|  |
| --- |
| Students’ Space Association  The Faculty of Power and Aeronautical Engineering  Warsaw University of Technology |
| PW07-wersja-podstawowa  Interface Control Document |
| Electrical Power System |
|  |

September 2017

Issue no. 1

# **Who-Am-I**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Description** | **Expected result** | **Result** | **Pass/Fail** |
| **1** | **Connect OBC with EPS (I2C) via Flatsat PCBs with a 34-pin ribbon cable.** | **Photo.** |  |  |
| **2** | **Connect logic analyzer probes to I2C lines, both PLD and BUS I2C buses.** | **Photo.** |  |  |
| **3** | **Power on EPS via EXTY+ (connect power supply wires to Flatsat PCB’s connector). Setup power supply: 10 V, 0.5 A.** |  |  |  |
| **4** | **Read EPS startup logs.** | **Git revision**  **Git state == CLEAN:** |  |  |
| **5** | **Turn on logic analyzer capture.** |  |  |  |
| **6** | **Send eps hk\_a command to OBC.** | **HK\_A telemetry is printed. No “Error”.** |  |  |
| **7** | **Stop logic analyzer and capture screenshot of transaction (place it in “Result” column).** | **Verify first transaction bytes:**   1. **Start + Write (0x35 + W)** 2. **0x00** 3. **Repeated start (0x35 + R)** 4. **0x61** |  |  |

# **Power cycle counter**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Description** | **Expected result** | **Result** | **Pass/Fail** |
| **1** | **Reflash EPS (make EPS\_A.flash).** | **No errors** |  |  |
| **2** | **Read EPS startup logs.** | **Git revision:**  **Git state == CLEAN:**  **Bootup number == 0**  **Safety counter == 0** |  |  |
| **3** | **Send eps hk\_a command to OBC.** | **CTRL\_A.SAFETY\_CTR == 0**  **CTRL\_A.PWR\_CYCLES == 0** |  |  |
| **4** | **Reboot EPS board at least 200 times.** |  |  |  |
| **5** | **Read EPS startup logs.** | **Git revision:**  **Git state == CLEAN:**  **Bootup number > 200**  **Safety counter == 193** |  |  |
| **6** | **Send eps hk\_a command to OBC.** | **CTRL\_A.SAFETY\_CTR == 193**  **CTRL\_A.PWR\_CYCLES > 200** |  |  |
| **7** | **Reboot EPS. Verify emergency sail deployment sequence at startup.** | **TKMain LCL ON**  **Sail BURN switch ON**  **Voltage on Sail Thermal Knife > 7.00 V** |  |  |
| **8** | **Wait for TBD. Verify emergency sail deployment sequence end.** | **TKMain LCL OFF**  **Sail BURN switch OFF**  **Voltage on Sail Thermal Knife < 0.1 V** |  |  |
| **9** | **Wait for 30 minutes.** | **Note following line on EPS debug port:**  Reset Safety Counter |  |  |
| **10** | **Reboot EPS board and note bootup log.** | **Git revision:**  **Git state == CLEAN:**  **Bootup number > 200**  **Safety counter == 0** |  |  |

# Uptime counter

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Description** | **Expected result** | **Result** | **Pass/Fail** |
| **1** | **Read EPS startup logs.** | **Git revision:**  **Git state == CLEAN:** |  |  |
| **2** | **Reboot EPS board.** | **Bootup sequence printed.** |  |  |
| **3** | **Send eps hk\_a command to OBC.** | **CTRL\_A.UPTIME < 10** |  |  |
| **4** | **Wait for 5 minutes.** |  |  |  |
| **5** | **Send eps hk\_a command to OBC.** | **300 < CTRL\_A.UPTIME < 310** |  |  |

