Embeddable Smart Single Battery Charger Specification

Document Number

DS486A

Description

Smart Charger Electronics, With Pass-through, Boost Configuration

Inspired Energy Part Number

EB486A

Statement of Confidentiality

Charger Specification

Specification Number	DS486A
Specification Revision	1.0
Prepared By	KO
Issue date	4/22/21

TABLE OF CONTENTS

1. REVISION HISTORY

Revision	Release Date	Revisions	Issued By	Approved By
0.1	9/24/20	Engineering Release	KO	JAB
1.0	4/22/21	Production Release – Connectors, input spec updated.	KO	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 EB486A Smart Charger assembly. It will handle lithium ion (only) batteries rated up to 28.8V (8 cells).

The EB486A 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 and active monitoring of current reported by the battery compared to the current being sourced from the charger.

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: 10-40V, 60W. The input has reverse polarity protection, and is fused at 8A slow-blow. Charger will shut off below 10VDC.

3.1.2. Power-On-Reset

The LEDs will flash on for 2 seconds 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

J1A pin assignments (also refer to the mechanical drawing for additional details).

Terminal	Legend	Description
1	(+)	10-40V DC input.
2	(-)	DC GND input.

J3C pin assignments (also refer to the mechanical drawing for additional details).

Terminal	Legend	Description
1,2	(+)	10-40V DC output or +Vbattery DC output. This is reverse-current protected.
3,4	(-)	DC GND output.

J5A pins (also refer to the mechanical drawing for additional details).

Terminal	Legend	Description
A1	(+)	DC Positive to battery. This is fused at 25A fast-blow.
1	(-)	DC Negative to battery.
2	(C)	SMBus Clock.
3	(D)	SMBus Data.
4	(THM)	Thermistor (300 ohm) connection to battery.
5	NC	No connection
A2	(-)	DC Negative to battery.

- The SMBus Clock and data lines will be pulled up by the charger to a nominal 5V Vdd. a 15KΩ pull-up resistor is used, but please refer to the SMBus Specification for additional information.

J7A 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

J8A pin assignments (also refer to the mechanical drawing for additional details).

Terminal	Legend	Description
1		Passthrough Enable – (connect to ground to enable passthrough)
2		Ground

J6C 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 Optional +V Input (3-5V)
5		
6		Charge Enable – (connect to ground to disable charging)

3.2. Charger Electronics

3.2.1. Overview of Operation

The 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 1.0 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	10-40V input power is applied.
Battery leakage current consumption	<4.8mA	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 continuously 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 circuitry which has been configured to deliver up to 35 volts and 4 amps, but limited in firmware to 30W. The present voltage and current of the battery are constantly read from the battery every second and compared with the charger voltage and current. Normal charge termination occurs when the battery reaches full charge and begins requesting 0 current and issues the TERMINATE_CHARGE_ALARM warning.

When a 300-ohm resistor is detected on the ‘T’ battery pin, after a 500 mA 0.2 second current pulse an 80mA wake-up current is provided until the battery broadcasts the desired charge voltage and current. If the battery does not respond within 210 seconds, the charger shuts off the wake-up current and indicates an error condition. The battery is charged at constant current until the battery voltage is near the final charge voltage, 4.2V times the number of lithium cells in series. The charger then switches to constant voltage charging.

If either the voltage reported by the battery differs from that measured in the charger by more than 12%, or the battery voltage exceeds the maximum design voltage by 12%, for more than 20 seconds, the charger will shut down and indicate an error condition.

If either the current measured by the charger exceeds the max current requested by the battery by more than 12%, or the battery reports it is receiving more than the maximum design current by more than 12%, for more than 60 seconds, the charger will shut down and indicate an error condition. This function is disabled when the battery is requesting less than 900mA.

Once fully charged, if the battery is left in the charger, the charger will re-initiate charge as requested by the battery. The battery will begin requesting current following a predetermined amount of self-discharge. Batteries can be left connected to the charger indefinitely without harm.

The charger is disabled for input voltages less than 10VDC.

Charge Enable:
J6C-6 controls the charge enable switch. It is modeled as 5V sourced through 1Mohm, with a level below about 1V disabling the charger. There is a 5.6V zener clamp on this pin. When J6C-6 is above 1V, the charger will be enabled. J6C-1 is a ground pin.

3.2.4. Charger Regulation/Measurement Accuracy

3.2.4.1.Voltage

The charge voltage is measured and regulated to ±1.5% of the battery requested value.

3.2.4.2.Current

The charge current is measured and regulated to ±5% of the battery requested value, or 30 mA, whichever is greater.

