**EVO Main Board Test**

**2023-11-20**

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# Introduction

This document lists critical functions and test of the EVO Main board.

# Battery and Assembly Information

## Battery Details

List information for batteries used for this verification (vendor, part number, capacity, etc.):

|  |  |
| --- | --- |
| **Type** | LiFePO4:  9.6V 6700mAh |
| **Part Num:**  **Vendor:** | C00281-103-EL-IFR26650G2W-3S2P  BST Battery |

## PCA Parts list

|  |  |
| --- | --- |
| **PCA Assembly number and revision:** | P???? Ver B  A??? Rev 01 |

## Firmware Information

|  |  |
| --- | --- |
| **Version:** | 0.9 |
| **File(s):** | ???.bin |
| **Other notes:** |  |

## References

|  |  |
| --- | --- |
| **Schematic:** | ??? rev 1.0 |
|  |  |
|  |  |

## Dates

|  |  |
| --- | --- |
| **Date started:** | 11/20/2023 |
| **Date completed:** | 12/03/2023 |

## Other Notes

# Power supply substitute for battery (select sections)

When indicated, substitute the battery with the following:

1. DC Power Supply rated for 4A 5V minimum.
2. Resistive load of 6.8 ohms rated 5W connected across the power supply output.
3. Plug with wires connected to the power supply terminals. Plug must be compatible with JST p/n B2P-VH-FB-B(LF)(SN).

# Line Latch

1. Adjust the output voltage of the [power supply substitute for battery](#_Power_supply_substitute) to 4.5V.
2. Connect an ammeter in series with the plug and the power supply of the [power supply substitute for battery](#_Power_supply_substitute).
3. Connect the plug of the [power supply substitute for battery](#_Power_supply_substitute) to J1.
4. With no AC applied check the following:

|  |  |
| --- | --- |
| **Description** | **Data/Notes** |
| **Lamps are off:** | Lamps are off |
| **Battery current:** | 353.87 μA (VBATTERY = 4.5004VDC) |

# Full charge and full discharge cycle

## Battery conditioning

Perform battery conditioning before acquiring charge data (next section):

1. Connect B350007 to J1.
2. Apply AC power to the appropriate AC power plug wires.
3. Wait for status LED to indicate steady red.
4. Disconnect AC power.
5. Wait for lamps to turn off.

## Charge Data with 115VRMS at 60Hz

Once the battery has been conditioned per the previous section, do the following:

1. Apply AC voltage set to 115VRMS at 60Hz to the appropriate AC power plug wires.
2. Periodically record the input AC voltage, input power, J1 voltage, current into J1, indicating LED status, and U6 pin 4 voltage in the [following table](#Battery_charge_parameters_B350007). **Input power must be logged at a sample rate of 1 reading per minute for a duration of 2 times the rated charge time.**
3. Save the logged data in the project folder (Compact Emergency Light Project) and note the location of the data file in the following table:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Battery charge parameters:** | |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Date & Time  (Clock) | Charge Duration  (hours) | VAC  RMS | PIN  (W) | VJ4  (DC) | VR28 (2.4Ω)  (DC) | IJ4 (R28)  (DC mA) | Ind.  LED status | VU2 pin 2  (DC) | | 03/29/2023 09:28 | 0 | 0 | 0 | 3.4805 | 0.0001 | 0.0 | Off | - | | 03/29/2023 23:28 | 14 | 115 | 6.2883 | 4.4418 | 0.9335 | 389.0 | Red | - | | 03/30/2023 00:28 | 15 | 114.99 | 6.2863 | 4.4441 | 0.9334 | 388.9 | Red | - | | 03/30/2023 01:28 | 16 | 115 | 6.2906 | 4.4464 | 0.9338 | 389.1 | Red | - | | 03/30/2023 09:28 | rated charge time | 114.99 | 0.454 | 4.2809 | 0.0000 | 0.0 | Green | - | | 03/30/2023 10:28 | rated charge time plus 1 hour | 115 | 0.4538 | 4.2717 | 0.0000 | 0.0 | Green | - | | 03/30/2023 11:28 | rated charge time plus 2 hours | 115 | 0.4532 | 4.2641 | 0.0001 | 0.0 | Green | - | | 03/30/2023 12:28 | rated charge time plus 3 hours | 114.99 | 0.4539 | 4.2572 | 0.0000 | 0.0 | Green | - | | 03/30/2023 13:28 | rated charge time plus 4 hours | 114.99 | 0.4539 | 4.2511 | 0.0000 | 0.0 | Green | - | | 03/30/2023 14:28 | rated charge time plus 5 hours | 115 | 0.4532 | 4.2458 | 0.0001 | 0.0 | Green | - | | 03/31/2023 09:28 | 2 times rated charge time | 115 | 0.4535 | 4.3030 | 0.0000 | 0.0 | Green | - | |
| **Average Maintenance Input Power:** | **0.727W**  Average of the logged input power data from rated charge time to end of acquisition: |
| **Input Power log file location:** | \\EVENLITECADSVR\Engineering Files\Evenlite Engineering\!Engineering Projects Files\Compact Emergency Light Project\2. Electrical Project Files\12. Electrical Test References\Low Power Curve\Firmware Verification\CURVE-9W-SD\_0.61\Curve 9W-Charge.xlsx |