# CTRLA temperatures

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Description** | **Expected result** | **Result** | **Pass/Fail** |
| **1** | **Reboot EPS board.** | **Git revision**  **Git state == CLEAN:** |  |  |
| **2** | **Send eps hk\_a command to OBC.** | **CTRL\_A.TEMP**  **CTRL\_A.SUPP\_TEMP**  **MPPT\_X.TEMP**  **MPPT\_Y\_PLUS.TEMP**  **MPPT\_Y\_MINUS.TEMP**  **DCDC3V3.TEMP**  **DCDC5V.TEMP**  **BATC.TEMP**  **Calculate real temperatures (with conversion formulas from ICD) and compare with actual** |  |  |
| **3** | **Heat up and cool down CTRL\_A.TEMP sensor and ask for HK\_A TM.** | **CTRL\_A.TEMP**  **CTRL\_A.SUPP\_TEMP**  **MPPT\_X.TEMP**  **MPPT\_Y\_PLUS.TEMP**  **MPPT\_Y\_MINUS.TEMP**  **DCDC3V3.TEMP**  **DCDC5V.TEMP**  **BATC.TEMP** |  |  |
| **4** | **Heat up and cool down CTRL\_A. SUPP\_TEMP sensor and ask for HK\_A TM.** | **CTRL\_A.TEMP**  **CTRL\_A.SUPP\_TEMP**  **MPPT\_X.TEMP**  **MPPT\_Y\_PLUS.TEMP**  **MPPT\_Y\_MINUS.TEMP**  **DCDC3V3.TEMP**  **DCDC5V.TEMP**  **BATC.TEMP** |  |  |
| **5** | **Heat up and cool down MPPT\_X.TEMP sensor and ask for HK\_A TM.** | **CTRL\_A.TEMP**  **CTRL\_A.SUPP\_TEMP**  **MPPT\_X.TEMP**  **MPPT\_Y\_PLUS.TEMP**  **MPPT\_Y\_MINUS.TEMP**  **DCDC3V3.TEMP**  **DCDC5V.TEMP**  **BATC.TEMP** |  |  |
| **6** | **Heat up and cool down MPPT\_Y\_PLUS.TEMP sensor and ask for HK\_A TM.** | **CTRL\_A.TEMP**  **CTRL\_A.SUPP\_TEMP**  **MPPT\_X.TEMP**  **MPPT\_Y\_PLUS.TEMP**  **MPPT\_Y\_MINUS.TEMP**  **DCDC3V3.TEMP**  **DCDC5V.TEMP**  **BATC.TEMP** |  |  |
| **7** | **Heat up and cool down MPPT\_Y\_MINUS.TEMP sensor and ask for HK\_A TM.** | **CTRL\_A.TEMP**  **CTRL\_A.SUPP\_TEMP**  **MPPT\_X.TEMP**  **MPPT\_Y\_PLUS.TEMP**  **MPPT\_Y\_MINUS.TEMP**  **DCDC3V3.TEMP**  **DCDC5V.TEMP**  **BATC.TEMP** |  |  |
| **8** | **Heat up and cool down DCDC3V3.TEMP sensor and ask for HK\_A TM.** | **CTRL\_A.TEMP**  **CTRL\_A.SUPP\_TEMP**  **MPPT\_X.TEMP**  **MPPT\_Y\_PLUS.TEMP**  **MPPT\_Y\_MINUS.TEMP**  **DCDC3V3.TEMP**  **DCDC5V.TEMP**  **BATC.TEMP** |  |  |
| **9** | **Heat up and cool down DCDC5V.TEMP sensor and ask for HK\_A TM.** | **CTRL\_A.TEMP**  **CTRL\_A.SUPP\_TEMP**  **MPPT\_X.TEMP**  **MPPT\_Y\_PLUS.TEMP**  **MPPT\_Y\_MINUS.TEMP**  **DCDC3V3.TEMP**  **DCDC5V.TEMP**  **BATC.TEMP** |  |  |
| **10** | **Heat up and cool down BATC.TEMP sensor and ask for HK\_A TM.** | **CTRL\_A.TEMP**  **CTRL\_A.SUPP\_TEMP**  **MPPT\_X.TEMP**  **MPPT\_Y\_PLUS.TEMP**  **MPPT\_Y\_MINUS.TEMP**  **DCDC3V3.TEMP**  **DCDC5V.TEMP**  **BATC.TEMP** |  |  |

