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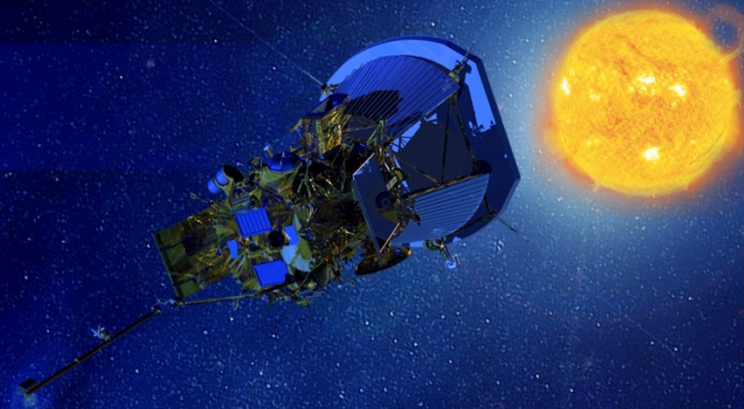

SPP Spacecraft Emulator (SCE) Requirements Peer Review

Sam Sawada
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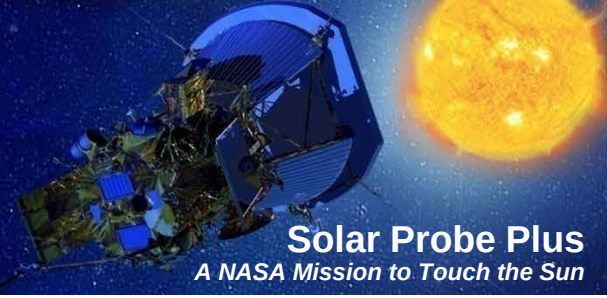
June 27, 2013

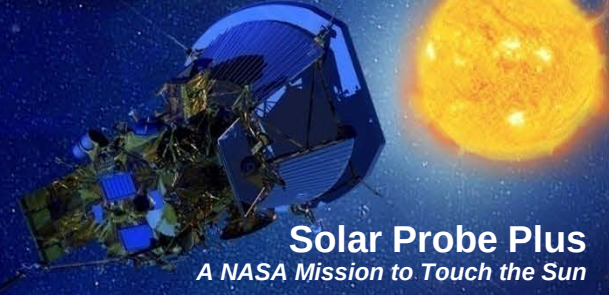
APL
The Johns Hopkins University
APPLIED PHYSICS LABORATORY

Agenda



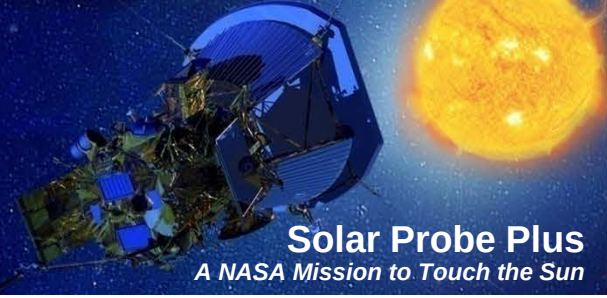
- Staffing
- Purpose/Goal of Review
- Timeline (Emulator Development)
  - Results of SCE Tag Up MTG w/Instrument Teams on 6/21/13
- Emulator Status Requirements Flow
- Emulator Overview
  - Differences between Mini Emulator and Full Emulator
  - SPP Mini-Emulator Block Diagram
  - SPP Full-Emulator Block Diagram
  - SPP Emulator Updates
- Requirement Document Review (Walk Thru Page by Page)
- Conclusion
- Back Up Slides

SCE Staffing



- **SPP SC Emulator Development Team**
- **Sam Sawada, SPP Emulator Lead, Samuel.Sawada@jhuapl.edu**
- **Mike Furrow, SPP Mission Systems Software Lead, Mike.Furrow@jhuapl.edu**
- **Martha Kusterer, SPP SOC Lead, Martha.Kusterer@jhuapl.edu**
- **Thomas Hauck, GSEOS, hauck@gseos.com**
- **Harry Eaton, Embedded SW**
- **Doug Wenstrand, FPGA Design**
- **Geff Ottman, Engineering Support, Geffrey.Ottman@jhuapl.edu**
- **Other Contributors**
  - **Additional Emulator Weekly Meeting Team Members**
    - **Joe Sheehi (RBSP Emulator Lead)**
    - **Alan Mick (Data Systems Engineering)**
    - **John Hayes (WISPR DPU/ISIS-EPI-Lo)**

Purpose of Review

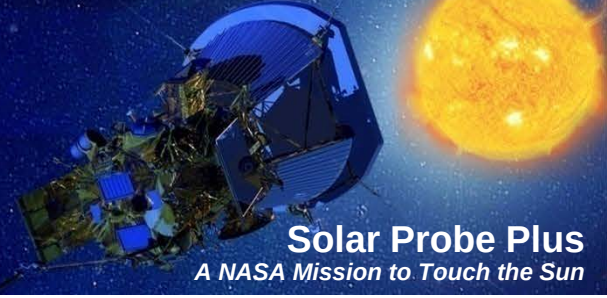


- **Primary Purpose:**
  - **Finalize requirements for FULL Emulator, specifically those related to physical interfaces to the instrument**
- **Secondary Purpose:**
  - **Discuss GSEOS Requirements, Embedded Software Requirements**
  - **APL Independent Reviews**
    - **RBSP Emulator Lead**
      - **Joe Sheehi**
    - **SPP Instrument Emulators Leads for Avionics HW testing**
      - **Taylor Green**
      - **Dave Stott**
      - **Andrew Harris**

Timeline (Emulator Development)

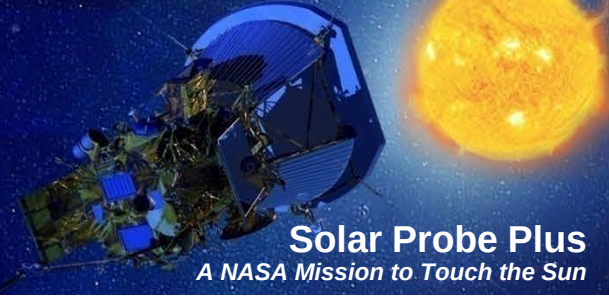
- **FEB 2013** — **SCE Emulator Intro Review w/Instrument Teams**
- **APR 2013** — **Mini Emulator Schematic Review**
- **MAY 2013** — **DRAFT Emulator Requirements Doc Completed**
- **JUN 12, 2013** — **Mini Emulator PWAs Testing completed**
- **JUN 20, 2013** — **Start Mini Emulator Deliveries**
- **JUN 20, 2013** — **Start Support of Mini Emulator Deliveries**
- **JUN 21, 2013** — **SCE Tag Up MTG w/Instrument Teams**
- **JUN 27, 2013** — **Emulator Requirements Peer Review**
- **DEC 2013** — **Start Full Emulator Design**
- **FEB 2014** — **Emulator Design Peer Review**
- **April 2014** — **Start Full Emulator Deliveries**
- **April 2014** — **Start support of Full Emulator Deliveries**

SCE Tag Up Meeting with Instrument Team - Results



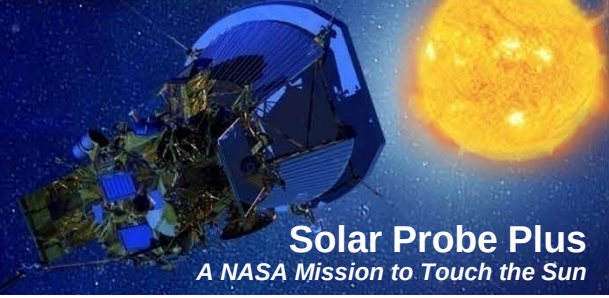
- **Held a "Pre-Emulator Requirements Review" Meeting with the Instrument team on 6/21/13**
- **Issues Discussed/Resolution**
  - **Item #1: Instrument Team requested to Baseline Linux, Emulator baseline is Windows-7**
    - **All instrument teams say they are okay with Windows, however, WISPR and EPI Hi says they prefer Linux (ie. Windows prone to reduced performance during Windows updates, & reboot issues). Also favor Linux for long term OS platform solution.**
    - **Action: Elena Adams to Work with Martha Kusterer, SPP SOC Lead and Mike Furrow, SPP Mission Systems Software Lead to update GSEOS SOW to exercise the Linux OS option. (Additional Cost). If accepted, Emulator would be compatible with both Windows and Linux OS platforms and Instrument team can choose desired OS to use. Instrument teams to justify need and document request in email.**

SCE Tag Up Meeting with Instrument Team - Results



- **Issues Discussed/Resolution**
  - **Item #2: Seems none of the Instrument teams use the Full Emulator Internal 30V power supply used for Instrument power outputs and Aux power outputs (ie., Heater/Actuator outputs). They all use an external power supply. FIELDS in particular would like to have the power supply removed or turned off to reduce power supply switching noise coupling to data signals.**
    - **FIELDS would also use their own EGSE for Power switching circuits.**
    - **Other Instruments would still use the Emulator internal power switching circuits (FETS).**
    - **Options:**
      1. **Remove Internal 30V Power Supply from the design.**
      2. **Add a switch so that the 30V Power Supply can be turned off.**
         1. **Action: Emulator Team's choice to implement the easiest/design generic option.**
      3. **Note: GSEOS SW supports GPIB device drivers using external USB/GPIB converter HW, allowing control of external power supply.**

Emulator Status

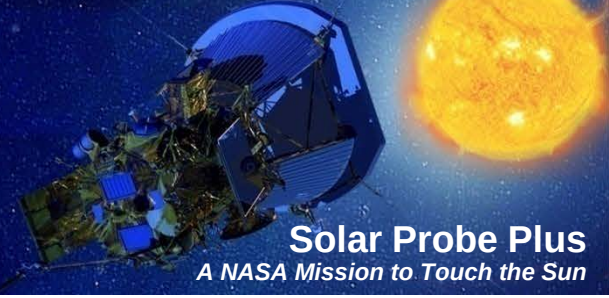


- **Mini Emulator Hardware Status**
  - **16 boards are assembled/tested – 6/12/13**
  - **16 Emulator Front/Rear panels engraved – 6/19/13**
  - **1st Delivery to Instrument teams completed on 6/20/13**
    - **Purpose for Mini Emulators**
      - **Familiarize users with GSEOS and Emulator**
      - **Improve and fix issues with the Emulator and GSEOS early**
      - **Determine issues about customization early**

- **SPP Embedded Software Status**
  - **UART Release 0 will be ready for delivery, ~ 6/25/13**
  - **SpaceWire Release 0 will be ready for delivery, ~ 7/31/13**

- **SPP GSEOS Software Status**
  - **UART Release 0 will be ready for delivery, ~ 6/25/13**
  - **SpaceWire Release 0 will be ready for delivery, ~ 7/31/13**

