Embeddable Smart Single –Battery Charger Specification

Document Number

DS478A

Description

Smart Single-Battery Charger Board (5S) with DC Pass-through, Non-Boost Configuration

Inspired Energy Part Number

EB478A

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1. REVISION HISTORY

Revision	Release Date	Revisions	Issued By	Approved By
1.0	1/7/20	Production release	JAB	KP
1.1	8/28/23	Updated EMC and Safety	KP	JAB

2. INTRODUCTION

2.1. Scope

This specification describes the physical, functional and electrical characteristics of a smart charger board supplied by Inspired Energy. This specification is the interface document between Inspired Energy and its customers. It is understood that the customer may create their own internal specification. However, this specification is the master that defines the charger operation. The charger produced will meet this specification.

2.2. Smart Charger Overview

This specification describes the physical, functional and electrical requirements for the EB478A Smart Charger assembly.

The EB478A is capable of communicating with battery through the System Management Bus (SMBus) and is fully SMBus Rev. 1.0, SBDS Rev. 1.1 and SCDS Rev. 1.1 compliant.

Redundant safety protection is provided by constant communications between the battery and charger and by monitoring the battery on-board thermistor. In addition, the charger has passive over-current protection on both the input and output.

2.3. General Precautions

2.3.1. Handling

- ESD sensitive.
- Avoid shorting.
- Do not immerse in water.
- Do not disassemble or deform.
- Avoid excessive physical shock or vibration.
- Caution – during charging the battery connector and the charger may become warm.

2.3.2. Charge

- Never use a charger or battery that appears to have suffered abuse.
- Only approved batteries should be charged.
- Never use a modified or damaged battery or charger.
- Specified product use only.

2.3.3. Storage

- Store in a cool, dry and well-ventilated area in ESD approved packaging.

3. REQUIREMENTS

3.1. General Requirements

3.1.1. Input Power

The input power should comply to the following parameters: 24-26VDC, 60W. The input has reverse polarity protection, and is fused at 8A slow-blow. Charger will shut off below 18VDC. *(Please note that 5S battery designs will require the input voltage to not drop below 23.5Volts or Full Charge is not guaranteed. Confirm power supply voltage tolerance prior to using)*

3.1.2. Power-On-Reset

The LEDs will flash on for 1 second on charger power up.

3.1.3. Operation

Operational Temperature Limits: 0°C to +50°C, ≤ 80%RH

3.1.4. Storage

Storage Temperature Limits: -20°C to +80°C, ≤ 80%RH

The Smart Charger should be stored in an environment with low humidity, free from corrosive gas.

3.1.5. Terminal Specifications

J1 pin assignments (also refer to the mechanical drawing for additional details).

Terminal	Legend	Description
1	(+)	24-26V DC input.
2	(-)	DC GND input.

J3 pin assignments (also refer to the mechanical drawing for additional details).

Terminal	Legend	Description
1	(+)	24-26 VDC input or +Vbattery DC output. This is reverse-current protected.
2, 3	(-)	DC GND output.

J2A pins (also refer to the mechanical drawing for additional details).

Terminal	Legend	Description
1A,1B	(+)	DC Positive to battery. This is fused at 10A slow-blow.
2A,2B	(C)	SMBus Clock.
3A,3B	(D)	SMBus Data.
4A,4B	(THM)	Thermistor (300 ohm) connection to battery.
5A,5B	(-)	DC Negative to battery.

- The SMBus Clock and data lines will be pulled up by the charger to a nominal 5V Vdd. A 10KΩ pull-up resistor is used, but please refer to the SMBus Specification for additional information.

J4 pin assignments (also refer to the mechanical drawing for additional details).

Terminal	Legend	Description
1		Output Enable – (connect to ground to enable output)
2		Ground

J5 pin assignments (also refer to the mechanical drawing for additional details).

Terminal	Legend	Description
1		SMB Ground
2		SMB Serial Data
3		SMB Serial Clock
4		SMB Alert (Interrupt)
5		SMB Optional +V Input (3-5V)

3.2. Charger Electronics

3.2.1. Overview of Operation

The Smart Charger is capable of providing all battery functions needed to recharge a Smart Battery.

