Embeddable Dual Smart Charger/Power Manager Specification

Document Number

DS310A

Description

Dual Smart Charger with Non-Passthrough Electronics

Inspired Energy Part Number

EB310A

Statement of Confidentiality

Dual Smart Charger Specification

Specification Number	DS310A
Specification Revision	1.1
Prepared By	WRL
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1. REVISION HISTORY

Revision	Release Date	Revisions	Issued By	Approved By
0.1	4/18/10	Preliminary	WRL	
0.3	6/15/10	Correct J5 clock and data	WRL	
1.0	11/15/10	Release, Rev 3 PCB	WRL	
1.1	12/19/12	Rev 5 PCB, PTCs, 14A limit, 2 FD clear, PNG Reset	WRL	

2. INTRODUCTION

2.1. Scope

This specification describes the physical, functional and electrical characteristics of a Dual 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 EB310A Dual Smart Charger assembly.

The EB310A is capable of communicating with both batteries through the System Management Bus (SMBus) and is fully SMBus Rev. 1.1, SBDS Rev. 1.1 and SCDS Rev. 1.1 compliant.

Redundant safety protection is provided by constant communications between the batteries 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.

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: 20-24VDC, 60W minimum. The input has reverse polarity protection, and is fused at 8A slow-blow.

3.1.2. Power-On-Reset

The status LEDs will all turn on for 2 seconds on charger power up.

3.1.3. Operation

Operational Temperature Limits: -10°C to +50°C, ≤ 80%RH, unless otherwise restricted by batteries

3.1.4. Storage

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

The Dual 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	(+)	20-24V DC input. Fused at 8A slow-blow, polarity protected.
2, 3	(-)	DC GND input.

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

Terminal	Legend	Description
1, 2	(+)	+Vbattery DC output.
3, 4	(-)	DC GND output.

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

Terminal	Legend	Description
1	(+)	Output enable signal. Connect to J4-2 to enable output.
2	(-)	Output enable ground return.

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

Terminal	Legend	Description
1		No connection
2		External SMB +V input (3.0 – 5.5VDC)
3		SMB serial data line
4		SMB serial clock line
5		SMB Interrupt line
6		SMB ground return

J6A pins (also refer to the mechanical drawing for additional details).

Terminal	Legend	Description
1A,1B	(+)	DC Positive to battery1. This is fused at 10A slow-blow.
2A,2B	(C)	SMBus1 Clock.
3A,3B	(D)	SMBus1 Data.
4A,4B	(T)	Thermistor/ID pin connection to battery1.
5A,5B	(-)	DC Negative to battery1.

J7C pins (also refer to the mechanical drawing for additional details).

Terminal	Legend	Description
1A,1B	(+)	DC Positive to battery2. This is fused at 10A slow-blow.
2A,2B	(C)	SMBus2 Clock.
3A,3B	(D)	SMBus2 Data.
4A,4B	(T)	Thermistor/ID pin connection to battery2.
5A,5B	(-)	DC Negative to battery2.

- The SMBus Clock and data lines are pulled up to an externally provided voltage on J5-2. 10KΩ pull-up resistors are provided, but please refer to the SMBus Specification for additional information.

4. CHARGER ELECTRONICS

4.1.1. Overview of Operation

The Smart Charger is capable of providing all auxiliary battery functions needed to recharge one or two Smart Batteries.

The charger is capable of communicating with each battery through the System Management Bus (SMBus). A multiplexor (refer to LTC1760 data sheet section 2.1) allows external devices to communicate with the charger or either battery. The charger is fully SMBus and SBDS Revision 1.1 compliant. The charger is implemented as a level III SBS compliant system.

An 8-bit CPU is used to perform operations required for battery monitoring, output control and user display.

Pertinent battery parameters are constantly monitored throughout the charge cycle to ensure 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.

4.1.2. DC Specifications

Parameter	Limits	Remarks
Active current consumption	<15mA	24V input power is applied, power LED on
Battery leakage current consumption, mains off	<400uA	Parasitic leakage current from the batteries when input power has been removed from the charger.
Adder if batteries supply SMB pull-up current, and lines are pulled low externally	1mA	Battery maintains SMB pull-ups (T7 connected to T8)

4.1.3. Charging

During charge, the charger reads the battery status, battery mode, battery current, battery voltage, and battery temperature. The charge control chip is configured to deliver up to 16.8 volts and/or 4 amps (60W Max). The desired charging voltage and current of each battery is requested by the charge control device every second. . Charging will stop if a battery does not respond to its poll. The charger will not charge a battery less than 4.7V.