Emulator Requirements Flow



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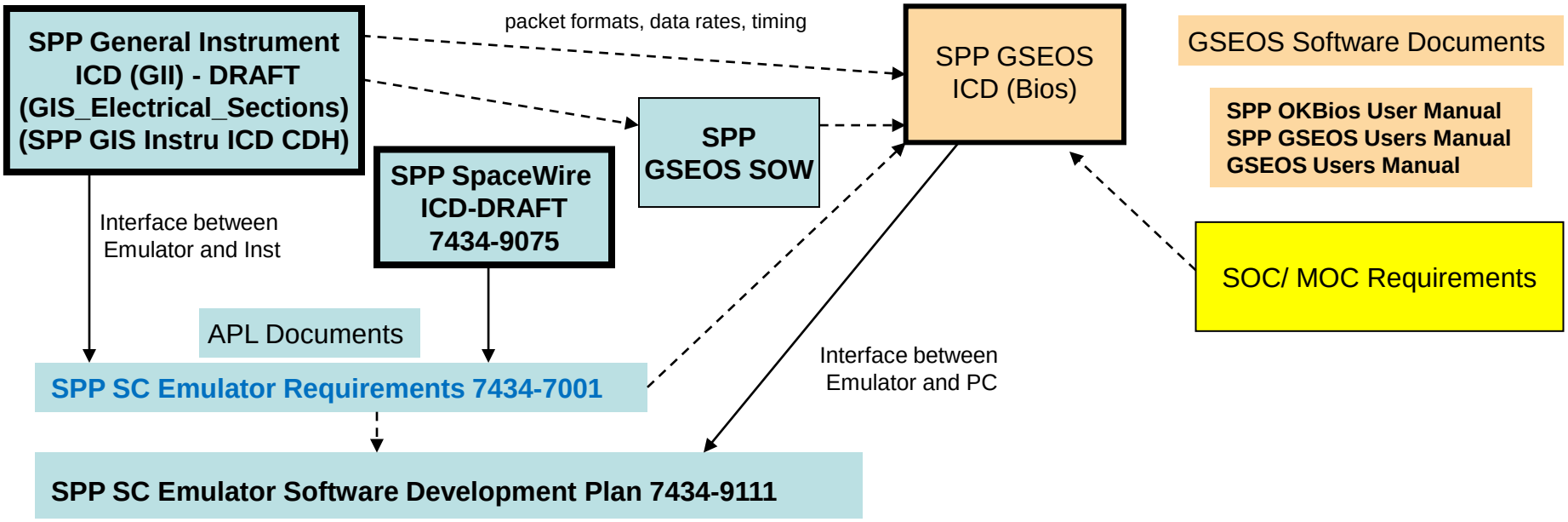
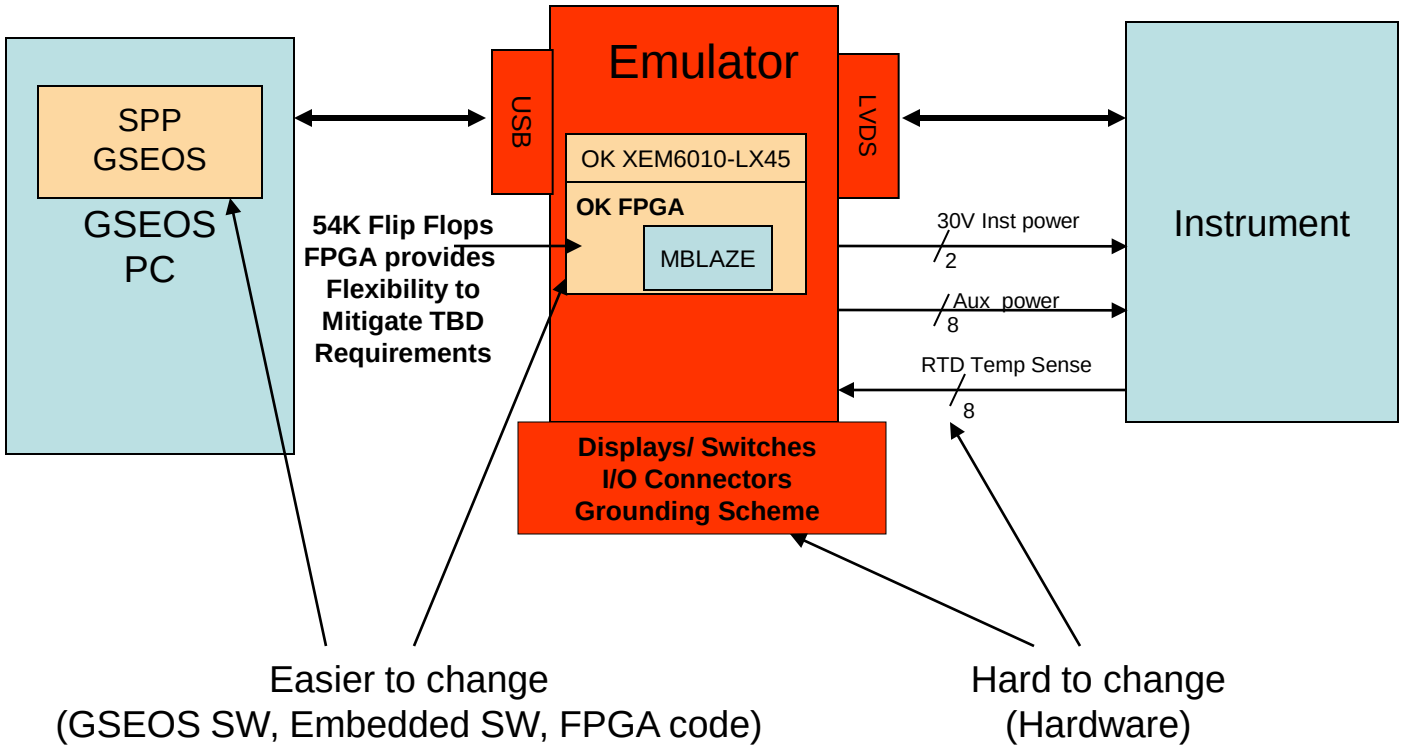


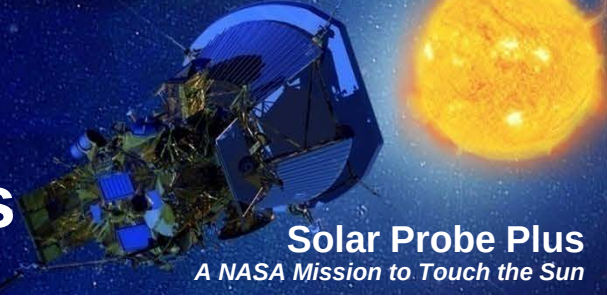
NOTES

- **Emulators are typically designed far in advance of S/C, Instruments and ground systems.**
- **Requirements process needs to be ITERATIVE since relevant ICD's are still changing**
- **Mitigation**
  - **The SPP Emulator design provides maximum flexibility since most of its functionality is in the FPGA and Microblaze processor.**
  - **11 Mini-Emulators to be delivered early to better determine future requirements / issues.**
  - **APL's experience with Emulator design: we are re-using best parts of prior emulators (RBSP, New Horizons, Messenger)**
  - **APL's experience with GSEOS**

Emulator Requirements Flow (Continued)



Differences: Full vs. Mini Emulators



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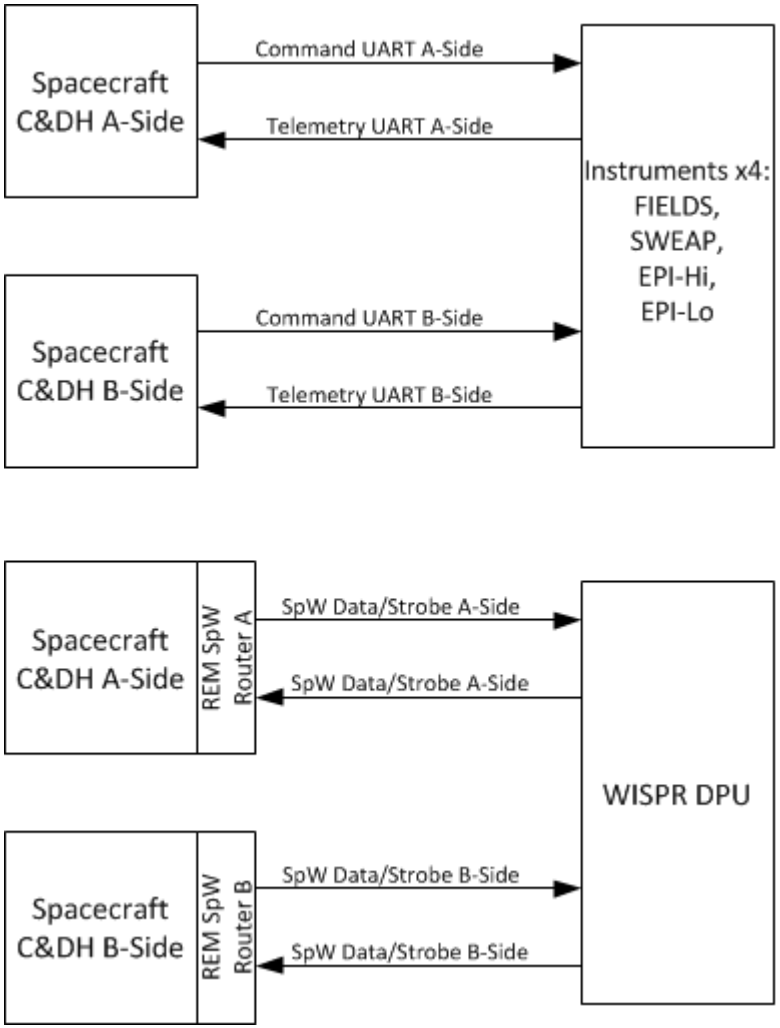
Capability	Full Emulator		Mini-Emulator
Instrument CMD/TLM (UART/SpW) (A/B) Interface	YES		YES
1PPS/PPS_Gated Interface (Instr EGSE IF)	YES		YES
USB Interface to PC (Opal-Kelly) (Note: USB Power not used)	YES		YES
External 5V Input for Internal Emulator Logic	NO		YES
External AC Input for Internal Emulator Logic (AC/DC converters)	YES		NO
Optical Isolation	YES		NO
30V Power OUTPUTS (10)	YES		NO
Temperatures (8)/Voltage/Current Sensors	YES		NO
EXT 30V SC BUS Power Supply Input/ Internal 30V SC BUS Power Supply	YES		NO
Rack Mount	YES (5”H x 19”W x 14”D		NO (1”H x 5”W x 7”D)

SPP Instrument Data Interfaces



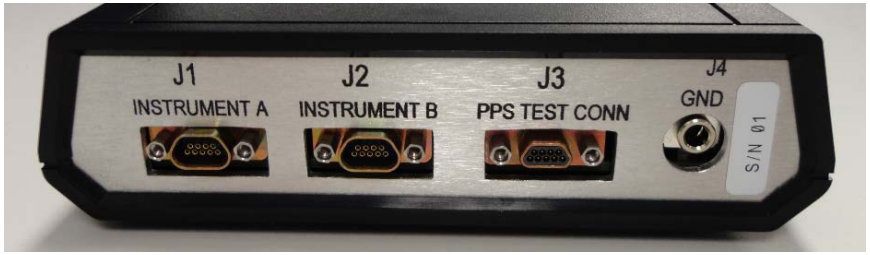
- **Note:**
  - **FIELDS = FIELDS1 & FIELDS2**