The charger is capable of communicating with the battery through the System Management Bus (SMBus). The charger is fully SMBus Revision 1.1 and SBDS Revision 1.1 compliant. The charger is implemented as a level III SBS compliant system.

An 8-bit Reduced Instruction Set CPU (RISC) is used to process the core algorithms and perform operations required for battery monitoring, charge control and user display.

Pertinent battery parameters are constantly monitored throughout the charge cycle to insure safe and reliable operation. The battery thermistor is monitored as an independent and redundant safety monitor. SMBus Alarms are monitored and acted upon as defined in the Smart Charger Data Specification (SCDS).

The user is notified of operational mode and fault conditions by the on-board LEDs.

3.2.2. DC Specifications

Parameter	Limits	Remarks
Active current consumption	<15mA	24V input power is applied.
Battery leakage current consumption	<500uA	Parasitic leakage current from the battery when input power has been removed from the charge control board. Processor is on.

3.2.3. Charging

During charge, the charger reads the battery status, battery mode, battery current, battery voltage, and battery temp. The battery voltage and current are then passed on to the charge control chip which has been configured to deliver up to 21 volts and/or 4 amps (60W max). The specified voltage and current of the battery is constantly read from the battery then relayed to the charge control chip every second.

Normal charge termination occurs when the battery reaches full charge, begins requesting 0 current, and issues the TERMINATE_CHARGE_ALARM Warning.

Once fully charged, if the battery is left attached to the charger, the charger will re-initiate charge as requested by the battery. Typically, the battery will either request a trickle current, or else will begin requesting current following a predetermined amount of self-discharge. Leaving charged batteries attached to the charger is permissible.

If communication is lost with either the battery or charger, charging will stop and an Error condition is indicated. Charging will resume automatically once communication is restored.

The charger is disabled for input voltages less than 18VDC.

3.2.4. Charger Regulation/Measurement Accuracy

3.2.4.1.Voltage

The charge voltage is measured and regulated to ±0.8% of the battery requested value.

3.2.4.2.Current

The charge current is measured and regulated to ±100mA or 5% of the battery requested value, whichever is greater.

3.2.5. LED Indication

The charger provides the following LED display to inform the user of operation mode and fault conditions.

BLUE on:	Input Power detected
Off:	No Battery
GREEN Flashing:	Charge in process
GREEN Solid:	Charge complete
RED:	Error

Error Conditions:

Smart Charge:	Unsuccessful Charger communications within timeout.
Battery:	No Battery Communications within timeout.

3.2.6. Output

As a pass-through design, the higher voltage of either the input from J1 or the battery is connected to the output connector J3 when J4-1 is held to ground by the supplied jumper or an external circuit. If there is no input and the battery is reporting FULLY_DISCHARGED status, or removed, then there will be no output at J3.

When an input >18V is present, the output is enabled by processor--even when no battery is present. The battery connector is fused at 10A slow-blow, while the input connector is fused at 8A slow-blow. To prevent overloading the input source, the charger will reduce the charge current as required to keep the input at 2.5A max, although the load may exceed 2.5A. This board is capable of delivering 10A continuously from the battery.

J4-1 controls the output switch. It is modeled as 5V sourced through 1Mohm, with a level below about 1V enabling the output. There is a 5.6V zener clamp on this pin. When J4-1 is above 1V, the output will be off in all cases. J4-2 is a ground pin.

3.2.7. Optional Configurations

The Smart Charger allows a number of alternate configurations and modes of operation for engineering development. Contact Inspired Energy to determine if and how the EB478 board may be configured for a specific application.

3.2.8. Heartbeat

For diagnostic purposes, there is a Heartbeat signal test point on the bottom side of the board. This signal transitions between 0 and 5V once per second, to allow verifying the processor is operational.

There is also a CHGEN test point on the top side of the board. This signal will go to a logic high when the battery charge circuit has been enabled.