# CTRLA Distribution

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Description** | **Expected result** | **Result** | **Pass/Fail** |
| **1** | **Reboot EPS board.** | **Git revision**  **Git state == CLEAN:** |  |  |
| **2** | **Send eps hk\_a command to OBC.** | **DISTR.CURR\_3V3**  **DISTR.CURR\_5V**  **DISTR.CURR\_VBAT**  **DISTR.VOLT\_3V3**  **DISTR.VOLT\_5V**  **DISTR.VOLT\_VBAT**  **Calculate real voltages and currents (with conversion formulas from ICD) and compare with actual ones (measured with DMM)** |  |  |
| **3** | **Increase load on 5V line and note telemetry change.** | **DISTR.CURR\_3V3**  **DISTR.CURR\_5V**  **DISTR.CURR\_VBAT**  **DISTR.VOLT\_3V3**  **DISTR.VOLT\_5V**  **DISTR.VOLT\_VBAT** |  |  |
| **4** | **Increase load on 3.3V line and note telemetry change.** | **DISTR.CURR\_3V3**  **DISTR.CURR\_5V**  **DISTR.CURR\_VBAT**  **DISTR.VOLT\_3V3**  **DISTR.VOLT\_5V**  **DISTR.VOLT\_VBAT** |  |  |

# Battery Pack Temperatures

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Description** | **Expected result** | **Result** | **Pass/Fail** |
| **1** | **Connect dummy Battery Pack.** |  |  |  |
| **2** | **Reboot EPS board.** | **Git revision:**  **Git state == CLEAN:** |  |  |
| **3** | **Send eps hk\_a command to OBC.** | **BP.TEMP\_A**  **BP.TEMP\_B** |  |  |
| **4** | **Heat up and cool down TEMP\_A sensor on Battery Pack.** | **BP.TEMP\_A**  **BP.TEMP\_B** |  |  |
| **5** | **Wait for temperature settle.** |  |  |  |
| **6** | **Heat up and cool down TEMP\_B sensor on Battery Pack.** | **BP.TEMP\_A**  **BP.TEMP\_B** |  |  |

# Battery controller TM

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Description** | **Expected result** | **Result** | **Pass/Fail** |
| **1** | **Connect battery simulator and dummy Battery Pack.** |  |  |  |
| **2** | **Reboot EPS board.** | **Git revision**  **Git state == CLEAN:** |  |  |
| **3** | **Verify proper BP temperatures.** | **BP.TEMP\_A**  **BP.TEMP\_B** |  |  |
| **4** | **Disconnect all loads.** |  |  |  |
| **5** | **Set battery voltage to 8.4 V and check TM.** | **BATC.VOLT\_A**  **BATC.CHRG\_CURR**  **BATC.DCHRG\_CURR**  **Battery current (measured with DMM)** |  |  |
| **6** | **Connect dummy load and check TM.** | **BATC.VOLT\_A**  **BATC.CHRG\_CURR**  **BATC.DCHRG\_CURR** |  |  |
| **7** | **Disconnect all loads.** |  |  |  |
| 8 | **Set battery voltage to 7.5 V and check TM.** | **BATC.VOLT\_A**  **BATC.CHRG\_CURR**  **BATC.DCHRG\_CURR** |  |  |
| **9** | **Enable external solar panel bypass voltage and check charging current.** | **BATC.VOLT\_A**  **BATC.CHRG\_CURR**  **BATC.DCHRG\_CURR** |  |  |

# Controller B supply voltage

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Description** | **Expected result** | **Result** | **Pass/Fail** |
| **1** | **Reboot EPS board.** | **Git revision**  **Git state == CLEAN:** |  |  |
| **2** | **Measure Controller B (ATMega324P) supply voltage.** | **CTRLB.VOLT\_B**  **With DMM** |  |  |
| **3** | **Cause overload on Controller B power rail.** |  |  |  |
| **4** | **Measure Controller B (ATMega324P) supply voltage.** | **CTRLB.VOLT\_B**  **With DMM** |  |  |