SCE Mini-Emulator

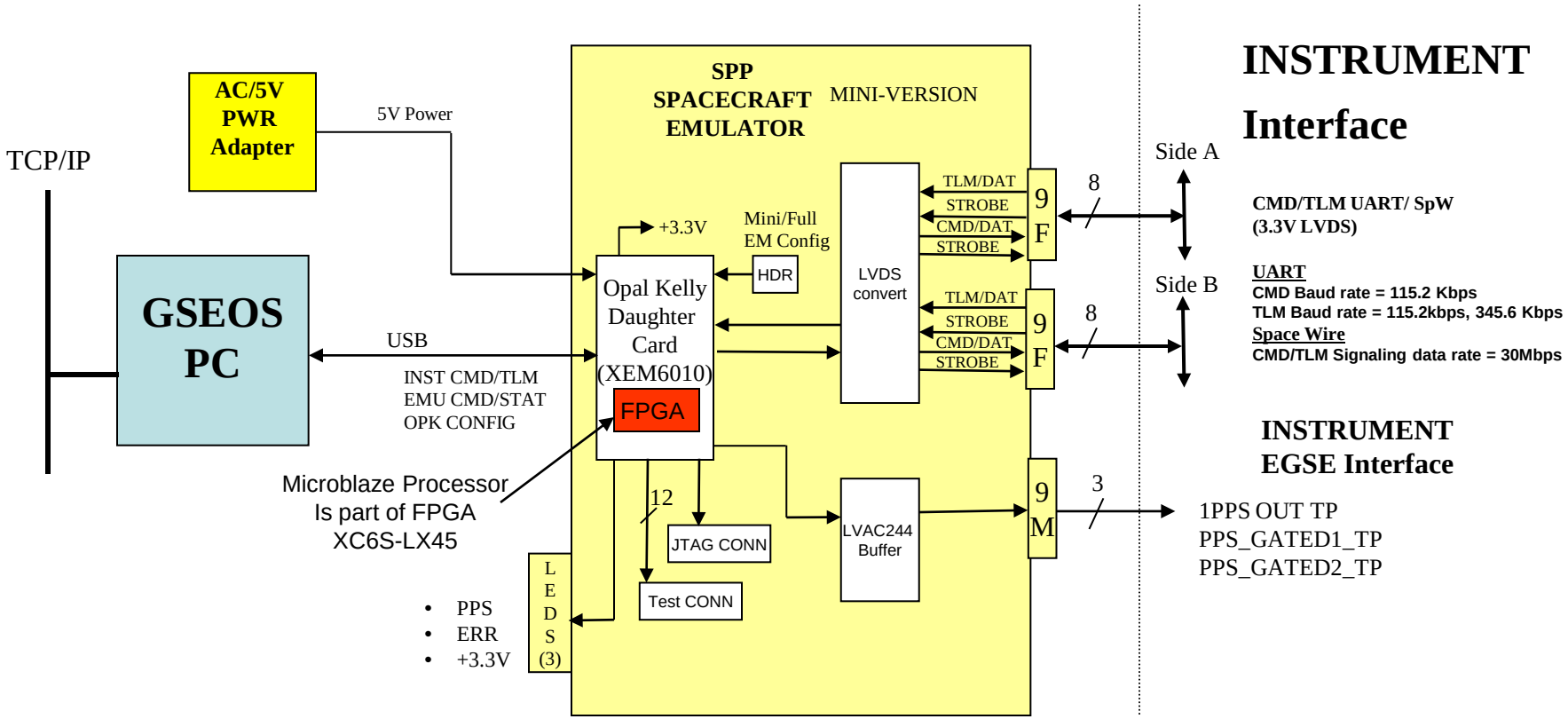
- **Provides Instrument Data Interfaces only, No Power Interfaces, No Temperature Interfaces**
- **Also provides 1PPS and Gated_PPS Interfaces for Instrument EGSE**
- **GSEOS Interface is fully compliant**
- **Non-flight use only**
  - **SCE data connectors are female MDMs (9F)**
  - **SCE PPS test connector is male MDM (9F)**

FRONT PANEL

REAR PANEL



Mini-Emulator Block Diagram

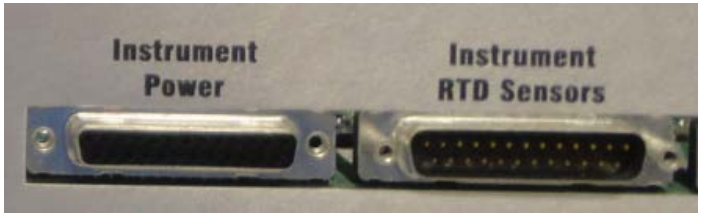


Note 1: USB Cable and 5V Adapter cable are provided with Emulator Delivery, PC is not part of Delivery.
Note 2: CMD/TLM UART Signals are shared with SpW Data Signals. Strobe signal is not used for UART interfaces

SCE Full-Emulator

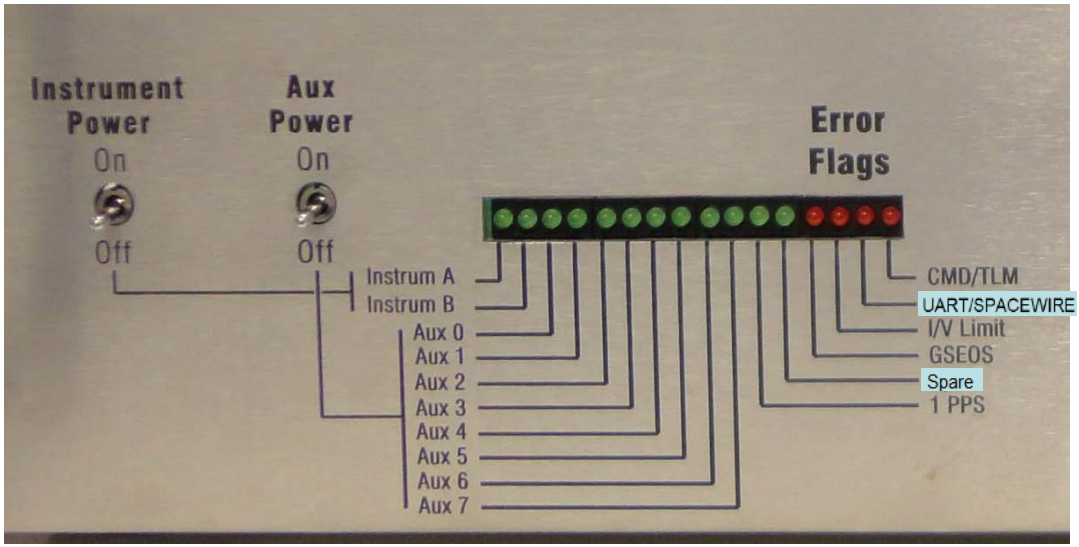
- **Provides Instrument Data, Power and Temperature Interfaces**
- **Also provides 1PPS and Gated_PPS Interfaces for Instrument EGSE**
- **GSEOS Interface is fully compliant**
- **Designed for use with Flight hardware**
  - **Data connectors are female MDMs (9F)**
  - **PPS test connector is male MDM (9M)**
  - **Instrument Power connector is female DSUB (9F)**
  - **Instrument RTD connector is male DSUB (9M)**
  - **External Power Supply IF: Banana Jacks**
  - **Front Panel D/S Test points: BNC**

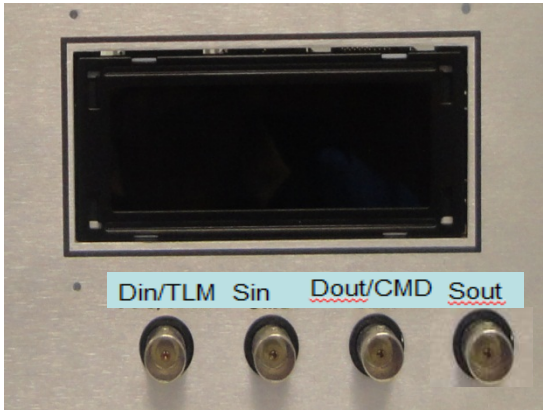
REAR PANEL



SCE Full-Emulator

- **Full Emulator Front Panel LED Interface/BNC TP Interface**

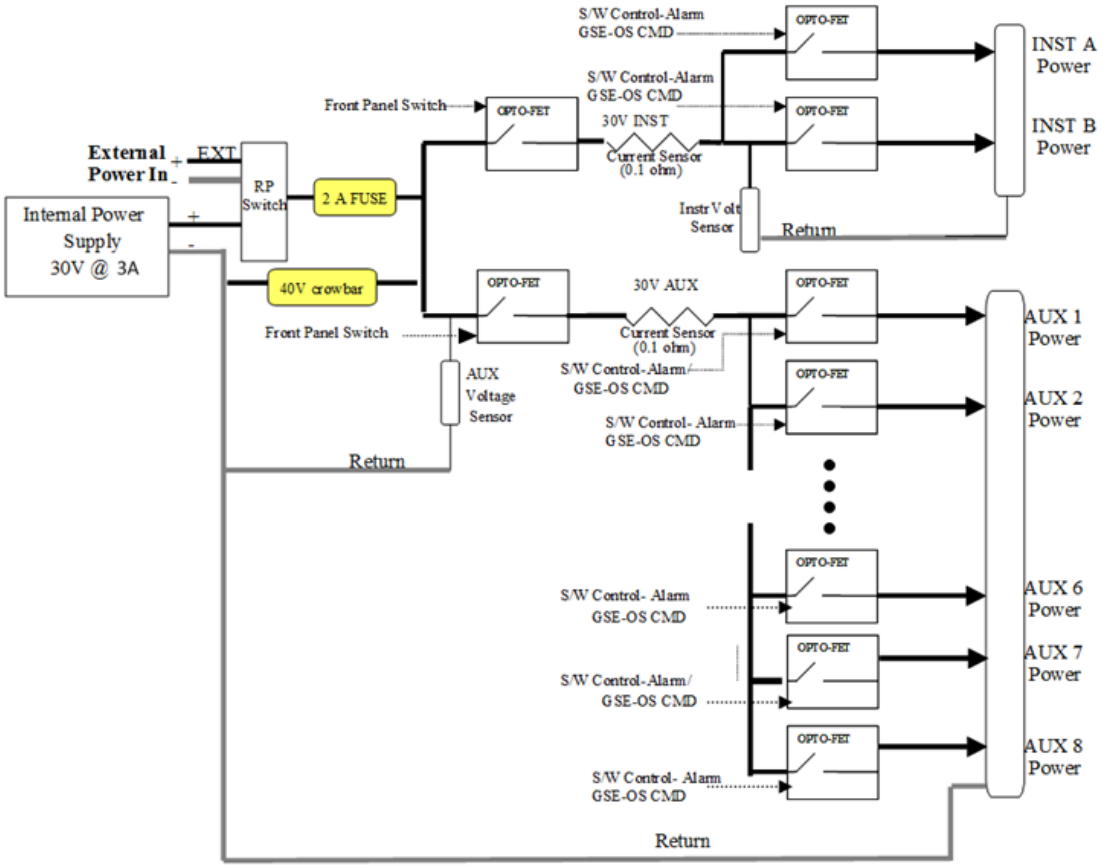




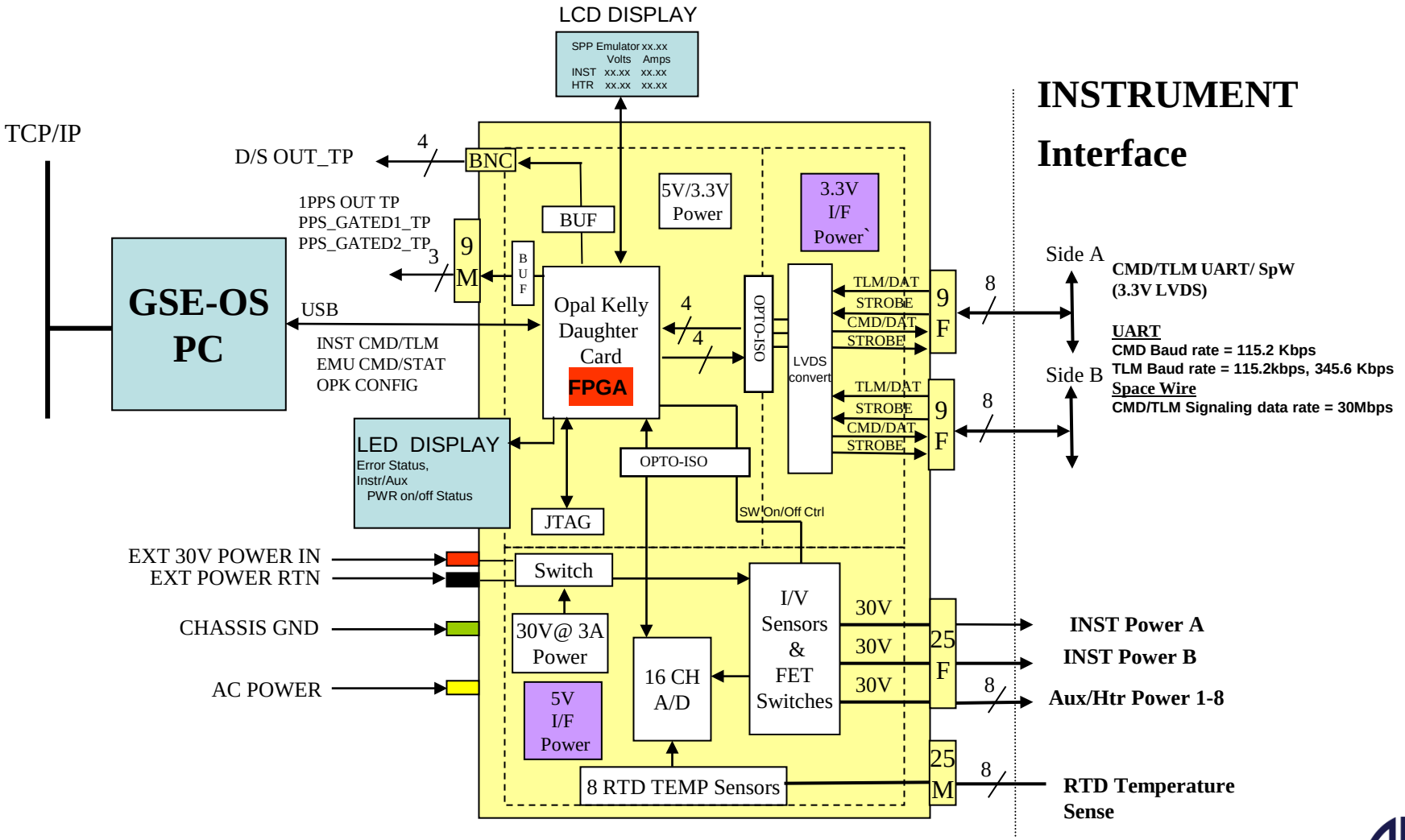
- **Note: The 2 switches above drive Power FETs on/off; Internal P/S remains powered. Individual Instrument and Aux power outputs are Software controlled on/off. See next Slide.**