3.3. SMBus and SBDS Parameters

3.3.1. Overview of Operations

The Smart Charger is fitted with a microprocessor and associated circuitry for communication with the smart battery. Reference should be made to the following specifications when reading this section:

- System Management Bus Specification (Rev 1.0, Feb 15, 1995)
- Smart Battery Data Specification (Rev 1.1, Dec 11, 1998)
- Smart battery Charger Specification (Rev 1.1, Dec 11, 1998)

3.3.2. SMBus Logic Levels

Symbol	Parameter	Limits		Units
		Min	Max	
Vil	Data/Clock input low voltage		0.6	V
Vih	Data/Clock input high voltage	1.4	5.5	V
Vol			0.4	V

3.3.3. Communication Protocol

SMBus Interface complies with SBS Specification Version 1.0. The charger includes a simple bi-directional serial data interface. The charger processor uses the interface to access various battery pack registers.

SMBus Interface complies with SBS Specification Version 1.1. The SMB communicating with the battery is shared with SMB communication with external devices. The external SMB communications port provides:

1. Bus isolation, so that an external device does not disable the internal communications bus when powered down. 15K pull-ups to the external +V are provided.
2. Voltage translation, so SMB voltages less than 5V can communicate with the 5V charger (connect external bus voltage between J5-1 and J5-5).
3. SMB Alerts (interrupts) caused by battery alarms.
4. Bidirectional SMB buffering, and active risetime acceleration.

No output will be seen on J5 unless external 3-5VDC is applied to the external pull-ups via J5-5. Alternatively, if isolation is not required, a jumper can be installed at R43 (across T7 and T8), to supply the charger 5V to the external pull-ups. The Alerts are active high. SMB clock/data idles high.

3.3.4. Initialization Procedure

The interface uses a command-based protocol, where the charger processor sends the battery address command byte to the battery pack. The command directs the battery pack to either store the next data received to a register specified command byte or output the data specified by the command byte.

The Charger communicates with the battery pack using one of three protocols:

- Write Word
- Read Word
- Read Block

3.3.4.1.Write Word

The first byte of a Write Word access is the command code. The next two bytes are the data to be written. In this example the master asserts the slave device address followed by the write bit. The device acknowledges and the master delivers the command code. The slave again acknowledges before the master sends the data word (low byte first). The slave acknowledges each byte according to the I²C specification, and the entire transaction is finished with a stop condition.

1	7	1	1	8	1	8	1	8	1	1
S	Battery Address	Wr	A	Command Code	A	Data byte low	A	Data byte high	A	P
ÀStart Condition		Write			À-------Acknowledge-------Ù			Stop Condition Ù		

Write Word Protocol

☐ (white)	SMBus Host (master)
▨ (hatched)	Smart Battery (slave)

3.3.4.2.Read Word

Reading data is slightly more complex than writing data. First the host must write a command to the slave device. Then it must follow that command with a repeated start condition to denote a read from that device's address. The slave then returns two bytes of data.

Note that there is not a stop condition before the repeated start condition, and that a "Not Acknowledge" signifies the end of the read transfer.

1	7	1	1	8	1	1	7	1	1	8	1	8	1	1
S	Battery Address	Wr	A	Command Code	A	S	Battery Address	Rd	A	Data byte low	A	Data byte high	!A	P

À---Repeated Start Condition

Read Word Protocol

SMBus Host (master) Smart Battery (slave)

3.3.4.3.Block Read

The Block Read begins with a slave address and a write condition. Then it must follow that command with a repeated start condition to denote a read from that device's address. After the repeated start, the slave issues a byte count that describes how many data bytes will follow in the message. If a slave had 20 bytes to send, the first byte would be the number 20 (14h), followed by the 20 bytes of data. The byte count may not be 0. A Block Read can transfer a maximum of 32 bytes.

1	7	1	1	8	1	1	7	1	1	
S	Battery Address	Wr	A	Command Code	A	S	Battery Address	Rd	A	…

8	1	8	1	8	1		8	1	1
Byte count=N	A	Data byte 1	A	Data Byte 2	A	≈	Data byte N	!A	P

Block Read

SMBus Host (master) Smart Battery (slave)

3.3.5. Charger to Battery Message

The charger acting in the role of a bus master, uses the read word, write word, and read block protocols to communicate with the battery, operating in slave mode.

