);
    year    = (in_array[7] > 4) * 10 + (in_array[7] & 0x0f);
    v_run = in_array[14] * 40.0 / 256.0;
    v_bat_neg = (in_array[15] - 4) * 19.7 / 256.0;
    v_bat = in_array[16] * 40.0 / 256.0;
    i_avg = in_array[17] * 10.0;
    temperature = in_array[13] * 5;
    gas_guage = 100 * (in_array[8] + in_array[9] * 256) / bat-
tery_cap;

    my_freq = in_array[19];
    alarm_counter = (in_array[23] < 24) + (in_array[22] < 16) +
        (in_array[21] < 8) + in_array[20];
    com_sync();
    return checksum;
}
/*
 *    Set the Real Time Clock
 */
void pwr_set()
{
    struct dostime_t dostime;
    struct dosdate_t dosdate;
    do {
        _dos_getdate(&dosdate);
        in_array[4] = dosdate.dayofweek;
        in_array[5] = dosdate.day;
        in_array[6] = dosdate.month;
        in_array[7] = dosdate.year;
        _dos_gettime(&dostime);
        in_array[1] = dostime.second;
        in_array[2] = dostime.minute;
        in_array[3] = dostime.hour;
        _dos_getdate(&dosdate);
/*      printf("%d/%d/%d\n", in_array[6], in_array[5], in_array[7]);
        printf("%d:%d:%d\n", in_array[3], in_array[2], in_array[1]);
*/
    } while (in_array[5] != dosdate.day ||
         in_array[6] != dosdate.month ||
         in_array[7] != dosdate.year);
    for (int i=1; i < 8; i++)
        in_array[i] = to_bcd(in_array[i]);
    in_array[18] = debug_loc;
    com_write("\rU ");
    int j = 0 - 'U';
    for (i = 0; i < 24; i++) {
        j -= in_array[i] & 0xff;
        pwr_out(in_array[i]);
        sendByte(port, ' ');
    }
    pwr_out(j);
    sendByte(port, 0x04);
    com_sync();
}
/*
```

```
 *    Sets the Gas Guage value (mahr)
 */
void pwr_gas_init(int gas)
{
    com_write("\rG ");
    int j = 0 - 'G';
    int i = gas & 0xff;
    pwr_out(i);
    j -= i;
    sendByte(port, ' ');

    i = (gas > 8) & 0xff;
    pwr_out(i);
    j -= i;
    sendByte(port, ' ');
    pwr_out(j);
    sendByte(port, 0x04);
    com_sync();
}
/*
 *    Set the number of seconds before alarm wakes unit up
 */
void pwr_alarm(long alarm_time)
{
    com_write("\rA ");
    int j = 0 - 'A';
    int i = alarm_time & 0xff;
    pwr_out(i);
    j -= i;
    sendByte(port, ' ');

    i = (alarm_time > 8) & 0xff;
    pwr_out(i);
    j -= i;
    sendByte(port, ' ');
    i = (alarm_time > 16) & 0xff;
    pwr_out(i);
    j -= i;
    sendByte(port, ' ');

    i = (alarm_time > 24) & 0xff;
    pwr_out(i);
    j -= i;
    sendByte(port, ' ');
    pwr_out(j);
    sendByte(port, 0x04);
    com_sync();
}
/*
 *    Turn on primary power
 */
void pwr_connect()
{
    com_write("\rC BD\x4");
    com_sync();
}
/*
 *    Turn off primary power
 */
void pwr_disconnect()
{
    com_write("\rD BC\x4");
    com_sync();
}
```

```
/*
 *    Set Push on - Push Off mode
 */
void pwr_hold()
{
    com_write("\rH B8\x4");
    com_sync();
}
/*
 *    Lock into an ON state
 */
void pwr_lock()
{
    com_write("\rL B4\x4");
    com_sync();
}
/*
 *    Turn power converter off.
 */
void pwr_off()
{
    com_write("\rF BA\x4");
    com_sync();
}
/*
 *    Reset non-volatile memory locations
 */
void pwr_reset()
{
    com_write("\rR AE\x4");
    com_sync();
}
/*
 *    Start charging cycle to top off the battery
 */
void pwr_topoff(int top_time)
{
    com_write("\rT ");
    int j = 0 - 'T';
    int i = top_time & 0xff;
    pwr_out(i);
    j -= i;
    sendByte(port, ' ');

    pwr_out(j);
    sendByte(port, 0x04);
    com_sync();
}
```