SCE Full-Emulator

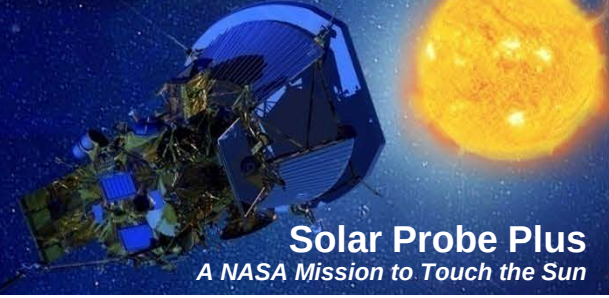
- **Full Emulator Instrument Power Interfaces**



Full-Emulator Block Diagram

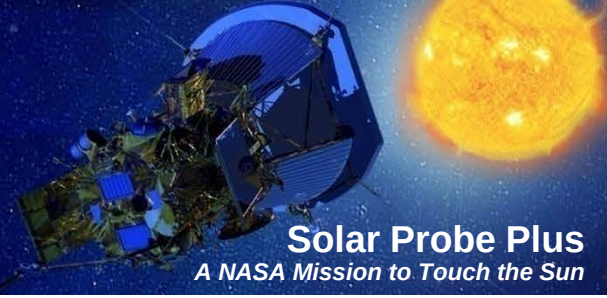


SPP SC Emulator Updates



- Update Requirements to SPP Instrument ICDs and SpW ICD for WISPR DPU
- Provide A/B UART interfaces
- Provide A/B SpW link with configurable SpW bus schedule
- Support Virtual PPS (no distinct 1PPS line)
- Support 345.6 KBAUD (Was 400 KBAUD) Telemetry link from FIELDS and SWEAP
- GSEOS version 7 will be used for SPP
- Mini- and Full-Emulators will have 2 gated-PPS test outputs with GSEOS command for arm/disarm/one-shot with programmable pulse width and delay from PPS (Timing on Next Slide)-In addition to 1 PPS output
- SCE data connectors will be female MDMs, PPS test connector will be male MDM

SPP SC Emulator Updates



- **5V Power no loner supplied thru USB interface, Separate External AC/5CV adapter plug used for Mini. Internal 5V supply used for Full**
- **GSEOS SW verified compatibility with GPIB Drivers, but requires Ext HW supplied by Instrument Team (eg USB/GPIB converter)**
- **Spacewire RMAP (Remote Memory Access Protocol) will be Implemented in Embedded SW**

SPP SC Emulator Updates

- **1PPS & GATED PPS Timing (To Instrument EGSE)**

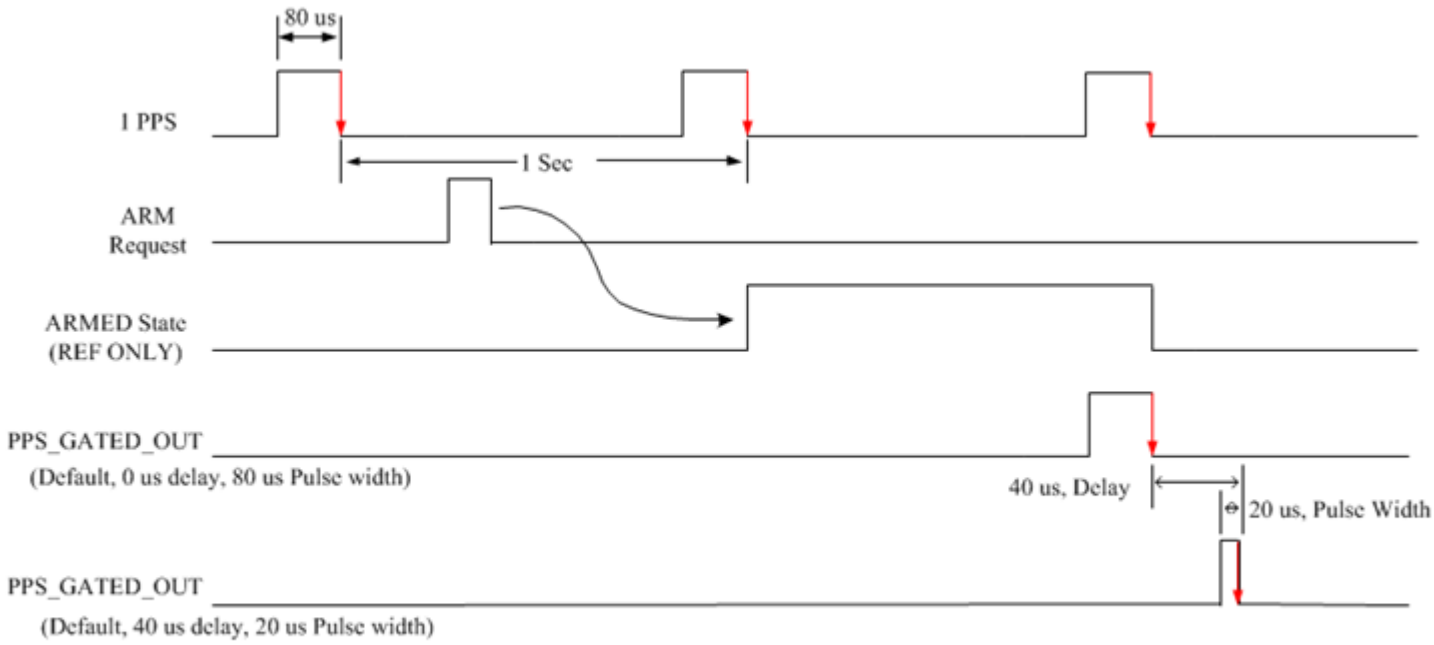
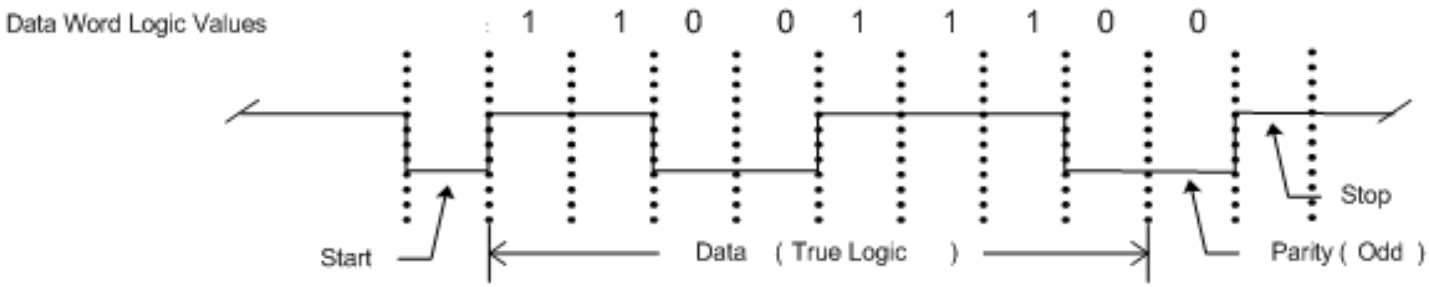