Charger-to-Battery Messages

Function	Command Code	Description	Unit	Access
BatteryMode()	0x03	Battery Operational Modes.	Bit flags	r/w
Temperature()	0x08	Returns the pack's internal temperature.	0.1 ºK	r
Voltage()	0x09	Returns the battery's voltage (measured at the cell stack)	mV	r
Current()	0x0a	Returns the current being supplied (or accepted) through the battery's terminals.	mA	r
RemainingCapacity()	0x0f	Returns the predicted remaining battery capacity.	mAh	r
FullChargeCapacity()	0x10	Returns the predicted battery capacity when fully charged.	mAh	r
AverageTimeToFull()	0x13	Returns the rolling average of the predicted remaining time until the battery reaches full charge.	minutes	r
ChargingCurrent()	0x14	Returns the battery's desired charging current rate.	mA	r
ChargingVoltage()	0x15	Returns the battery's desired charging voltage.	mV	r
BatteryStatus()	0x16	Returns the battery's status word.	Bit flags	r
ManufacturerName()	0x20	Returns a character array containing the manufacture's name.	string	r
DeviceName()	0x21	Returns a character array that contains the battery's name.	string	r
DeviceChemistry()	0x22	Returns a character array that contains the battery's chemistry.	string	r
ManufacturerData()	0x23	Returns data specific to the manufacture.		r

3.3.6. Battery to Charger Messages

The battery, acting in the role of a bus master, uses the write word protocol to communicate with the charger, operating in slave mode. If the CHARGER_MODE bit in BatteryMode() is clear, the battery will broadcast charger request information at 15-second intervals.

Battery-to-Charger Messages

Function	Command Code	Description	Unit	Access
ChargingCurrent()	0x14	Sends the desired charging current rate to the battery charger	mA	W
ChargingVoltage()	0x15	Sends the desired charging voltage to the battery charger	mV	W

3.3.7. Critical Messages

Whenever the battery detects a critical condition, it takes the role of a bus master and sends AlarmWarning() message to the charger. The battery broadcasts the AlarmWarning() message at 10 second intervals until the critical condition(s) has been corrected.

Battery Critical Messages

Function	Command Code	Description	Unit	Access
AlarmWarning()	0x16	This message is to the host and/or charger to notify them that one or more alarm conditions exist.	Formatted word	W

Alarm Bit Definitions

Hex	Battery Status	Status	Definition
4000	TERMINATE_CHARGE_ALARM	ON	Set when the battery detects that one or more of its charging parameters are out of range.
		OFF	Cleared when the parameters fall back within range.
1000	OVER_TEMP_ALARM	ON	Set when the battery detects that its internal temperature is greater than allowed.
		OFF	Cleared when the battery temperature falls back within acceptable range.
800	TERMINATE_DISCHARGE_ALARM	ON	Set when the battery determines that it has supplied all the charge it can without being damaged.
		OFF	Cleared when the battery reaches a state-of-charge sufficient for it to once again safely supply power.

Status Bit Definitions

80	INITIALIZED	ON	Always
		OFF	
40	DISCHARGING	ON	Battery “Current()” is not positive
		OFF	Battery “Current()” is positive
20	FULLY_CHARGED	ON	Set when the battery determines that it has reached a full charge termination point.
		OFF	Cleared when the battery determines that it can be charged again.
10	FULLY_DISCHARGED	ON	Set when the battery determines that it has supplied all the energy it can.
		OFF	Cleared when”RelativeStateOfCharge()” ≥ 20%.

3.4. Mechanical Specifications

3.4.1. Weight

Approximately 28g, 1 ounce

3.4.2. Mating Connector(s)

The recommended mating connectors for the connectors on the EB478 board:

J1C: DC barrel input connector 6.5mm OD x 3.0mm ID.

J2A: AMP/TYCO 787615-1, 787614-1 and 787613-1.

J3: JST VHR-3N housing with SVH-41T-P1.1 contacts.

J4: Molex 22-01-3027 housing with 08-50-0114 contacts, or a .1” Berg jumper.