3.2.5. LED Indication

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

Off:	No Battery
GREEN Flashing:	Charge in process
GREEN Solid:	Charge complete
RED:	Error
BLUE:	Input Voltage >10V Present

Error Conditions:

Smart Charger:	Unsuccessful internal communications, voltage or current delivered is different from that reported by battery or exceeds maximums.
Battery:	No Battery Communications within timeout.

Note: If removing the battery does not clear a Red LED error condition, it may be necessary to momentarily power the charger down to clear this condition.

3.2.6. Output

As an intelligent pass-through design, the higher of the input voltage or the battery voltage is connected to the output connector J3C when J7A-1 is held to ground by the supplied jumper or an external circuit. Paralleling multiple EB486A pcb's together via the outputs is possible as they are ideal diode protected to prevent reverse current. Paralleling multiple EB486A's together will allow for increased combined throughput and/or duration. However, the output is disabled if the battery is either reporting FULLY_DISCHARGED status or is removed and there is no input >10V.

When an input >10V is present, the output up to 60W limited by an 8A fuse is enabled by processor--even when no battery is present, passing the input voltage to the output. Note that cable losses at high currents could cause a low input voltage to drop below 10V, turning the output off again. The battery connector is fused at 25A fast-blow, while the input connector is fused at 8A slow-blow. This board is capable of delivering 20A continuously from the battery.

With passthrough output disabled, a load on the battery output will not change the current provided by the charger to the battery. A load current greater than the charging current will prevent the battery from charging as the current of the battery under load is charge current minus load current. With passthrough output enabled, the current required by the charger plus the output load cannot exceed the 7A limit of the input.

Large, abrupt increases in load current should be avoided when both the battery and input voltage are less than 11V, because of possible stability issues when a large increase in load current causes the input voltage to momentarily dip below the battery voltage or 10V minimum input voltage.

J7A-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 J7A-1 is above 1V, the output will be off in all cases. J7A-2 is a ground pin.

3.2.7. Passthrough Enable

The intelligent passthrough feature can be enabled or disabled via J8A-1. J8A-1 controls the passthrough switch. It is modeled as 5V sourced through 1Mohm, with a level below about 1V enabling the passthrough. There is a 5.6V zener clamp on this pin. When J8A-1 is above 1V, the passthrough will be disabled. J8A-2 is a ground pin.

3.2.8. 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 EB486 board may be configured for a specific application.

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 J6C-1 and J6C-4).
3. SMB Alerts (interrupts) caused by battery alarms.
4. Bidirectional SMB buffering, and active risetime acceleration.

No output will be seen on J6C unless external 3-5VDC is applied to the external pull-ups via J6C-4. A jumper can be installed at R62 (across T11 and T12), which will allow use of the on-board 5V bus. Using this jumper will preclude the use of any logic voltage other than 5V logic.

3.3.4. Initialization Procedure

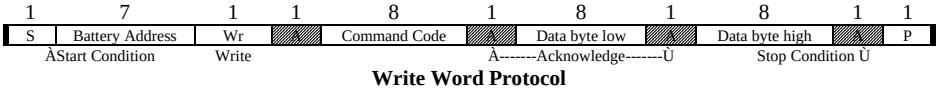
The interface uses a command-based protocol, where the charger processor sends the battery address command byte to the battery pack. The command directs the battery pack to either store the next data received to a register specified command byte or output the data specified by the command byte.

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.



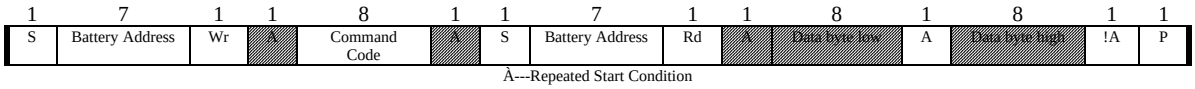
Write Word Protocol

SMBus Host (master) 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.

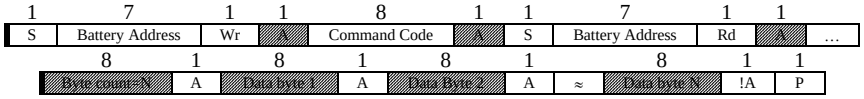


Read Word Protocol

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.



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 °K	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 82.2 grams.

3.4.2. Mating Connector(s)

The recommended mating connectors for the connectors on the EB486A board:

J1A: Standard 3.0mm X 6.5mm barrel jack.