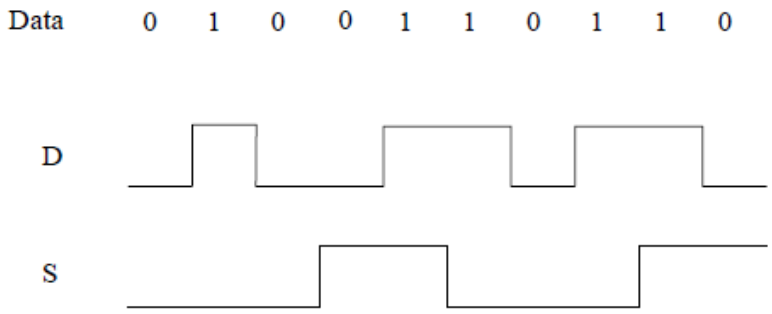
Figure 9. PPS_Gated1 (2) Timing

SPP SC Emulator Updates

- **UART Timing**

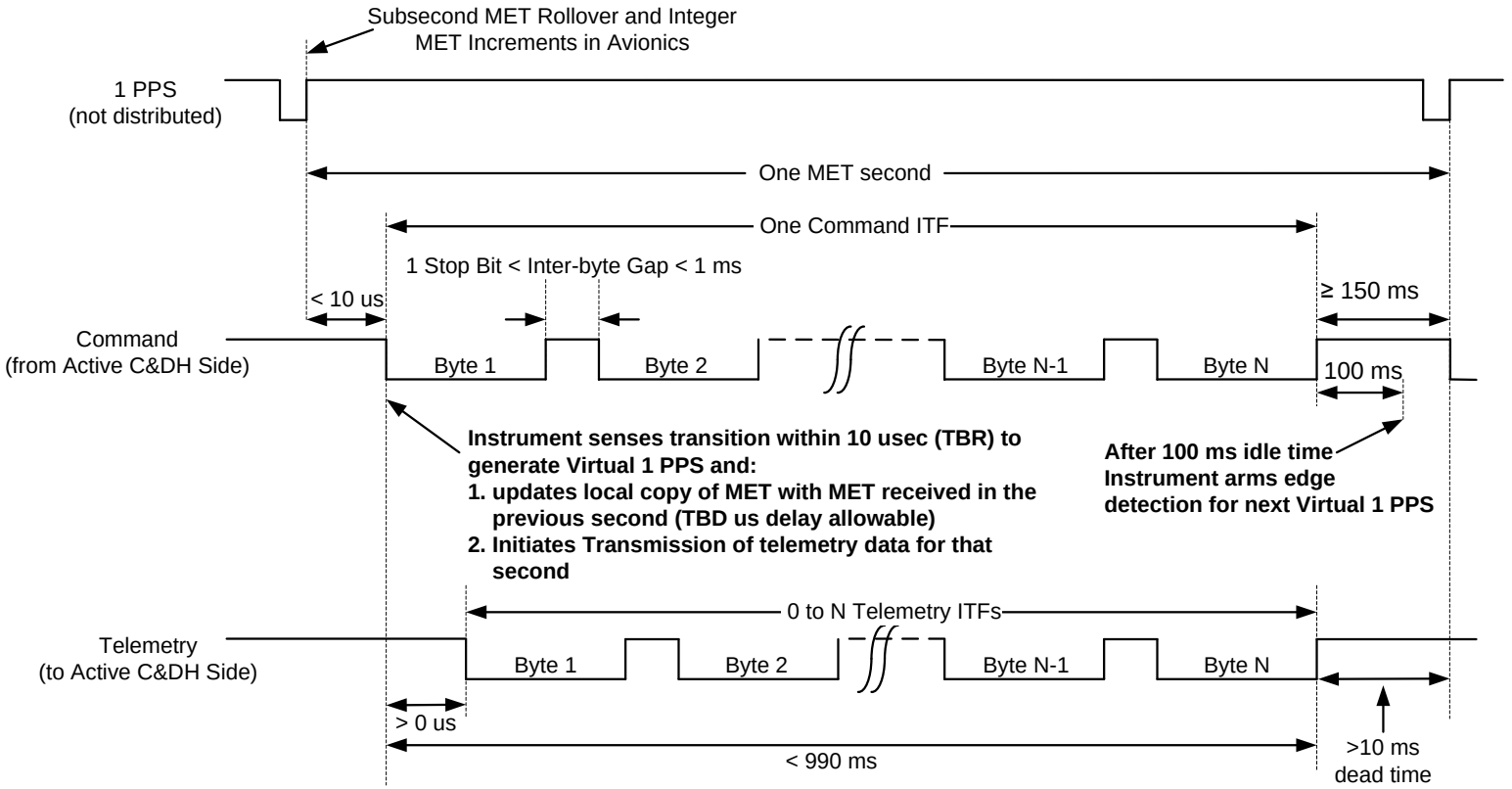


- **SpaceWire Data/Strobe Timing**



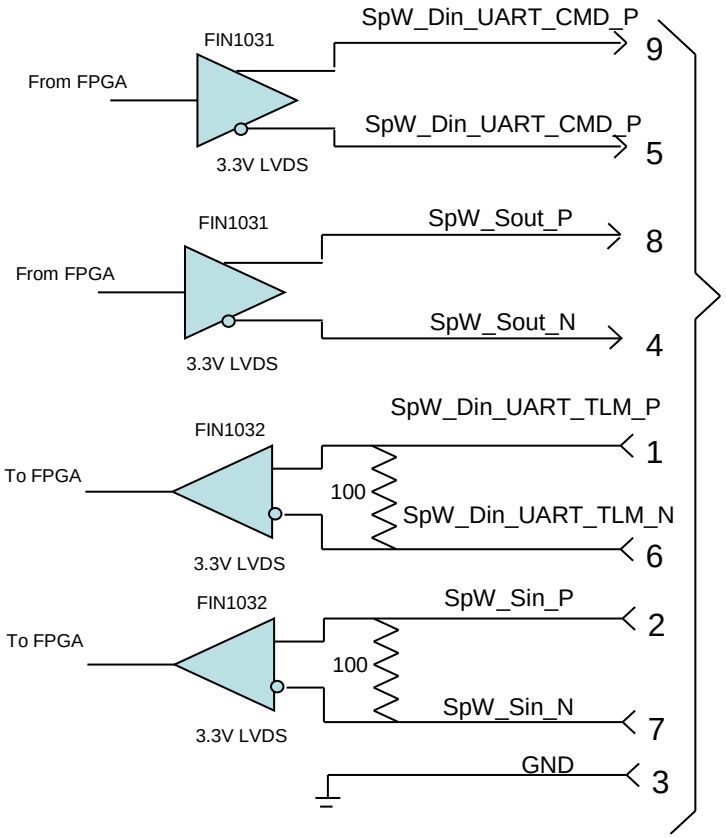
SPP SC Emulator Updates

- **Command/Telemetry Timing (UART)**



SPP SC Emulator Updates

First Circuit Interface (UART/Spacewire)



INSTRUMENT INTERFACE

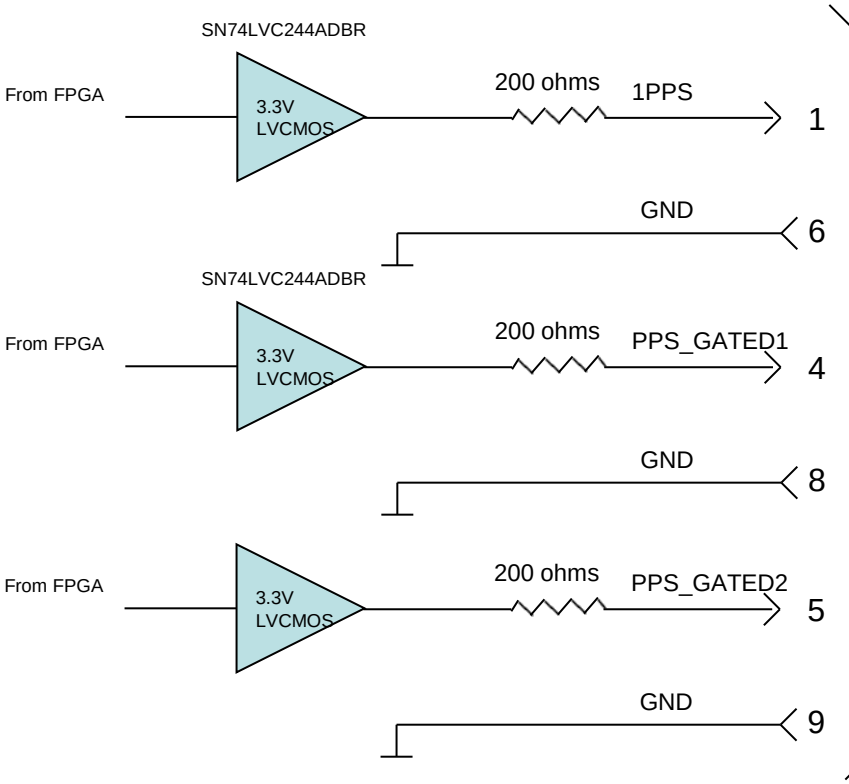
MDM9-FEMALE (J1, J2)
(Separate Connectors for Side A & Side B)
(mating connector is male)

Note: * = SpaceWire Strobe Signals
(Sin/Sout are not used for UART Interfaces)

Connector PN: M83513-13-A01CP (Right Angle)
(Glenair/Mouser)

SPP SC Emulator Updates

First Circuit Interface (1 PPS -EGSE I/F)

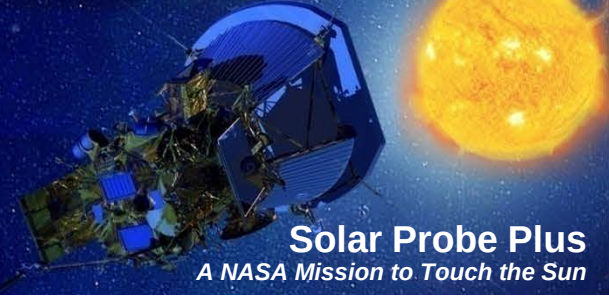


INSTRUMENT EGSE INTERFACE

MDM9-MALE (J3)
(mating connector is female)
Connector PN: M83513-10-A01CP (Right Angle)
(Glenair/Mouser)

Pins:2,3,7: Ground)

SPP SC Emulator Updates



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SPP Emulator Power Services Requirements

Emulator Baseline Internal Power Services Capability

Service Type	Output I (Max)	QTY
Instrument PWR	3A total Instru+ Aux outputs	2
AUX PWR	3A total Instru+ Aux outputs	8
TEMP	NA	8

(Internal power supply = 30V @3amps)

Instrument RTD Temperature Sensor Needs

Main	Instrument	Description	Total QTY			Emulator Meets Instrument Needs?	Comments
1	WISPR-Instrument	RTD TEMP	6			Yes	per E. Adams 4/23/13
2	FIELDS-Instrument	RTD TEMP	8			Yes	per E. Adams 6/08/13
3	SWEAP-Instrument	RTD TEMP	8			Yes	per E. Adams 6/08/13
4	ISIS-EPI HI-Instrument	RTD TEMP	3			Yes	per E. Adams 4/23/13
5	ISIS-EPI LO Instrument	RTD TEMP	3			Yes	per E. Adams 4/23/13

SPP SC Emulator Updates

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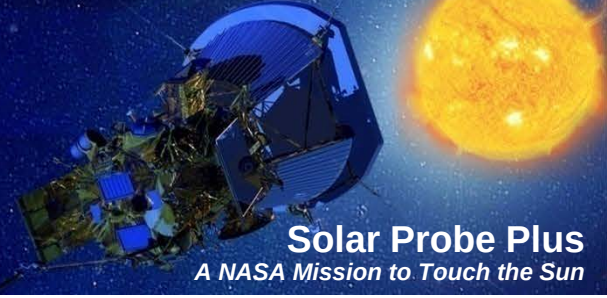
Instrument Power Services Needs

Main	Instrument	Description	Total QTY	PWR (W)	I (amps)	Emulator Meets Instrument Needs?	Comments
1	WISPR-Instrument	Main	1	15	0.68	Yes	
	WISPR-Aux		4			Yes	
		(WISPR Surv HTR)		3.4	0.10	Yes	per E. Adams 5/10/13
		(OP HTR)		4.6	0.13	Yes	per E. Adams 5/10/13
		(Door Deploy A/B-2)		90	3.00	No	per E. Adams 4/26/13, 3 Amps @ 28 V for 40 ms Note: Update 6/21/13 per Tag Up MTG: When Door deploy power is combined with main power (3.68 amps), exceeds internal supply capability, however, since WISPR will use its own external Power Supply and will not use the internal supply, this is not an issue.
2a	FIELDS1 -Instrument	Operational Power Input	1	11.5	0.52	N/A	N/A: Uses FIELDS EGSE Power Supply, per Stu Harris, 6/18/13
	FIELDS1 -Aux	Survival Power Input	1	3	0.09	N/A	N/A: Uses FIELDS EGSE Power Supply, per Stu Harris, 6/18/13
		(Ant Deploy whips Cage 1-4A)	4			N/A	N/A: Uses FIELDS EGSE, per Stu Harris, 6/18/13
		(Ant Deploy whips Cage 1-4B)	4			N/A	N/A: Uses FIELDS EGSE, per Stu Harris, 6/18/13
		(Ant Deploy Hinge 1A) TINI pin puller	1			N/A	N/A: Uses FIELDS EGSE, per Stu Harris, 6/18/13
		(Ant Deploy Hinge 2A)	1			N/A	N/A: Uses FIELDS EGSE, per Stu Harris, 6/18/13
		(Ant Deploy Hinge 3&4A)	2			N/A	N/A: Uses FIELDS EGSE, per Stu Harris, 6/18/13
		(Ant Deploy Hinge 3B) TINI pin puller	1			N/A	N/A: Uses FIELDS EGSE, per Stu Harris, 6/18/13
		(Ant Deploy Hinge 4B)	1			N/A	N/A: Uses FIELDS EGSE, per Stu Harris, 6/18/13
		(Ant Deploy Hinge 1&2B)	2			N/A	N/A: Uses FIELDS EGSE, per Stu Harris, 6/18/13
2b	FIELDS2 -Instrument	Operational Power Input	1	6.9	0.31	N/A	N/A: Uses FIELDS EGSE Power Supply, per Stu Harris, 6/18/13
	FIELDS2 -Aux	Survival Power Input	1	3	0.09	N/A	N/A: Uses FIELDS EGSE Power Supply, per Stu Harris, 6/18/13
3	SWEAP-Instrument	Main/Cover Mechanism/Op Heater	1	23.6	1.07	Yes	Note: Update 6/21/13: Assumes baseline where Instrument power also inclues Cover Mechanism and Operation Heater
	SWEAP-Aux		0			Yes	
4	ISIS-EPI HI-Instrument	Main	1	6	0.27	Yes	
	ISIS-EPI HI-Aux		2			Yes	
		(Surv & Warm Up HTR)		3.2	0.09	Yes	per E. Adams 5/6/13
		(OP HTR)		0.33	0.01	Yes	per E. Adams 5/6/13
5	ISIS-EPI LO Instrument	Main	1	5	0.23	Yes	
	ISIS-EPI LO -Aux		1			Yes	
		(Surv &Warm Up HTR)		2.5	0.07	Yes	per E. Adams 5/6/13