## Discharge Data with AC disconnected

Once the battery has been charged per the previous section, do the following:

1. Disconnect AC power.
2. Record the required data in the [following table](#Battery_discharge_parameters). Use a datalogging system (recommended sample rate of 1 reading per second) for the battery voltage to capture parameters t87.5%NOMINAL (time when battery voltage = 87.5% nominal), and VLVCO (minimum battery voltage). Continue logging battery voltage until the lamps turn off.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Battery discharge parameters** | |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Date & Time (Clock) | Discharge Duration (minutes) | VAC RMS | VJ4  (DC) | IJ4  (DC A) | VR27 (0.1Ω)  (DC) | VR21 (0.1Ω)  (DC) | Ind.  LED status | VJ3  (DC) | VJ2  (DC) | | 03/31/2023 10:28 | 0 | - | 4.2847 | - | 0.000748 | 4.00E-06 | - | 0.0286 | 0.0256 | | 03/31/2023 10:43 | 15 | 0 | 3.6667 | - | 0.11110 | 0.09605 | Off | 2.8937 | 2.868 | | 03/31/2023 10:58 | 30 | 0 | 3.6179 | - | 0.09986 | 0.08481 | Off | 2.8827 | 2.8558 | | 03/31/2023 11:28 | 60 | 0 | 3.5652 | - | 0.09619 | 0.08081 | Off | 2.8778 | 2.8497 | | 03/31/2023 11:43 | 75 | 0 | 3.5355 | - | 0.09621 | 0.08075 | Off | 2.8784 | 2.8497 | | 03/31/2023 11:58 | 90 | 0 | 3.4966 | - | 0.09630 | 0.08082 | Off | 2.8784 | 2.8497 | | 03/31/2023 12:13 | 105 | 0 | 3.4370 | - | 0.09623 | 0.08075 | Off | 2.8784 | 2.8491 | | 03/31/2023 12:28 | 120 | 0 | 3.3295 | - | 0.09630 | 0.08069 | Off | 2.8772 | 2.8497 |  |  |  |  |  | | --- | --- | --- | --- | | Parameter | Date & Time (Clock) | Discharge Duration (minutes) | Value | | t87.5%NOMINAL | n/a | n/a | n/a | | VLVCO | 08/23/2021 10:58:23 | 130.78 | 3.196 | |  |  |  |  | |  |  |  |  | |

# Charge gauge during discharge

To verify that the charge gauge is updated properly during a discharge, charge the battery until full charge is indicated. Apply the discharge conditions below and record the battery current. When the discharge completes, record the remaining chart items.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Discharge Condition** | **Battery current while lamps are on** | **Duration of hi charge after discharge** | **Charge current during hi charge after discharge** | **Notes** |
| **AC turned off for 5 minutes** | 1 min: 2.790A  2 min: 2.771A  3 min: 2.766A  4 min: 2.761A  5 min: 2.770A | 1 hour, 6 min | Start: -455.4mA DC  End: -417.4mA DC  \*See notes | Refer to:  \\EVENLITECADSVR\Engineering Files\Evenlite Engineering\!Engineering Projects Files\Compact Emergency Light Project\2. Electrical Project Files\12. Electrical Test References\Low Power Curve\Firmware Verification\CURVE-9W-SD\_0.61\Curve 9W-Charge Gauge.xlsx |
| **30 second user test** | 10 sec: 2.771A  20 sec: 2.770A  30 sec: 2.768A | 6 min, 49 sec | Start: -426.3mA DC  End: -425.5mA DC  \*See notes |
| **90-minute user test** | 1 min: 2.792A  2 min: 2.789A  3 min: 2.784A  4 min: 2.781A  5 min: 2.631A  \*See notes | 13 hours, 47 min | Start: -483.7mA DC  End: -419.6mA DC  \*See notes |
| **Self-test (can use accelerated schedule)** | 10 sec: 1.600A  20 sec: 1.600A  30 sec: 1.600A | 3 min, 49 sec | Start: -442.6mA DC  End: -441.6mA DC  \*See notes |