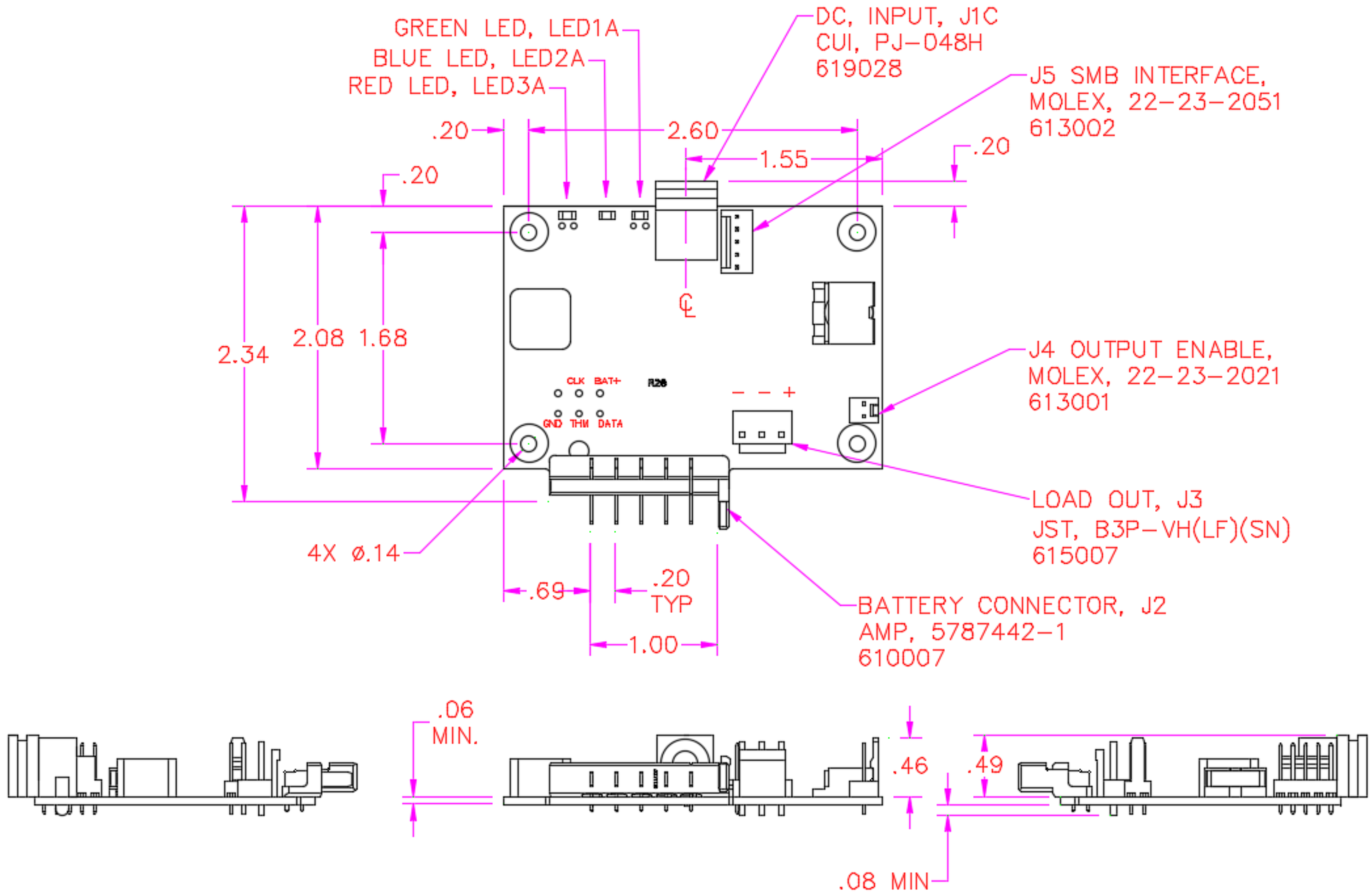
J5: Molex 22-01-3057 housing with 08-50-0114 contacts.

3.4.3. Date Code

A date code sticker will be attached on the back of each charger. The format is identified below:

EBZZZZZ <u>YYWW</u>
P/N___↑ ↑____Manufacturing date

3.4.4. Mechanical Drawing



3.5. Environmental/Safety Specifications

3.5.1. EMC and Safety

The Smart Charger has the following approvals:

- CE EN55032 conducted and radiated emissions
- CE EN55035 immunity
- FCC Part 15 Class B conducted and radiated emissions

3.6. Reliability

3.6.1. Warranty

A high-quality standard is maintained by Inspired Energy. All products are warranted against defects in workmanship, material and construction. The warranty period is one (1) year from the date of shipment from Inspired Energy.