# ObcWatchdog

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Description** | **Expected result** | **Result** | **Pass/Fail** |
| **1** | **Reboot EPS and OBC** | **Git revision**  **Git state == CLEAN:**  **Bootup number**  **Safety counter** |  |  |
| **2** | **Verify that OBC is constantly sending “Reset OBC watchdog” command.** | **Look for “**Reset OBC Watchdog” **log line from EPS and write down time difference between two of them.** |  |  |
| **3** | **Disconnect I2C lines between OBC and EPS.** |  |  |  |
| **4** | **Verify warning log from EPS.** | **After 9:30 min following line should appear:**  OBC Watchdog - 30 seconds left |  |  |
| **5** | **Re-connect OBC.** |  |  |  |
| **6** | **Verify that full power cycle haven’t occurred.** | **Following line appeared on EPS logs:** Reset OBC Watchdog |  |  |
| **7** | **Disconnect OBC.** |  |  |  |
| **8** | **Connect oscilloscope to power lines and Power cycle line from AVR. Setup single trigger on falling edge of power line.** |  |  |  |
| **9** | **Wait for 10 minutes.** | **After 9:30 min following line should appear:**  OBC Watchdog - 30 seconds left |  |  |
| **10** | **Check full power cycle execution.** | **Following line should appear:**  OBC Watchdog expired  **Capture oscilloscope screenshot.**  **Verify that all voltage lines dropped.** |  |  |
| **11** | **Wait for EPS reboot and note reboot counters.** | **Bootup number**  **Safety counter** |  |  |

# Powercycle command

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Description** | **Expected result** | **Result** | **Pass/Fail** |
| **1** | **Reboot EPS and OBC** | **Git revision**  **Git state == CLEAN:**  **Bootup number**  **Safety counter** |  |  |
| **2** | **Connect oscilloscope to power lines and Power cycle line from AVR. Setup single trigger on falling edge of power line.** |  |  |  |
| **3** | **Send** eps power\_cycle A **command to OBC** | **Confirm reception on EPS debug port:**  Performing full power cycle on demand.  Performing full power cycle...  **Save additional EPS debug messages.**  **Save oscilloscope screenshot** |  |  |
| **4** | **After reboot, note bootup log** | **Git revision**  **Git state == CLEAN:**  **Bootup number**  **Safety counter** |  |  |