# AC thresholds

## Minimum AC Voltage for Charging to Start

|  |  |
| --- | --- |
| **Min. AC voltage to start charging (slow ramp up from 0, record battery voltage when AC = 0)** | 99 VRMS, VBATTERY = 3.7171VDC |

## AC voltage for brownout

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **AC voltage to turn on lamps (slow ramp down from nominal)** | |  |  |  | | --- | --- | --- | | VAC, RMS when lamps turn on | Battery Voltage before lamps turn on | Notes | | 88 VRMS | 4.0062 VDC |  | |

# User Test operation

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | **How to test** | **Verified?** | **Notes** |
| **Insufficient charge indicated – test switch** | Press test switch after LED indicates hi charge after first AC power application | Work as expected | - Blinking red/green |
| **Insufficient charge indicated – infrared remote** | Press “90 Min.” button during hi charge | Work as expected | - Blinking red/green |
| **30 second test duration – test switch** | Press test switch during charge after unit has been charging without interruption for at least 10 minutes | Work as expected | - Test duration: ≈30 sec |
| **30 second test duration – infrared remote** | Press “30 Sec.” button during charge after unit has been charging without interruption for at least 10 minutes | Work as expected | - Test duration: ≈30 sec |
| **90-minute test duration – test switch** | Press and hold test switch for 4 seconds with full charge indicated | Work as expected | - Test duration: ≈90 min |
| **90-minute test duration – infrared remote** | Press “90 minute” button during full charge indication | Work as expected | - Test duration: ≈90 min |
| **Cancel user test with test switch** | Press and hold test switch for 1 second during user test while lamps are on | Work as expected | - |
| **Cancel user test with infrared remote 30 second** | Press “30 Sec.” button during user test while lamps are on | Work as expected | - |
| **Unplugging battery causes unit to go back to charge mode and blink LED** |  | Work as expected | - Blinking twice |

# Self-Diagnostic functions

## Accelerated Self-Test

With the unit set to run self-tests on an accelerated schedule and [power supply substitute for battery](#_Power_supply_substitute), verify the following:

### Program constants

List constants pertinent to the accelerated self test here:

|  |  |  |
| --- | --- | --- |
| **Constant** | **Value** | **Notes** |
| **INITIAL\_SELF\_TEST\_TIME** | **10** |  |
| **SELF\_TEST\_PERIOD** | **20** |  |
| **ST\_RESCHEDULE\_MIN** | **2** |  |
| **UPDATE\_ST\_MIN\_ST\_QSEC** | **229** |  |

List any other notable constants for the accelerated self-test here:

|  |  |  |
| --- | --- | --- |
| **Constant** | **Value** | **Notes** |
| INITIAL\_CHARGE\_GAUGE\_VALUE | **16190000** | NOM\_FULL\_CAPACITY  (900\*450\*4)/10 |
| NOM\_FULL\_CAPACITY | **16200000** |  |
|  |  |  |

### Additional code changes

List additional code changes (if any) here to accommodate the accelerated self test:

### Failure conditions

With the unit programmed to run self-tests on the accelerated schedule determined by the above constants, perform the following:

1. Confirm that the output voltage of the [power supply substitute for battery](#_Power_supply_substitute) is set to 3.8V and connect it to J1.
2. Apply AC power to the appropriate AC power plug wires.
3. Once the status LED of the PCA turns steady red, adjust the output of the [power supply substitute for battery](#_Power_supply_substitute) so that the voltage at J1 is 4.0V.
4. Verify the following:

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | **How to test** | **Detected?** | **Notes** |
| **50% reduction of lamp load** | Disconnect one lamp | Yes | 5 Blinks |
| **Non-functional transfer system** | Short base to emitter of Q2 or Q4 | Yes | 1 Blinks |
| **Reduced battery capacity** | After LED array illuminates, adjust [power supply substitute for battery](#_Power_supply_substitute) so that J1 voltage = 3.1V | Yes | -2 Blinks |

### Self-test reschedule

With the unit programmed to run self-tests on the accelerated schedule determined by the above constants, perform the following:

