EPS initial status at first AOS and Battery charging
File: H_LEO_EPS_BATF.xls
Author: E. Picallo

Procedure Summary

Objectives

This procedure describes to verify the initial status of the Power Subsystem (PCDU mode) at first AOS and the battery charging.

Summary of Constraints

Spacecraft Configuration

Start of Procedure

CDMU in default configuration.
DoD with a nominal launch time = 52% DoD (48% SoC) = 23.3 Vbatt

End of Procedure

CDMU in default configuration.
Battery fully charged (100% SoC) = 25.4 Vbatt

Reference File(s)

Input Command Sequences

Output Command Sequences

Referenced Displays

ANDs	GRDs	SLDs
ZAZ7H999	ZGA04999	(None)
	ZGA07999	

Configuration Control Information

DATE	FOP ISSUE	VERSION	MODIFICATION DESCRIPTION	AUTHOR	SPR REF
24/11/08	2	1	Created	E. Picallo	
03/03/09	2.1	2	Time to Battery end of charge addded verifitcation of battery temperature added	E. Picallo	

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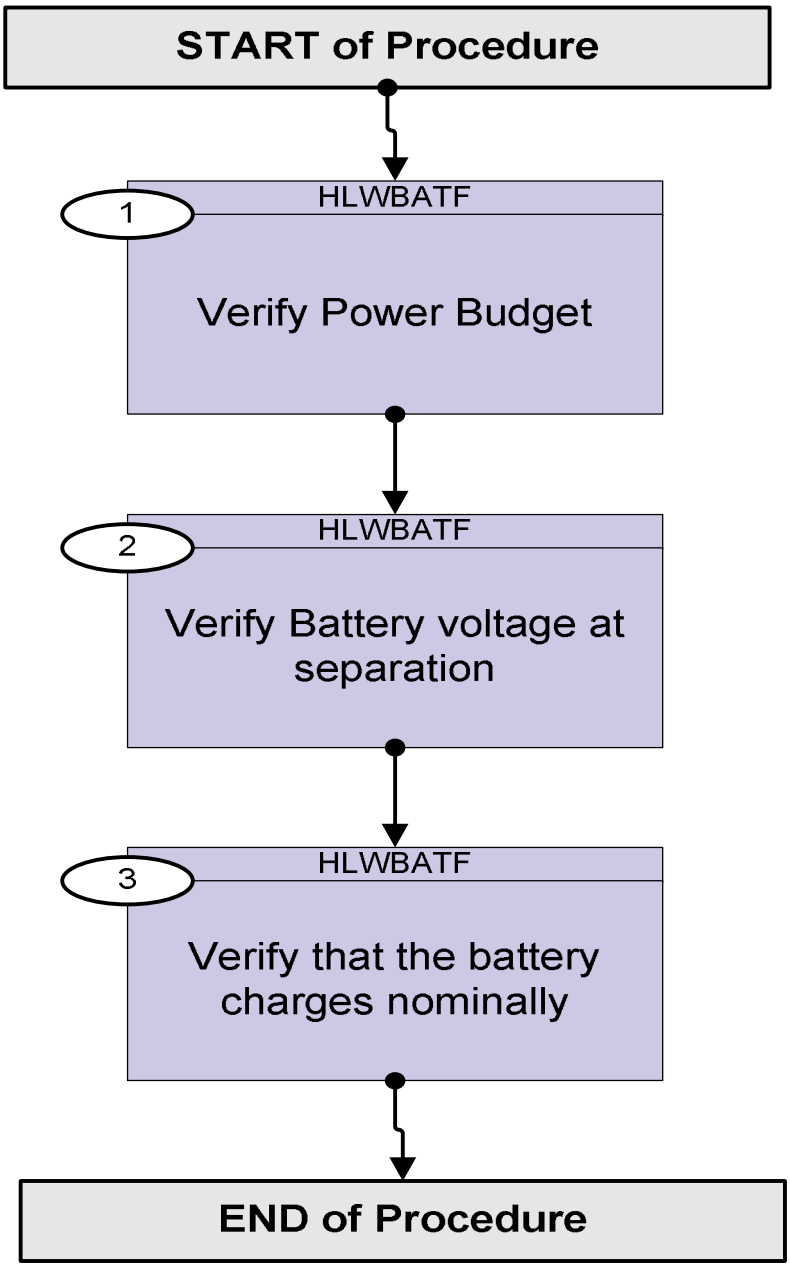
Procedure Flowchart Overview