Requirement Document Review

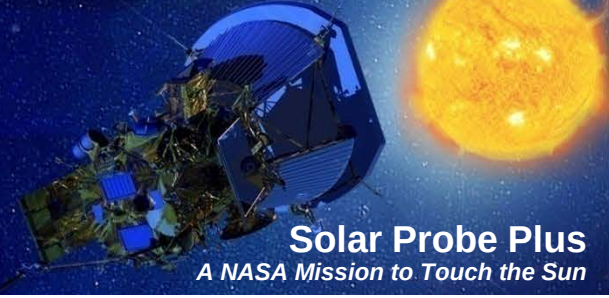
- **See SPP Emulator Requirements Document (7434-7001)**
  - **(Read Thru-page by page)**

Conclusion



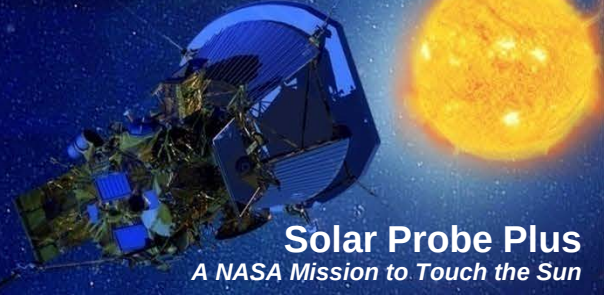
- **Instrument concerns**
- **Questions?**

Backup Slides



Backup slides

SPP Spacecraft Block Diagram



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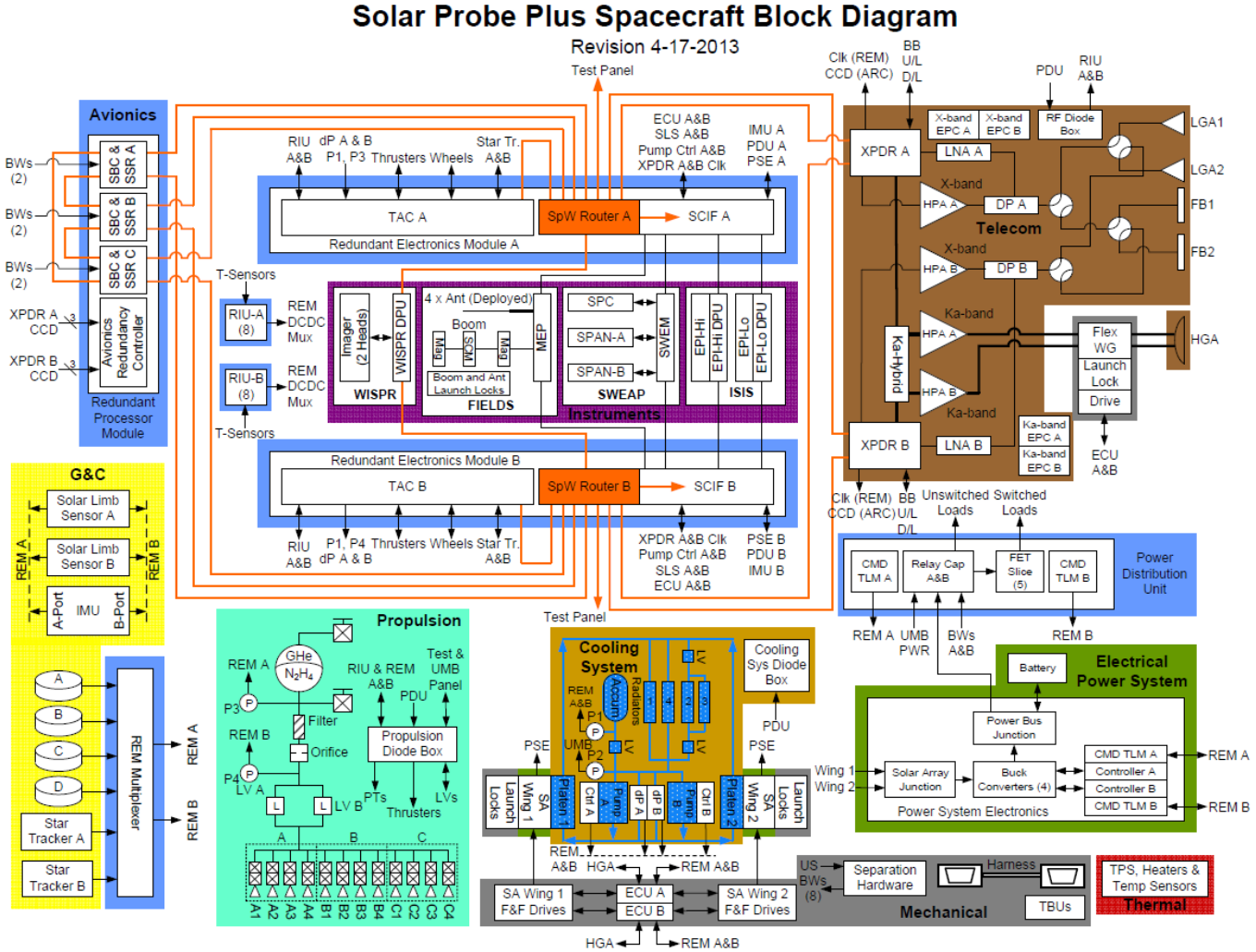

Opal Kelly Daughter Card

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XEM6010

Xilinx Spartan-6 FPGA Integration Module

> The Opal Kelly XEM 3010 is an expertly-designed module that is the heart of our instrument - the central core of our CMOS Image Sensor Lab ISL-1600. It provides a development platform and a communications layer that dramatically reduced development engineering expense and accelerated time-to-market.
>
> *- Martin Vasey, CEO, Jova Solutions*

The XEM6010 is a USB 2.0 integration module based on the remarkably-capable Xilinx Spartan-6 FPGA. In addition to a high gate-count FPGA, the XEM6010 utilizes the high transfer rate of USB 2.0 for configuration downloads, enabling speedy FPGA configuration and data transfer. With integrated SDRAM, power supplies, and platform flash, the XEM6010 is a worthy successor to the most popular Opal Kelly module.

On-Board SDRAM

Built with an integrated 128-MiB SDRAM, the XEM6010 has abundant on-board memory for high-performance applications, including data and image acquisition as well as signal processing.

Need More Bandwidth?

The XEM6110 is a footprint-compatible version of the XEM6010 that uses external PCI Express offering a nearly 5x bandwidth improvement over USB 2.0.

XEM6010 -LX45 — Price: $399.95 — Add to Cart

XEM6010 -LX150 — Price: $699.95 — Add to Cart

FrontPanel Software Control Panel and API

Opal Kelly's FrontPanel software interface is an easy-to-use, robust API for communication, configuration, and interfacing to your PC. FrontPanel handles all the interaction between your software and the FPGA internals, dramatically reducing the time and effort required to interface to a design.

Prototyping and OEM Integration

The XEM6010 is ideally suited to prototyping systems and integration into OEM devices where a USB interface, flexible hardware solution, or PC software interface would be useful. The XEM6010 can easily be added to a new board design to provide turnkey USB integration with the convenience of the FrontPanel programmer's interface and existing USB drivers.

Azido Support

AZIDO

Download the free Azido System Description for the XEM6010 and accelerate your development.

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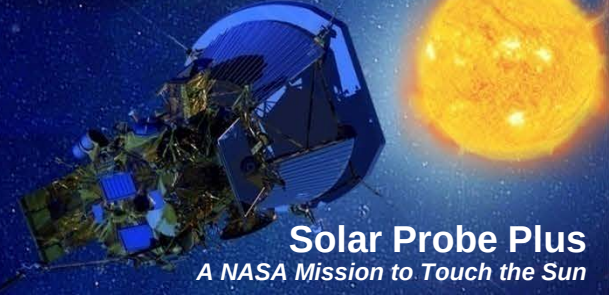

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RBSP SPP

Product Comparison

Feature	XEM3010-1500P	XEM6010-LX45	XEM3050-4000P	XEM6010-LX150
FPGA Minimum Xilinx Tools Required	XC3S1500-4 ISE WebPack	XC6SLX45-2 ISE WebPack	XC3S4000-5 ISE Logic Edition	XC6SLX150-2 ISE Logic Edition
Slice Architecture[1]	2 4-LUT, 2 DFF	4 6-LUT, 8 DFF	2 4-LUT, 2 DFF	4 6-LUT, 8 DFF
Slices	13,312	6,822	27,648	23,038
DFFs	26,624	54,576	55,296	184,304
Dist. RAM	208 Kib	401 Kib	432 Kib	1,355 Kib
Block RAM	576 Kib	2,088 Kib	1,728 Kib	4,824 Kib
MULT / DSP[2]	32	58	96	180
MCB[3]		✓		✓
PLLs[4]		✓ (4 CMT)		✓ (6 CMT)
On-Board Memory Banks, Width	32 MiB SDRAM One, x16	128 MiB DDR2 One, x16	64 MiB SDRAM Two, x16	128 MiB DDR2 One, x16
Peak Memory Bandwidth	2.128 Gb/s	10 Gb/s	4.256 Gb/s	10 Gb/s

[1] Spartan-6 has improved slice density with 6-input LUTs and more LUTs and DFFs per slice.

[2] Spartan-6 DSP blocks include MULT and integrated 48-bit accumulator.

[3] Spartan-6 MCBs (memory controller blocks) reduce the fabric resources consumed for memory support.

[4] Spartan-6 includes PLLs for greater clock management flexibility.