# LCL commands

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Description** | **Expected result** | **Result** | **Pass/Fail** |
| **1** | **Reboot EPS and OBC** | **Git revision**  **Git state == CLEAN:** |  |  |
|  | **Send command to OBC:**  eps hk\_a | DISTR.LCL\_STATE == 0  DISTR.LCL\_FLAGB == 63 |  |  |
| **2** | **Send command to OBC:**  eps enable\_lcl 1  eps hk\_a | **Following line appear on EPS port:**  [LCL] ON TKmain  **Voltage on TKmain rail > 6.5 V**  DISTR.LCL\_STATE == 1  DISTR.LCL\_FLAGB == 63 |  |  |
|  | **Send command to OBC:**  eps disable\_lcl 1  eps hk\_a | **Following line appear on EPS port:**  [LCL] OFF TKmain  **Voltage on TKmain rail < 0.1 V**  DISTR.LCL\_STATE == 0  DISTR.LCL\_FLAGB == 63 |  |  |
|  | **Send command to OBC:**  eps enable\_lcl 2  eps hk\_a | **Following line appear on EPS port:**  [LCL] ON SunS  **Voltage on SunS rail > 3 V**  DISTR.LCL\_STATE == 2  DISTR.LCL\_FLAGB == 63 |  |  |
|  | **Send command to OBC:**  eps disable\_lcl 2  eps hk\_a | **Following line appear on EPS port:**  [LCL] OFF SunS  **Voltage on SunS rail < 0.1 V**  DISTR.LCL\_STATE == 0  DISTR.LCL\_FLAGB == 63 |  |  |
|  | **Send command to OBC:**  eps enable\_lcl 3  eps hk\_a | **Following line appear on EPS port:**  [LCL] ON CamNadir  **Voltage on CamNadir rail > 3 V**  DISTR.LCL\_STATE == 4  DISTR.LCL\_FLAGB == 63 |  |  |
|  | **Send command to OBC:**  eps disable\_lcl 3  eps hk\_a | **Following line appear on EPS port:**  [LCL] OFF CamNadir  **Voltage on CamNadir rail < 0.1 V**  DISTR.LCL\_STATE == 0  DISTR.LCL\_FLAGB == 63 |  |  |
|  | **Send command to OBC:**  eps enable\_lcl 4  eps hk\_a | **Following line appear on EPS port:**  [LCL] ON CamWing  **Voltage on CamWing rail > 3 V**  DISTR.LCL\_STATE == 8  DISTR.LCL\_FLAGB == 63 |  |  |
|  | **Send command to OBC:**  eps disable\_lcl 4  eps hk\_a | **Following line appear on EPS port:**  [LCL] OFF CamWing  **Voltage on CamWing rail < 0.1 V**  DISTR.LCL\_STATE == 0  DISTR.LCL\_FLAGB == 63 |  |  |
|  | **Send command to OBC:**  eps enable\_lcl 5  eps hk\_a | **Following line appear on EPS port:**  [LCL] ON Sens  **Voltage on Sens rail > 4.8 V**  DISTR.LCL\_STATE == 16  DISTR.LCL\_FLAGB == 63 |  |  |
|  | **Send command to OBC:**  eps disable\_lcl 5  eps hk\_a | **Following line appear on EPS port:**  [LCL] OFF Sens  **Voltage on Sens rail < 0.1 V**  DISTR.LCL\_STATE == 0  DISTR.LCL\_FLAGB == 63 |  |  |
|  | **Send command to OBC:**  eps enable\_lcl 6  eps hk\_a | **Following line appear on EPS port:**  [LCL] ON Ants  **Voltage on Antenna rail > 4.8 V**  DISTR.LCL\_STATE == 32  DISTR.LCL\_FLAGB == 63 |  |  |
|  | **Send command to OBC:**  eps disable\_lcl 6  eps hk\_a | **Following line appear on EPS port:**  [LCL] OFF Ants  **Voltage on Antenna rail < 0.1 V**  DISTR.LCL\_STATE == 0  DISTR.LCL\_FLAGB == 63 |  |  |

# LCL overcurrent handling

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Description** | **Expected result** | **Result** | **Pass/Fail** |
| **1** | **Reboot EPS and OBC** | **Git revision**  **Git state == CLEAN:** |  |  |
| **2** | **Send command to OBC:**  eps enable\_lcl 1  eps enable\_lcl 2  eps enable\_lcl 3  eps enable\_lcl 4  eps enable\_lcl 5  eps enable\_lcl 6  eps hk\_a | DISTR.LCL\_STATE == 63  DISTR.LCL\_FLAGB == 63 |  |  |
|  | **Simulate overcurrent on TKmain**  **Send:** eps hk\_a | DISTR.LCL\_STATE == 62  DISTR.LCL\_FLAGB == 62 |  |  |
|  | **Simulate overcurrent on SunS**  **Send:** eps hk\_a | DISTR.LCL\_STATE == 60  DISTR.LCL\_FLAGB == 60 |  |  |
|  | **Simulate overcurrent on CamNadir**  **Send:** eps hk\_a | DISTR.LCL\_STATE == 56  DISTR.LCL\_FLAGB == 56 |  |  |
|  | **Simulate overcurrent on CamWing**  **Send:** eps hk\_a | DISTR.LCL\_STATE == 48  DISTR.LCL\_FLAGB == 48 |  |  |
|  | **Simulate overcurrent on Sens**  **Send:** eps hk\_a | DISTR.LCL\_STATE == 32  DISTR.LCL\_FLAGB == 32 |  |  |
|  | **Simulate overcurrent on Antenna**  **Send:** eps hk\_a | DISTR.LCL\_STATE == 0  DISTR.LCL\_FLAGB == 0 |  |  |