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Step No.	Time	Activity/Remarks	TC/TLM	Display/ Branch
		Beginning of Procedure		
		TC Seq. Name :HLWBATF (EPS AOS & Bat.charge) EPS initial status at first AOS and Battery charging *TimeTag Type: N* *Sub Schedule ID:*		
1		*Verify Power Budget*		Next Step: 2
1.1		*Verify Bus voltage telemetries*		
		Verify Telemetry **TM1_VBUS WMT06565**	**>= 28.0 V <= 28.36 V**	AND=ZAZ7H999
		Verify Telemetry **TM2_VBUS WMT07565**	**>= 28.0 V <= 28.36 V**	AND=ZAZ7H999
1.2		*Verify total solar array current through SUNs module*		
		Verify Total solar array current through SUN1 **TM_ISA_S3R_1 WMT14565**	**> 18.8 A**	AND=ZAZ7H999
		Verify Total solar array current through SUN2 **TM_ISA_S3R_2 WMT15565**	**> 18.8 A**	AND=ZAZ7H999
		Verify Total solar array current through SUN3 **TM_ISA_S3R_3 WMT16565**	**> 18.8 A**	AND=ZAZ7H999
		Expected SA power 1700W = 56.6 A (full exposition i.e. SAA = 0 deg).		
1.3		*Verify Sun vector and Solar aspect angle*		
		Check stability of SA power and Solar Aspect angle.		
		Verify Telemetry **Sunvector X BRF AEUVX001**	**approx. 0**	GRD=ZGA04999
		Verify Telemetry **Sunvector Y BRF AEUVY001**	**approx. 0**	GRD=ZGA07999
		Verify Telemetry **Sunvector Z BRF AEUVZ001**	**approx. 1**	GRD=ZGA07999
		Verify Telemetry **Sun asp angle AESAN002**	**< 1 degree**	(None)

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Step No.	Time	Activity/Remarks	TC/TLM	Display/ Branch
1.4		*Verify BDRs output current*		
		Verify BDR1 output current telemetry **TM_IOUT_BDR1 WMT08565**	**approx. 0**	AND=ZAZ7H999
		Verify BDR2 output current telemetry **TM_IOUT_BDR2 WMT09565**	**approx. 0**	AND=ZAZ7H999
1.5		*Verify total current of all distribution lines*		
		Verify Telemetry **ILOAD_EXT XD031992**		AND=ZAZ7H999
1.6		*Verify battery charge current*		
		Each TM gives the total battery charge current		
		Verify Battery charge current through BDR1 Telemetry **TM_Icharg1 WMT10565**	**< 5.6 A**	AND=ZAZ7H999
		Verify Battery charge current through BDR2 Telemetry **TM_Icharg2 WMT11565**	**< 5.6 A**	AND=ZAZ7H999
1.7		*Verify Vmea voltage*		
		Verify MEA voltage 1 Telemetry **TM1_MEA_S3R_BDR WMT04565**	**< 20.76 V** **> 8.8 V**	AND=ZAZ7H999
		Verify MEA voltage 2 Telemetry **TM2_MEA_S3R_BDR WMT05565**	**< 20.76 V** **> 8.8 V**	AND=ZAZ7H999
		The PCDU in "Sunlight" mode, detected by the MEA value. **When 8.883V < VMEA < 20.76 then PCDU is in sunlight mode; SA power is sufficient to supply the bus load (PCDU internal consumption + external load) and to charge the battery if needed.** **The BDRs don't supply the bus; their output power as well as the battery discharge current must be zero.**		
		Verify the Power balance: **ISA + IOUT_BDR > ILOAD_EXT + ICHG + IPCDU_INT** **Where:** **IPCDU_INT = 33W = 1.17A** **IOUT_BDR = 0 A**		