J3C: JST VHR-4N - Connector Housing VH 3.96mm - White

J5A:

a. Amphenol L177TWA7W2S connector shell with female signal pins, Inspired Energy p/n 699018
b. Amphenol L17DM53744-1 40A female solder cup inserts (2 required), Inspired Energy p/n 699019
c. Amphenol L17DTZK15K optional protective backshell, Inspired Energy p/n 699012

Items a & b are available as a kit, Inspired Energy p/n 699020

J6C: 6-pin berg jumper included

J7A: 2-pin berg jumper included

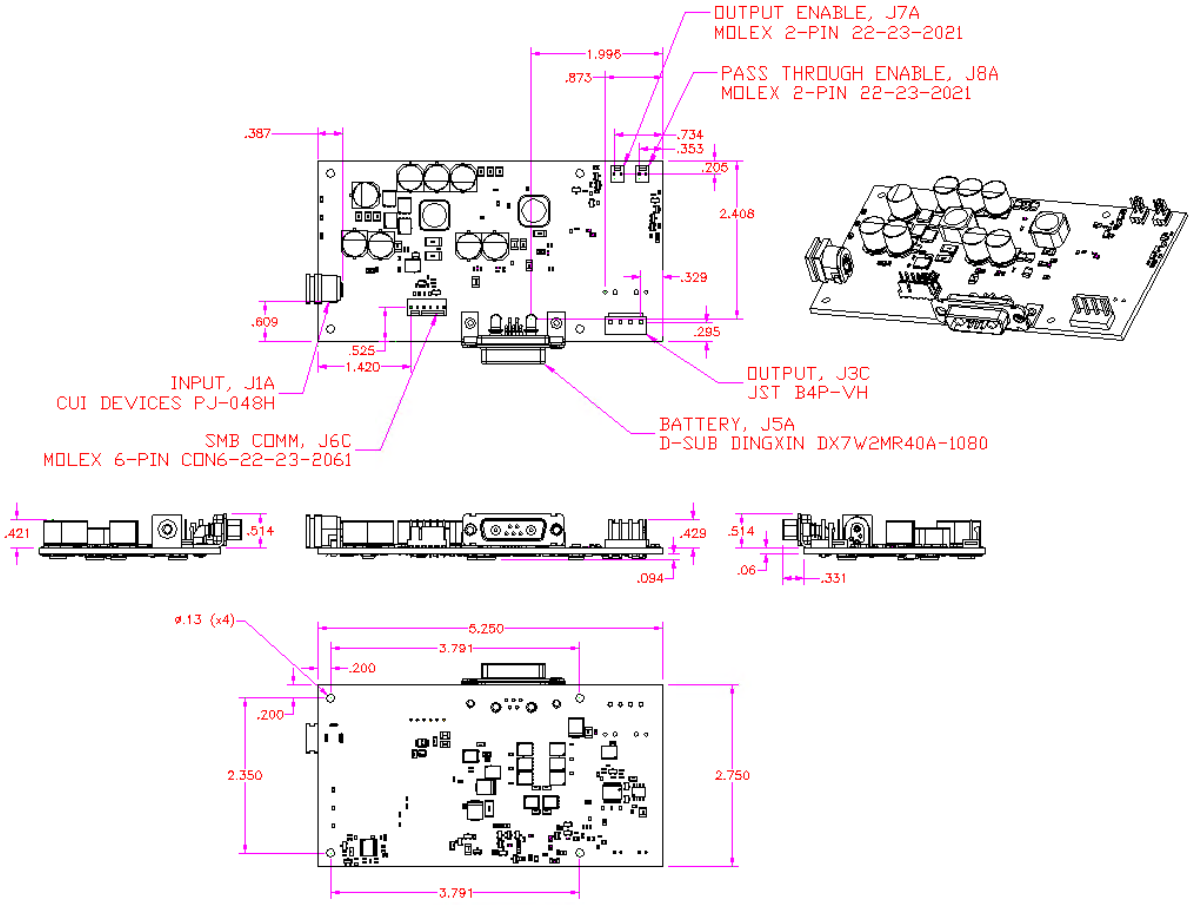
J8A: 2-pin berg jumper included

3.4.3. Date Code

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

EBZZZZZ YYWW
P/N___↑ ↑____Manufacturing date

3.4.4. Mechanical Drawing



Note: All dimensions are in inches.
Drawing shows board with all pads populated

3.5. Environmental/Safety Specifications

3.5.1. EMC and Safety

The Smart Charger has the following approvals:

- CE EN550022 conducted and radiated emissions
- CE EN55024 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.