The batteries are charged in parallel, with one battery receiving all the charge until the battery voltages are equal, then both batteries are charged simultaneously. Normal charge termination occurs when a 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.

4.1.4. Regulation/Measurement Accuracy

4.1.4.1.Voltage

The requested and actual voltage reported by each battery is read once per second, and the charge voltage is incremented in 16mV steps accurate within ±32mV from the actual value reported by the battery, up to the requested battery voltage +512mV. The charge voltage is never allowed to exceed the lower requested battery voltage of the two batteries + 512mV. Note the actual voltage delivered is limited by the requested battery current until the end of the charge cycle.

4.1.4.2.Current

The requested and actual current reported by each battery is read once per second, and incremented in 8mA steps within ±10mA of the actual value reported by the battery, up to the requested battery current + 125mA. The 4A maximum output of the charger is split between the two batteries, with the lower voltage battery receiving proportionally more charge current.

4.1.5. LED Indication

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

PWR Off	No input
PWR BLUE	Input power
BATT1 GREEN Flashing	Battery 1charge in process
BATT1 GREEN Solid	Battery 1 charge complete
BATT1 GREEN off	No battery, or error if red LED also on
BATT2 GREEN Flashing	Battery 2 charge in process
BATT2 GREEN Solid	Battery 2 charge complete
BATT2 GREEN off	No battery, or error if red LED also on
ERR RED	Error

Error Conditions:

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

4.1.6. Output

The higher of the two battery voltages (or from both batteries, if they are the same voltage) is available at connector J3. An ideal diode prevents current flow back into the battery, and disconnects the output unless it is enabled by jumpering J4-1 to J4-2 (ground). This output is not fused, although each battery input is fused at 10A. The batteries will turn off their outputs if the rated battery current is exceeded.

The unit is capable of delivering 14A continuously if two batteries are present.

- Note the output is turned off unless J4-2 is connected to ground (J4-1). The transition should be fully to ground to prevent the output transistors from overheating due to linear operation.
- Note that the maximum current from each battery is battery dependent, and may limit the total output current available.
- Note that this demo unit is intended to draw no more than 2.5A from the 24V input, and charging will stop completely if more than 2.5A is delivered to the input. The output current does NOT affect the input current to the charger.
- Note if batteries of different states of charge are asked to deliver more current than the higher battery alone can deliver, the batteries will shut down on overcurrent. If the load is more than one battery can supply, remove the output enable jumper, add a second battery of equal charge, wait 90 seconds for the first battery to turn on again, then apply the jumper again.
- Note if all batteries present discharge to the point where FULLY_DISCHARGED status is reported, the output is turned off and the batteries will require charging until all batteries present report FULLY_DISCHARGED status is cleared before the charger will allow the batteries to supply the load again.
- It is possible to “hot-swap” batteries, assuming the one battery left in the system can supply the load and is not FULLY_DISCHARGED. The new battery can have FULL_DISCHARGED status without affecting the output.
- If the load exceeds what one battery can support, if the batteries are different ages, out of calibration, etc., at very low charge, it is possible that the batteries will pulse off due to overcurrent for several minutes before both batteries report FULLY_DISCHARGED ant the output stays off.
- If both batteries are FULL_DISCHARGED, or removed, there will be no output at connector J3.
- The output is turned off if the output voltage drops lower than 5.1V.

- If the charger IC detects a POWER_NOT_GOOD fault condition, either overcurrent or low output voltage, it will turn off the output. The output can be enabled again by either applying input current momentarily or powering the board down by removing the batteries. If input power is already on, the output will restore automatically in one second.
- Because of thermal limitations, if more than 10A are drawn from the batteries, the charger will be turned off. If more than 14A are drawn from the batteries for more than about 10 seconds, the output will be turned off for about 60 seconds to allow cooling. The output will turn back on again after this timeout.