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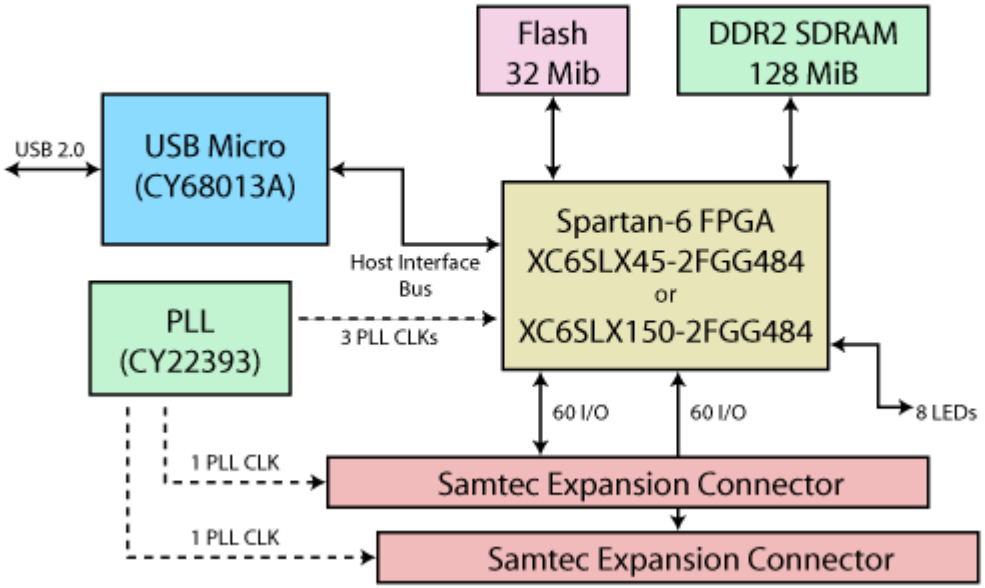
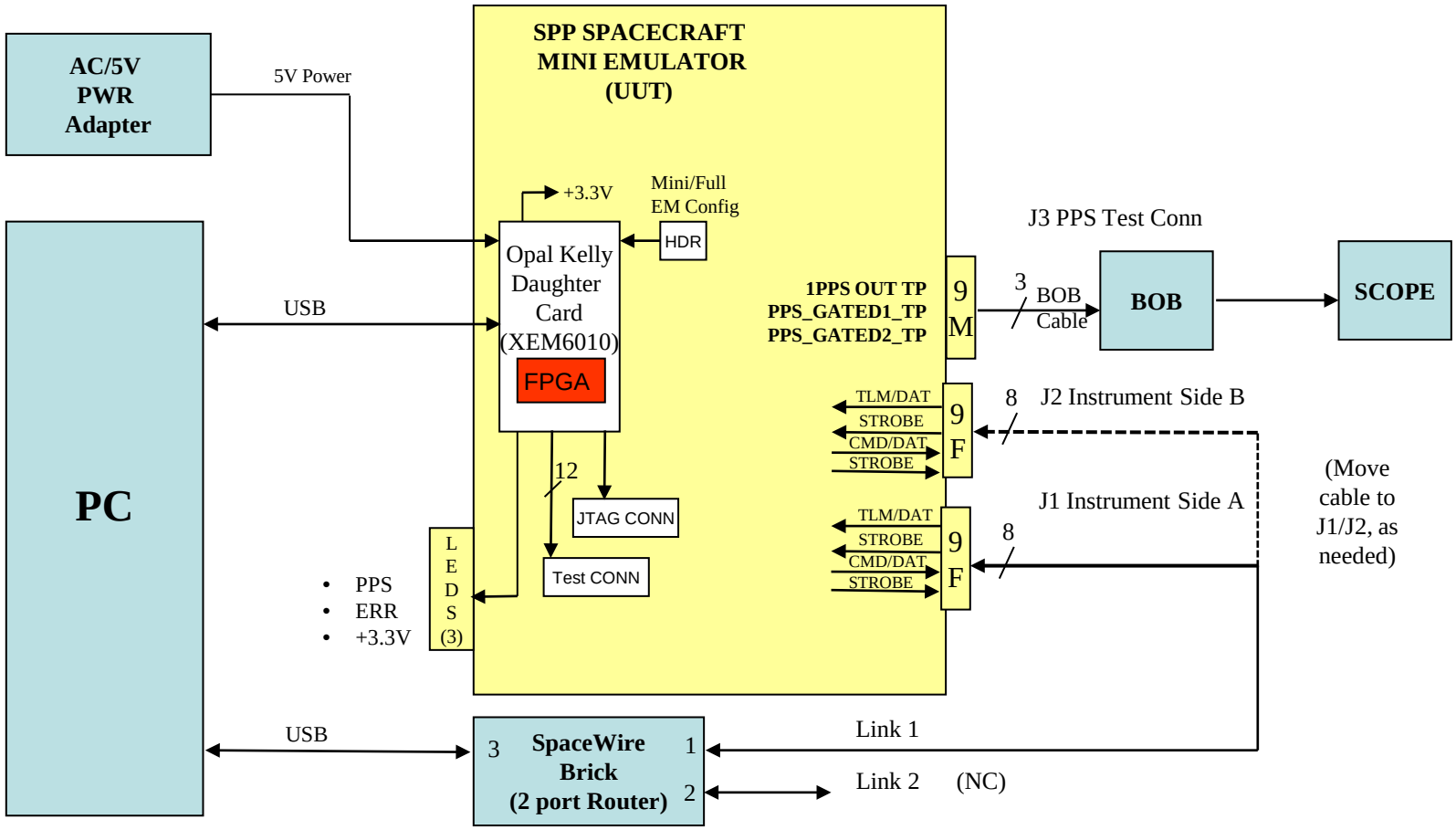
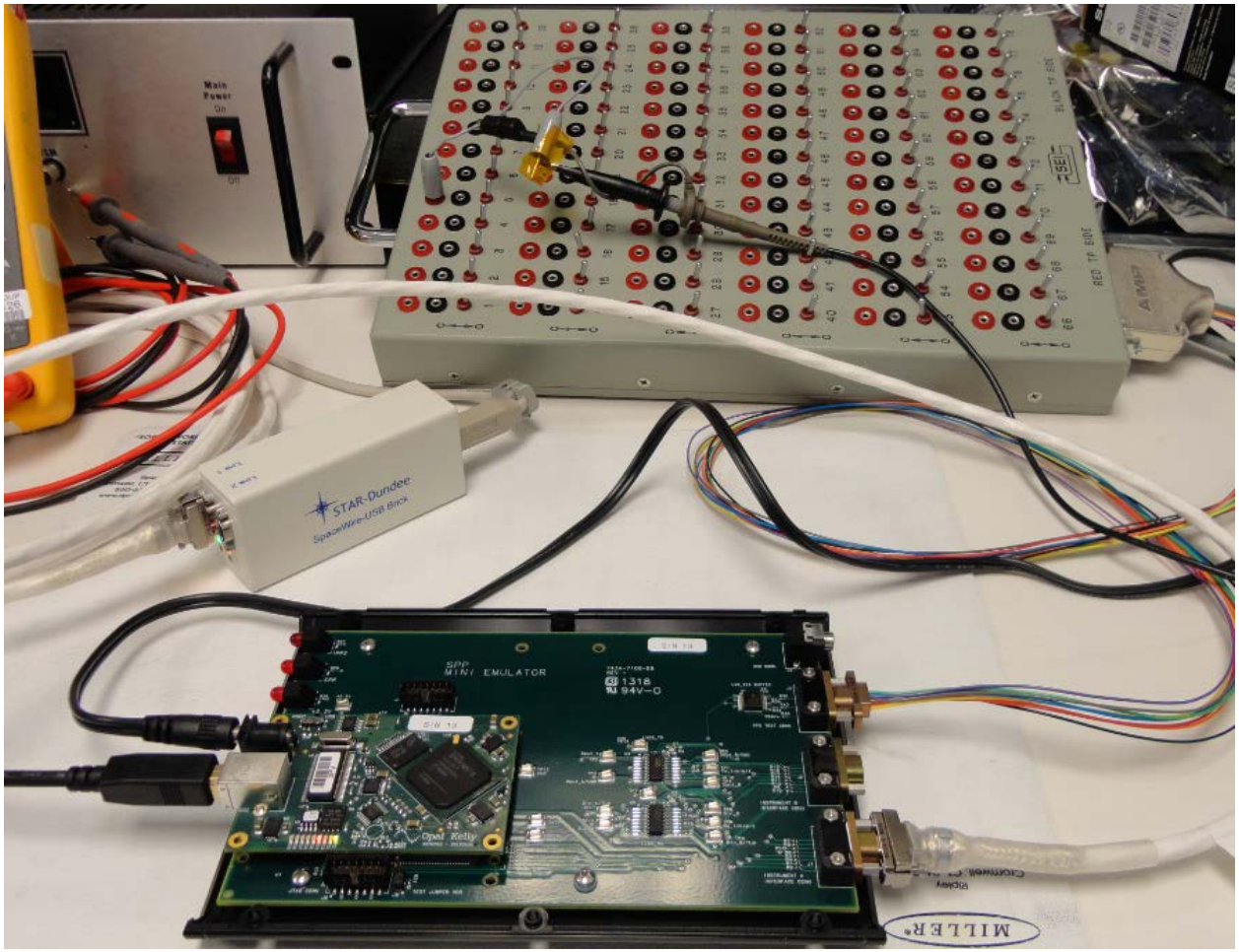
Block Diagram



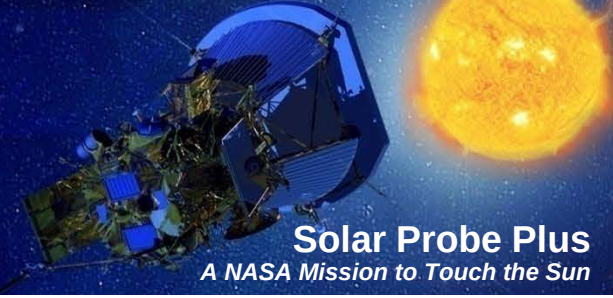
Mini Emulator HW Test Setup



Mini Emulator HW Test Setup (Photo)



WISPR DPU Delivery DEMO
GSEOS Screen Shot Results



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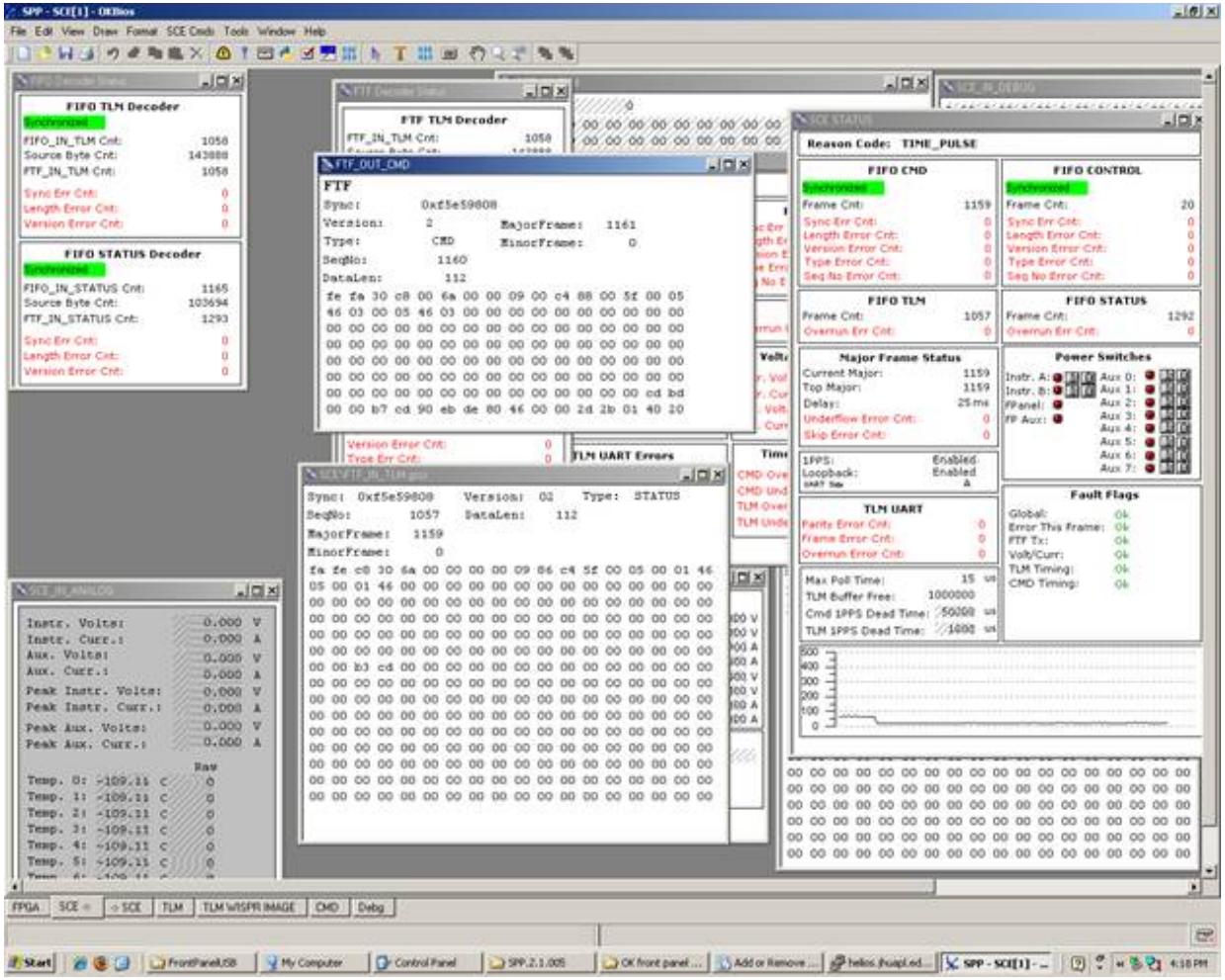
- **Results from Mini Emulator SN1 Delivery to WISPR DPU Instrument Team running GSEOS Demo SW (Internal Loopback). Green indicates data is synchronized and running.**