1. Confirm that the output voltage of the [power supply substitute for battery](#_Power_supply_substitute) is set to 3.8V and connect it to J1.
2. Apply AC power to the appropriate AC power plug wires.
3. Once the status LED of the PCA turns steady red, adjust the output of the [power supply substitute for battery](#_Power_supply_substitute) so that the voltage at J1 is 4.0V.
4. Verify the following:

|  |  |  |
| --- | --- | --- |
| **Description** | **Verified?** | **Notes** |
| **Self-test rescheduled during brownout condition** | Yes | - Disconnect AC 1 min before the test time  - Re-apply AC 1 min after the test time  - Expected test time: 5/17/23 14:09  - Rescheduled to: 5/17/23 14:35 |
| **Self-test rescheduled when brownout occurs during test** | Yes | - Disconnect AC for 30 sec during the test  - Expected test time: 5/18/23 09:18  - Did not reschedule by: 5/18/23 09:28 |
| **Self-test rescheduled during hi charge** | Yes | - Disconnect AC 2 min before the test time  - Re-apply AC for 1 min before the test time  - Expected test time: 5/17/23 15:55  - Rescheduled to: 5/17/23 16:10P |

## User test

### Failure conditions

Initiate a user test pressing the test switch to verify the following:

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | **How to test** | **Detected?** | **Notes** |
| **50% reduction of lamp load** | Disconnect one lamp | Yes | - Blinking 5 times |
| **Non-functional transfer system** | Short base to emitter of Q2 or Q4 | Yes | - Blinking once |

## Emergency mode

Run the unit in emergency mode and verify the following:

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | **How to test** | **Detected/**  **Verified?** | **Notes** |
| **50% reduction of lamp load** | Disconnect one lamp | Yes | - Blinking 5 times |
| **Non-functional transfer system** | Short base to emitter of Q2 or Q4 | Yes | - Blinking once |

## Charge mode

### Failures detecting during charge

Verify the following:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Description** | **How to test** | **Detected?** | **Is indication cleared without test switch when failure condition removed?** | **Notes** |
| **Disconnected battery** | Disconnect battery | Yes | Cleared | Blinking twice |
| **Charger failure** | Short Q1 base emitter | Yes | Cleared | Blinking 3 times |

### Test switch

Verify that pressing and holding the test switch for 1 second will clear failure indications:

|  |  |  |
| --- | --- | --- |
| **Failure indicated** | **Cleared by pressing test switch?** | **Notes** |
| **Reduced battery capacity** | Cleared | After LED array illuminates, adjust [power supply substitute for battery](#_Power_supply_substitute) so that J1 voltage = 3.1V |
| **Lamp failure** | Cleared | Disconnect lamp |
| **Transfer system failure** | Cleared | Short base to emitter of Q2 or Q4 |

## Indication Priority

Create the following failure conditions **in order**. Generate them (except battery and charger failure – initiate these during charge mode) during a user test and **DO NOT CLEAR THE INDICATIONS!** Verify that failure indication priority is maintained (lowest to highest: Lamp failure, Transfer system failure, Battery failure, Charger failure.)

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | **How to test** | **Detected (and priority maintained)?** | **Notes** |
| **50% reduction of lamp load** | Disconnect one lamp | Yes | - Blinking 5 times |
| **Non-functional transfer system** | Short base to emitter of Q2 or Q4 | Yes | - Blinking once |
| **Disconnected battery** | Disconnect battery during charge | Yes | - Blinking twice |
| **Charger failure** | Short Q1 base emitter | Yes | - Blinking 3 times |

# Defeat Monthly Diagnostic Testing option

With a unit programmed with the [Accelerated Test Schedule](#_Accelerated_Self_Test) as noted in [section 8.1](#_Accelerated_Self_Test), perform the following:

1. Remove jumper DD from a unit programmed with the [Accelerated Test Schedule](#_Accelerated_Self_Test) as noted in [section 8.1](#_Accelerated_Self_Test) (Jumpers XC and TD should still be inserted).
2. Confirm that the output voltage of the [power supply substitute for battery](#_Power_supply_substitute) is set to 3.8V and connect it to J1.
3. Apply AC power to the appropriate AC power plug wires.
4. Once the status LED of the PCA turns steady red, adjust the output of the [power supply substitute for battery](#_Power_supply_substitute) so that the voltage at J1 is 4.0V.
5. Verify the following:

|  |  |
| --- | --- |
| **Description** | **Data/Notes** |
| **Self-tests do not run with DD jumper removed** | The unit works normally after a DD jumper was removed.  The self-test is disable |

# Time Delay option

With TD jumper removed (Jumpers XC and DD should still be inserted), charge a unit until full charge is indicated and check the following:

|  |  |
| --- | --- |
| **Description** | **Data/Notes** |
| **Duration lamps stay on after AC reapplied** | The LED stays on for ≈15 minutes after AC has been reapplied |
| **Cycle AC off, on, then off again** | The LED stays on as expected |

# Additional Tests

|  |  |
| --- | --- |
| **Test Description** | **Notes** |
|  |  |