4.2. SMBus and SBDS Parameters

4.2.1. Overview of Operations

The Smart Charger is optionally 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 1.1, Dec 11, 1998)
- Smart Battery Data Specification (Rev 1.1, Dec 11, 1998)
- Smart Battery Charger Specification (Rev 1.1, Dec 11, 1998)

4.2.2. Internal 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

4.2.3. Communication Protocol

SMBus Interface complies with SBS Specification Version 1.1. The SMB communicating with the batteries is isolated from the SMB communication with external devices. Depending on desired configuration, the SMB communications port can be modified to offer various combinations of bus translation voltages, pull-ups, and bus isolation including:

1. Simple 5V clock and data with 10K pull-ups on-board (enable by connecting test point T7 to T8).
2. Bus isolation, so that an external device does not disable the communications bus when powered down.
3. Voltage translation, so SMB voltages other than 5V can communicate with the charger (connect external bus voltage between J5-2 and J5-6).
4. SMB Interrupts caused by battery alarms.

The charger uses one port of the SMB interface to poll the batteries at least once per second, and the second port for communication with a charger processor and external devices.

4.2.4. Initialization Procedure

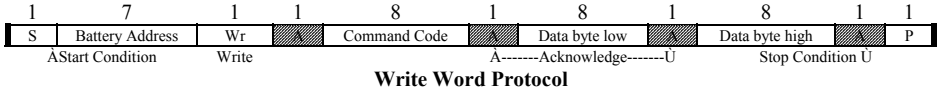
The interface uses a command-based protocol, where the charger or internal processor sends the battery address command byte to the battery pack. The command directs the battery pack to either store the next data received to a register specified command byte or output the data specified by the command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

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

- Write Word
- Read Word
- Read Block

4.2.4.1.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.



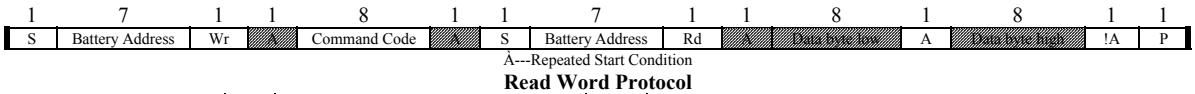
Write Word Protocol

SMBus Host (master) Smart Battery (slave)

4.2.4.2.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.

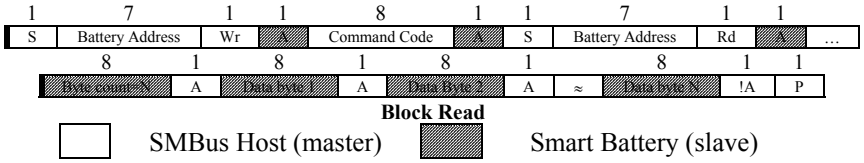


Read Word Protocol

SMBus Host (master) Smart Battery (slave)

4.2.4.3.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.



4.2.5. 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

4.2.6. 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

4.2.7. 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%.

4.2.8. External Device to Charger Messages

The external device, acting in the role of a bus master, uses the write word protocol to communicate with the LTC1760 charger, operating in slave mode. The address for the charger is 0x14.

External Device-to-Charger Messages

Function	Command Code	Description	Unit	Access
BatterySystemState()	0x01	Selects which battery should be connected to the external SMB, 1 or 2	--	R/W
BatterySystemStateCont()	0x02	Read state of charger	--	R/W
Charger Info	0x04	Charger responds with 0x00 83, supporting 2 batteries	--	

4.3. Mechanical Specifications

4.3.1. Weight

Approximately 46 grams, 1.6 ounce

4.3.2. Mating Connector(s)

The recommended interconnection mating connectors:

J1A: DC barrel input connector 5.5mm OD x 2.1mm ID x 9.5mm long. Use CUI PP3-002A cable connector.

J1B: JST VHR-2N housing with SVH-41T-P1.1 contacts

J3: JST VHR-4N housing with SVH-41T-P1.1 contacts

J4: Molex 22-01-3027 housing with 08-50-0114 contacts

J5: Molex 22-01-3067 housing with 08-50-0114 contacts

J6A, J7A, J7C: Tyco/AMP P/N 5787422-1 or 5787446-1.