# Thermal Knives switches

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Description** | **Expected result** | **Result** | **Pass/Fail** |
| **1** | **Reboot EPS and OBC** | **Git revision**  **Git state == CLEAN:**  **Bootup number**  **Safety counter** |  |  |
| **2** | **Enable LCLs for TKmain:**  eps enable\_lcl 1  eps hk\_a | DISTR.LCL\_STATE == 1  DISTR.LCL\_FLAGB == 63 |  |  |
|  | **Enable SAIL burn switch**  eps enable\_burn\_switch 1 1 | **Following line appear on EPS port:**  Enable burn switch: SAILmain |  |  |
|  | **Verify main thermal knife for sail voltage** | **Voltage on** SAIL **thermal knife > 6.5 V** |  |  |
|  | **Measure current:**  eps hk\_a | DISTR.CURR\_VBAT  BATC.DCHRG\_CURR  DISTR.LCL\_STATE == 1  DISTR.LCL\_FLAGB == 63 |  |  |
|  | **Wait for 2 minutes** |  |  |  |
|  | **Verify main thermal knife for sail voltage** | **Voltage on** SAIL **thermal knife < 0.1 V** |  |  |
|  | **Measure current:**  eps hk\_a | DISTR.CURR\_VBAT  BATC.DCHRG\_CURR  DISTR.LCL\_STATE == 1  DISTR.LCL\_FLAGB == 63 |  |  |
|  | **Enable SADS burn switch**  eps enable\_burn\_switch 1 2 | **Following line appear on EPS port:**  Enable burn switch: SADSmain |  |  |
|  | **Verify main thermal knife for sail voltage** | **Voltage on** SADS **thermal knife > 6.5 V** |  |  |
|  | **Measure current:**  eps hk\_a | DISTR.CURR\_VBAT  BATC.DCHRG\_CURR  DISTR.LCL\_STATE == 1  DISTR.LCL\_FLAGB == 63 |  |  |
|  | **Wait for 2 minutes** |  |  |  |
|  | **Verify main thermal knife for sads voltage** | **Voltage on** SADS **thermal knife < 0.1 V** |  |  |
|  | **Measure current:**  eps hk\_a | DISTR.CURR\_VBAT  BATC.DCHRG\_CURR  DISTR.LCL\_STATE == 1  DISTR.LCL\_FLAGB == 63 |  |  |

# Overheat submode

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Description** | **Expected result** | **Result** | **Pass/Fail** |
| **1** | **Reboot EPS and OBC** | **Git revision**  **Git state == CLEAN:**  **Bootup number**  **Safety counter** |  |  |
| **2** | **For every sensor in:** CTRL\_A.TEMP  CTRL\_A.SUPP\_TEMP  MPPT\_X.TEMP  MPPT\_Y\_PLUS.TEMP  MPPT\_Y\_MINUS.TEMP  DCDC3V3.TEMP  DCDC5V.TEMP  BATC.TEMP  **Repeat steps 3-7** |  |  |  |
| **3** | **Enable all LCLs:**  eps enable\_lcl 1  eps enable\_lcl 2  eps enable\_lcl 3  eps enable\_lcl 4  eps enable\_lcl 5  eps enable\_lcl 6  eps hk\_a | DISTR.LCL\_STATE == 63  DISTR.LCL\_FLAGB == 63  CTRL\_A.TEMP  CTRL\_A.SUPP\_TEMP  MPPT\_X.TEMP  MPPT\_Y\_PLUS.TEMP  MPPT\_Y\_MINUS.TEMP  DCDC3V3.TEMP  DCDC5V.TEMP  BATC.TEMP |  |  |
| **4** | **Heatup sensor > 70 degrees** |  |  |  |
| **5** | eps hk\_a | DISTR.LCL\_STATE == 0  DISTR.LCL\_FLAGB == 63 |  |  |
| **6** | **Wait for cooldown** |  |  |  |
| **7** | **Disable overheat submode:**  eps disable\_overheat A | **Check for following line in EPS debug port:**  Disable Overheat protection |  |  |
| **8** | **Repeat step 2.** | **For all sensors:**  DISTR.LCL\_STATE == 63  DISTR.LCL\_FLAGB == 63 |  |  |