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Step No.	Time	Activity/Remarks	TC/TLM	Display/ Branch
2		*Verify Battery voltage at separation*		Next Step: 3
		Verify Battery voltage from BDR1 Telemetry **TM_VBATT_BDR_1 WMT02565**	**>= 23.3 V**	AND=ZAZ7H999
		Verify Battery voltage from BDR2 Telemetry **TM_VBATT_BDR_2 WMT03565**	**>= 23.3 V**	AND=ZAZ7H999
		From the Herschel Power budget the battery DoD with a nominal launch time = 52% DoD (48% SoC) = 23.3 Vbatt **Note: 52% DoD considering ESA margins and 41% without ESA margins**		
		This means to recahrge the battery is necessary to provide 52% of 36AHr = 18.72 Ahr or 14.76 Ahr (without margin). **If the default battery EoC level is selected (EoC high) then the battery will be charged using 3 Solar Array sections until the battery voltage = 25.23V (which corresponds to about 98% charged battery), i.e there will be a total of 5.6A from the 3 S/A sections and so the battery will be 98% charged in under 3 Hrs.**		
		The remaining charge from 98% to 100% SoC is as follows: **Charge until Vbatt = 25.32V = 99% charge of battery, the charger will use 2 S/A sections, a total of 3.7A** **and finally the last 1% from 25.32 until 25.4V will be achieved using 1 S/A section and the maximum current will be 1.8A but this will be tapered down to almost 0 as the Vbatt approaches 25.4V**		
2.1		*Verify programmed EoC level*		
		Verify Battery end of charge level Telemetry **EoC_Level_STS WMT1D565**	**= High (25.4V)**	AND=ZAZ7H999
3		*Verify that the battery charges nominally*		Next Step: END
3.1		*Verify that the battery voltage increases*		
		Verify Battery voltage from BDR1 Telemetry **TM_VBATT_BDR_1 WMT02565**	**>= 23.3 V** **<= 25.4 V**	AND=ZAZ7H999
		Verify Battery voltage from BDR2 Telemetry **TM_VBATT_BDR_2 WMT03565**	**>= 23.3 V** **<= 25.4 V**	AND=ZAZ7H999

Step No.	Time	Activity/Remarks	TC/TLM	Display/ Branch
		When Vbatt = 25.4V A a fully charged Battery (36AHr) condition has been reached. **The battery shall be 98% charged after ~3 hours.**		
3.2		*Verify battery charge current decreases*		□
		Verify Battery charge current through BDR1 Telemetry **TM_Icharg1 WMT10565**	**>= 0.0 A** **< 5.6 A**	AND=ZAZ7H999
		Verify Battery charge current through BDR2 Telemetry **TM_Icharg2 WMT11565**	**>= 0.0 A** **< 5.6 A**	AND=ZAZ7H999
		Note: When the battery reaches EoC = 25.4 Vbat, the BCR3 ensures battery taper charge. The taper charge current maximun value is 2.2 mA.		
3.3		*Verify battery temperature during the recharge period*		□
		Verify Telemetry **BATTERY_TEMP_1 WMB01568**		AND=ZAZ7H999
		Verify Telemetry **BATTERY_TEMP_2 WMB02568**		AND=ZAZ7H999
		Verify Telemetry **BATTERY_TEMP_3 WMB03568**		AND=ZAZ7H999
		Verify Telemetry **BATTERY_TEMP_4 WMB04568**		AND=ZAZ7H999
3.4		*Verify BCRs current limitation activation*		□
		When Vbat < EoC => BCR Saturated mode (ISA charges the battery). **When EoC is reached => BCR works as a Current Limiter (the 3 BCRs will sequentially decrease to 0 the current to the battery, except for the last one which ensures linear DC tapering)** **The BCRs current limitation thresholds for Battery EoC high = 25.4 V are:** **BCR1 current limitation threshold = 25.23V** **BCR2 current limitation threshold = 25.32V** **BCR3 current limitation threshold = 25.40V**		
		Verify BCR1 current limitation status @ 25.23 Vbat **BCR1_LIM_STS WMT1E565**	**= ACTIVE**	AND=ZAZ7H999

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Step No.	Time	Activity/Remarks	TC/TLM	Display/ Branch
		Verify BCR2 current limitation status @ 25.32 Vbat **BCR2_LIM_STS** **WMT1F565**	**= ACTIVE**	AND=ZAZ7H999
		Verify BCR3 current limitation status @ 25.40 Vbat **BCR3_LIM_STS** **WMT1G565**	**= ACTIVE**	AND=ZAZ7H999
		End of Procedure		