Mini Emulator Schematic

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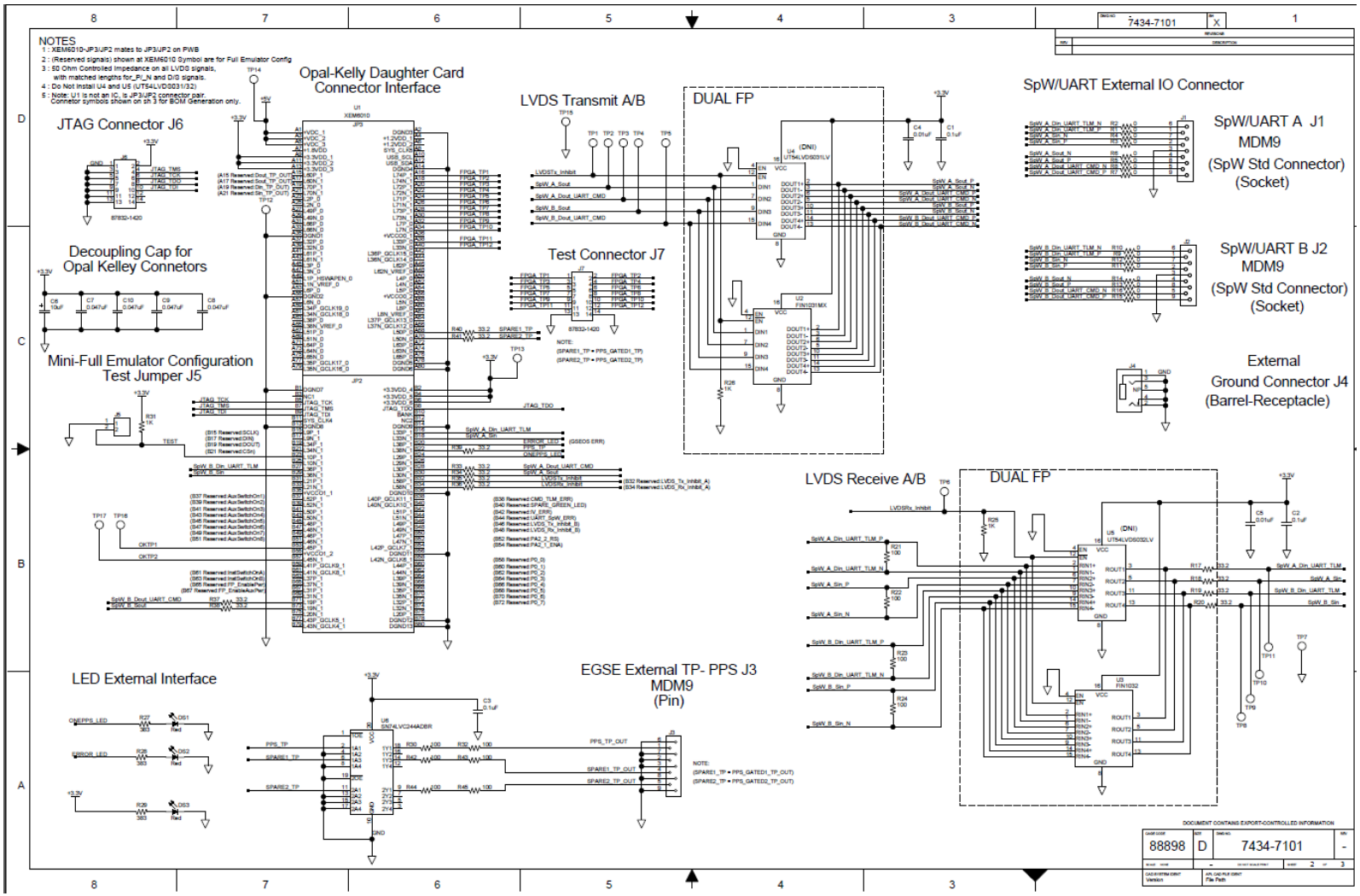
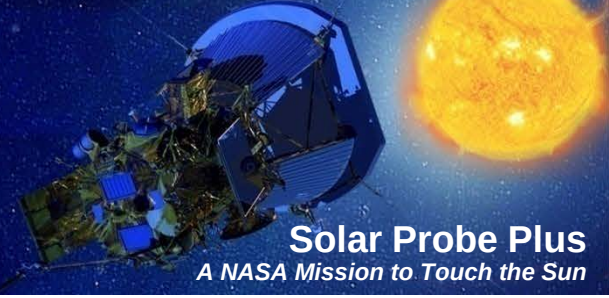
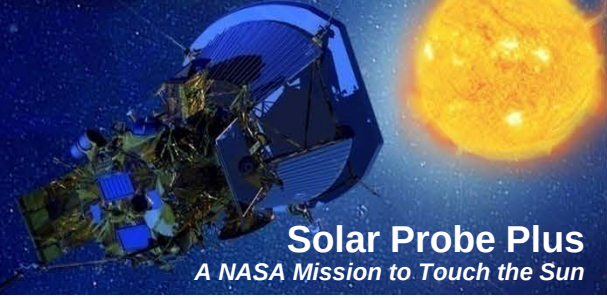


Emulator Documentation



- APL Documents
  - SPP GSEOS Statement of Work
  - SPP GSEOS Proposal – response to SOW above
  - SPP SC Emulator Requirements (7434-7001)
  - SPP SC Emulator Software Development Plan (7434-9111)
  - SPP Emulator Software Design Document (7434-xxxx)
- Design Files (PLM)
  - SPP Mini Emulator Top Assembly (7434-7110)
    - PWA (7434-7100)
    - Schematic (7434-7101)
    - Electrical Parts List (EPL) (7434-7102)
    - PWB (7434-7104)
  - SPP FPGA Design Files (GFORGE Repository)
  - SPP Emulator Embedded Software (GFORGE Repository)

Emulator Documentation (Continued)



- **GSE Software Documentation (www.gseos.com)**
  - **SPP Emulator ICD (Bios Manual) (Rev 11)**
    - **–describes packets between Emulator and GSEOS**
  - **SPP OK Bios Users Manual –describes Opal Kelly interface**
  - **SPP GSEOS User Manual (Rev xx) –How to use SPP GSEOS**
  - **GSEOS User Manual**
- **APL Procedures**
  - **SPP Mini Emulator HW Test Procedure(7434-7021)**
  - **SPP Mini Emulator Startup Procedure (7434-7022)**

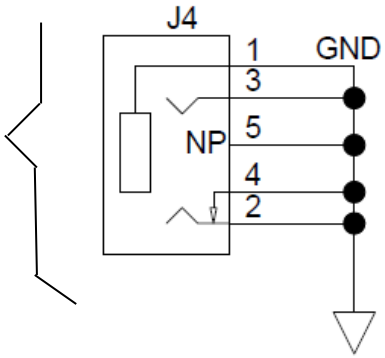
SPP SC Emulator Updates (Mini EM)

First Circuit Interface (GND-EGSE I/F)

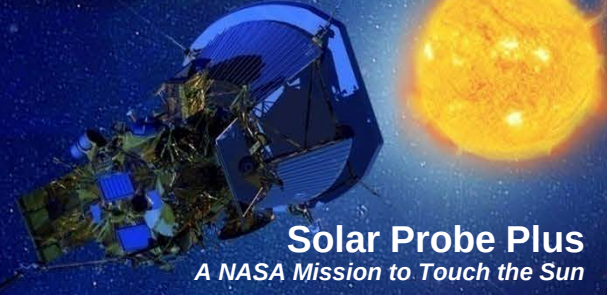
GROUND INTERFACE (Optional)

Barrel Receptacle

Connector PN: SJ1-3544N (CUI Inc/Digikey)

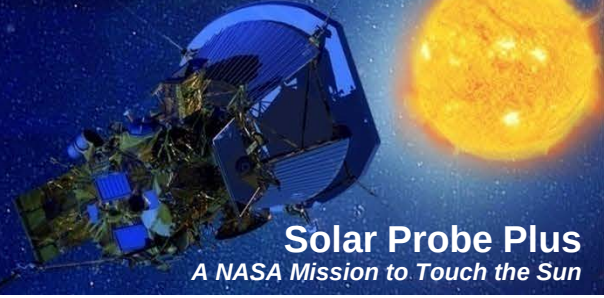


Emulator Team Test Support



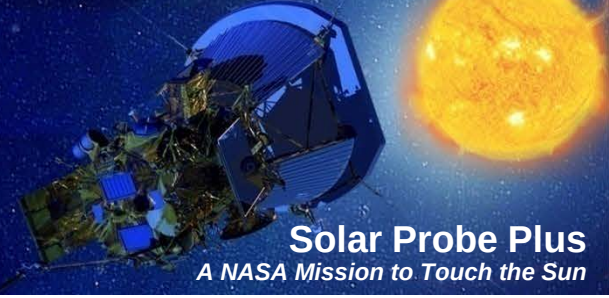
- SCE deliverables will be the Mini- and Full-Emulators and GSEOS deployment via downloads.
- SCE Team will develop Hardware and GSEOS Software User Manuals
  - User's Manual will describe host PC configuration
  - User's Manual will describe steps to complete a GSEOS, embedded firmware and embedded software upgrade
- SCE Team will maintain a website forum for SCE Users

Instrument Team Test Support



- **Instrument Teams will provide:**
  - **Host PC to run GSEOS**
    - **The Mini-Emulator will be designed and tested for compatibility to 64-bit Windows 7 (32-bit Windows 7 would be OK with the proper Opal Kelly drivers and minor GSEOS configs)**
    - **The Full Emulator will offer additional flexibility as requested**
    - **GSEOS support of SOC operations will offer additional flexibility as requested**
    - **SCE will use an Opal Kelly XEM6010, the PC will need to have driver version 4.x installed (current designing to 4.2.5)**
  - **Harnessing**
  - **Flight-rated power supply for use with flight-unit testing using the Full-Emulator**
  - **As needed for HW development , test and debug: Detailed analysis and compliance GSE (O'scopes, logic analyzers, SpW/UART protocol analyzers, EMI/EMC and EDTRD-specific testing)**

Emulator Deliverables



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- **Mini-Emulator earliest delivery is in June 2013**
- **Full-Emulator earliest delivery is in April 2014**
- **Emulator Schedule updates will be via the Project IMS**

		FIELDS	WISPR	ISIS	SWEAP	Project Spares
Mini-Emulators	qty	4	2	3	2	2
Full Emulators	qty	1	2	3	2	2

- **FIELDS requested for 1 additional Full EM 5/28/13**
  - **(Total: 11 Full EMs)**

Detail Mini-Emulator Deliverables

	#	Delivery Date	Instrument User	Comment
Mini-Emulators	1	6/20/13	DPU #1	
	2	6/21/13	FIELDS #1	
	3	6/26/13	ISIS #1	
	4	7/1/13	SWEAP #1	
	5	7/5/13	FIELDS #2	
	6	7/10/13	DPU #2	
	7	7/15/13	ISIS #2	
	8	7/18/13	SWEAP #2	
	9	7/23/13	FIELDS #3	
	10	7/26/13	ISIS #3	
	11	7/31/13	FIELDS #4	
	12	8/13/13	SPARE #1	
	13	8/21/13	SPARE #2	