# Battery heater

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Description** | **Expected result** | **Result** | **Pass/Fail** |
| **1** | **Connect fake battery pack** |  |  |  |
| **2** | **Reboot EPS and OBC** | **Git revision**  **Git state == CLEAN** |  |  |
| **3** | eps hk\_a | BP.TEMP\_A  BP.TEMP\_B  BATC.STATE bit 2 == 0 |  |  |
| **4** | **Check if heater is off** | **Voltage on heater < 0.1 V** |  |  |
| **5** | **Cooldown TMP\_1 sensor on fake battery pack below 0 degrees**  eps hk\_a | BP.TEMP\_A  BP.TEMP\_B  BATC.STATE bit 2 == 0 |  |  |
| **6** | **Check if heater is off** | **Voltage on heater < 0.1 V** |  |  |
| **7** | **Wait for 5 minutes** |  |  |  |
| **8** | **Cooldown TMP\_2 sensor on fake battery pack below 0 degrees**  eps hk\_a | BP.TEMP\_A  BP.TEMP\_B  BATC.STATE bit 2 == 0 |  |  |
| **9** |  | BP.TEMP\_A  BP.TEMP\_B  BATC.STATE bit 2 == 0 |  |  |
| **10** | **Check if heater is off** | **Voltage on heater < 0.1 V** |  |  |
| **11** | **Cooldown both TMP\_1 and TMP\_2 sensors on fake battery pack below 0 degrees**  eps hk\_a | BP.TEMP\_A  BP.TEMP\_B  BATC.STATE bit 2 == 1 |  |  |
| **12** | **Check if heater is on** | **Voltage on heater > 6.5 V** |  |  |
| **13** | **Wait 1 minute**  eps hk\_a | BP.TEMP\_A  BP.TEMP\_B  BATC.STATE bit 2 == 0 |  |  |
| **14** | **Check if heater is off** | **Voltage on heater < 0.1 V** |  |  |

# Battery Charger

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Description** | **Expected result** | **Result** | **Pass/Fail** |
| **1** | **Connect fake battery pack, battery simulator and external power source to simulate solar power** |  |  |  |
| **2** | **Reboot EPS and OBC** | **Git revision**  **Git state == CLEAN** |  |  |
| **3** | **Set battery voltage to 8.4 V** | BP.TEMP\_A  BP.TEMP\_B  BATC.VOLT\_A  BATC.CHRG\_CURR  BATC.DCHRG\_CURR  BATC.TEMP  BATC.STATE |  |  |
| **4** | **Verify that battery is not charging** |  |  |  |
| **5** | **Set battery voltage to 7.9 V** | BP.TEMP\_A  BP.TEMP\_B  BATC.VOLT\_A  BATC.CHRG\_CURR  BATC.DCHRG\_CURR  BATC.TEMP  BATC.STATE |  |  |
| **6** | **Verify that battery is not charging** |  |  |  |
| **7** | **Set battery voltage to 7.5 V** | BP.TEMP\_A  BP.TEMP\_B  BATC.VOLT\_A  BATC.CHRG\_CURR  BATC.DCHRG\_CURR  BATC.TEMP  BATC.STATE |  |  |
| **8** | **Verify that battery is charging** |  |  |  |
| **9** | **Set battery voltage to 7.9 V** | BP.TEMP\_A  BP.TEMP\_B  BATC.VOLT\_A  BATC.CHRG\_CURR  BATC.DCHRG\_CURR  BATC.TEMP  BATC.STATE |  |  |
| **10** | **Verify that battery is charging** |  |  |  |
| **11** | **Set battery voltage to 7.5 V** | BP.TEMP\_A  BP.TEMP\_B  BATC.VOLT\_A  BATC.CHRG\_CURR  BATC.DCHRG\_CURR  BATC.TEMP  BATC.STATE |  |  |
| **12** | **Verify that battery is charging** |  |  |  |
| **13** | **Heat up TMP\_1 > 45 deg C** | BP.TEMP\_A  BP.TEMP\_B  BATC.VOLT\_A  BATC.CHRG\_CURR  BATC.DCHRG\_CURR  BATC.TEMP  BATC.STATE |  |  |
| **14** | **Verify that battery is not charging** |  |  |  |
| **15** | **Wait for TMP\_1 < 35 deg C** | BP.TEMP\_A  BP.TEMP\_B  BATC.VOLT\_A  BATC.CHRG\_CURR  BATC.DCHRG\_CURR  BATC.TEMP  BATC.STATE |  |  |
| **16** | **Verify that battery is charging** |  |  |  |
| **17** | **Repeat steps 13-16 for TMP\_2** |  |  |  |