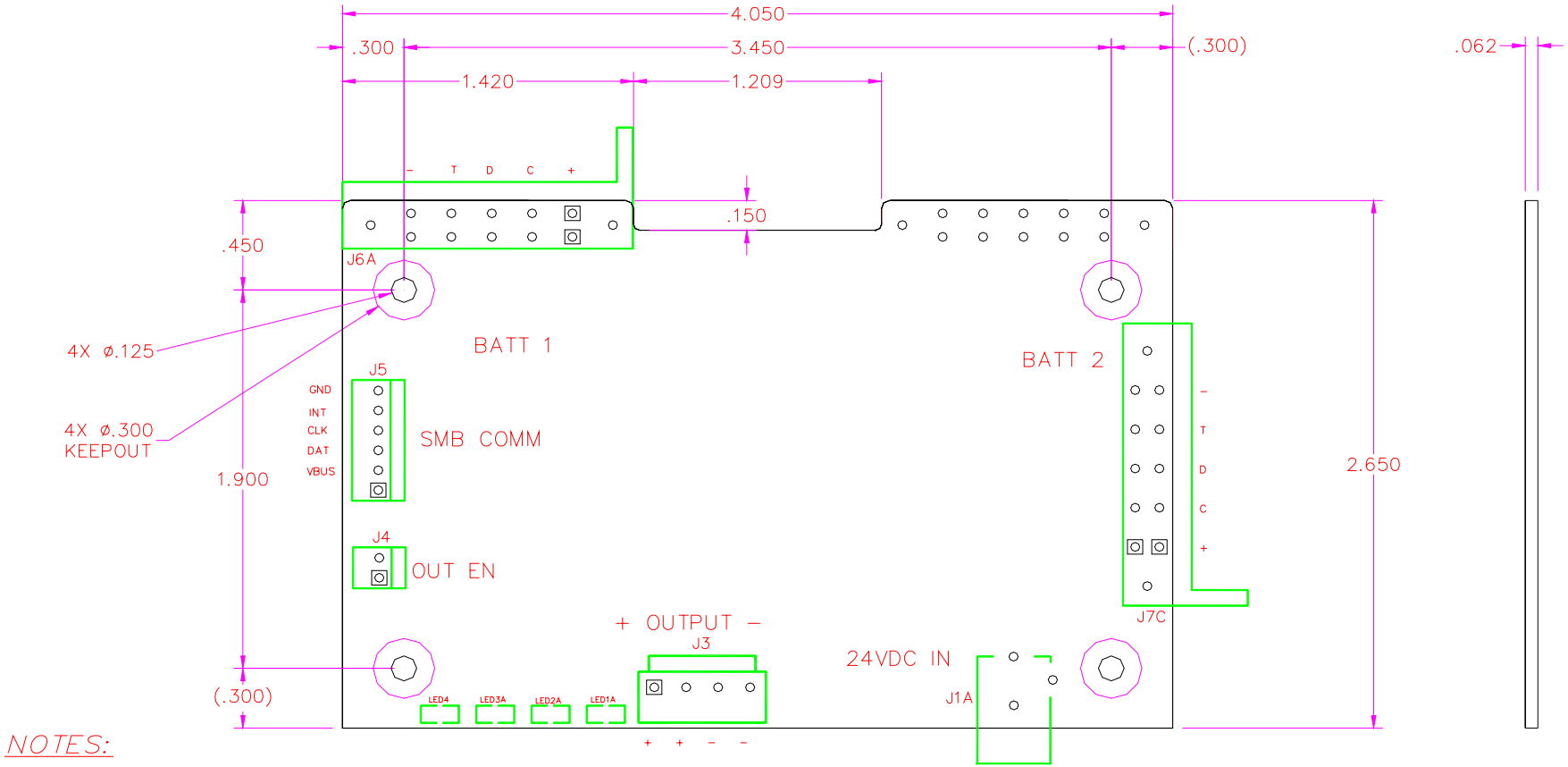
J6B, J7B: JST VHR-5N housing with SVH-41T-P1.1 contacts. Male connector to battery is AMP P/N 5787422-1 or 5787446-1.

4.3.3. Date Code

An identifier/date code sticker will be place on each charger. The format is specified below:

EBZZZAZ.Z D/CYYWWRR
P/N-Rev___↑ ↑Manufacturing year/Week/Revision

4.3.4. Mechanical Drawing



4.4. Environmental/Safety Specifications

4.4.1. EMC and Safety

The Smart Charger has the following approvals:

- CE EN55022 conducted and radiated emissions
- CE EN55024 immunity, including Level 4 ESD
- FCC Part 15 Class B conducted and radiated emissions

4.5. Reliability

4.5.1. 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.