# Low voltage protection

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Description** | **Expected result** | **Result** | **Pass/Fail** |
| **1** | **Connect fake battery pack, battery simulator and external power source to simulate solar power** |  |  |  |
| **2** | **Reboot EPS and OBC** | **Git revision**  **Git state == CLEAN** |  |  |
| **3** | **Set battery voltage to 7 V** | BP.TEMP\_A  BP.TEMP\_B  BATC.VOLT\_A  BATC.CHRG\_CURR  BATC.DCHRG\_CURR  BATC.STATE |  |  |
| **4** | **Verify isLowBattery is high** | **14 of AVR > 2.5 V** |  |  |
| **5** | **Set battery voltage to 6.5 V** | BP.TEMP\_A  BP.TEMP\_B  BATC.VOLT\_A  BATC.CHRG\_CURR  BATC.DCHRG\_CURR  BATC.STATE |  |  |
| **6** | **Verify isLowBattery is high** | **14 of AVR > 2.5 V** |  |  |
| **7** | **Set battery voltage to 6 V** | BP.TEMP\_A  BP.TEMP\_B  BATC.VOLT\_A  BATC.CHRG\_CURR  BATC.DCHRG\_CURR  BATC.STATE |  |  |
| **8** | **Verify isLowBattery is low** | **14 of AVR < 1 V** |  |  |
| **9** | **Set battery voltage to 6.5 V** | BP.TEMP\_A  BP.TEMP\_B  BATC.VOLT\_A  BATC.CHRG\_CURR  BATC.DCHRG\_CURR  BATC.STATE |  |  |
| **10** | **Verify isLowBattery is low** | **14 of AVR < 1 V** |  |  |
| **11** | **Set battery voltage to 7 V** | BP.TEMP\_A  BP.TEMP\_B  BATC.VOLT\_A  BATC.CHRG\_CURR  BATC.DCHRG\_CURR  BATC.STATE |  |  |
| **12** | **Verify isLowBattery is high** | **14 of AVR > 2.5 V** |  |  |
| **13** | **Heat up TMP\_1 > 60 deg C** | BP.TEMP\_A  BP.TEMP\_B  BATC.VOLT\_A  BATC.CHRG\_CURR  BATC.DCHRG\_CURR  BATC.STATE |  |  |
| **14** | **Verify isLowBattery is low** | **14 of AVR < 1 V** |  |  |
| **15** | **Wait for cooldown** | BP.TEMP\_A  BP.TEMP\_B  BATC.VOLT\_A  BATC.CHRG\_CURR  BATC.DCHRG\_CURR  BATC.STATE |  |  |
| **16** | **Verify isLowBattery is high** | **14 of AVR > 2.5 V** |  |  |
| **17** | **Repeat steps 13-16 for TMP\_2** |  |  |  |