 GLAST LAT COMPONENT SPECIFICATION LEVEL IV SPECIFICATION	Document # LAT-SS-00183-R2	Date Effective 12/21/01
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Document Title LAT Power Supply Modules - Level IV Specification		

Gamma-ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT)

Power Supply Modules Specification

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes	DCN #
1	7/16/01	Initial Release	
2		TKR bias range changed to ***50 to 150 V*** . CAL bias range changed to ***–50 to –100 V*** ., . Defined new Power Module, the GT, ACD and SIG Distribution (GAS) Power Module. Sections added: 5.3.4.2.1-5.3.4.2.12, 5.3.4.5, 5.3.4.6, 5.3.2.4.1-5.3.2.4.12, 5.3.2.5.1-5.3.2.5.12, 5.3.2.6.1-5.3.2.6.12 5.3.1.1.1-5.3.1.1.12, 5.3.1.2.1-5.3.1.2.7, 5.3.1.3.1-5.3.1.3.12 5.3.2.1.1-5.3.2.1.12, 5.3.2.2.1-5.3.2.2.12, 5.3.2.3.1-5.3.2.3.14 5.3.2.7.1-5.3.2.7.14, 5.3.2.8.1-5.3.2.8.12, 5.3.3.1.1-5.3.3.1.12 5.3.4.1.1-5.3.4.1.12, 5.3.4.2.1-5.3.4.2.12 Sections Deleted: 5.1.5, 5.2.8.2, 5.2.8.3, 5.2.9, 5.2.9.4, 5.3.1.2.8-5.3.1.2.12, 5.3.5, 5.3.3.4, 5.3.5, 5.3.5.1-5.3.5.12, 5.3.5.2 5.3.5.2.1-5.3.5.2.12, 5.3.5.3, 5.3.5.4, 5.3.5.5, 5.3.5.6, Tables 5-19, 5-20 Sections Revised:5.1.1, 5.1.4, 5.2.1, 5.2.3, 5.2.5, 5.2.5.1, 5.2.6.2 5.2.6.4, 5.2.8, 5.2.8.1, 5.3.1, 5.3.1.1, 5.3.1.2.1, 5.3.1.2.7, 5.3.1.3.1 5.3.1.3.8, 5.3.1.4, 5.3.1.5, 5.3.1.6, 5.3.2.1.11, 5.3.2.2, 5.3.2.3.1, 5.3.2.3.3, 5.3.2.8.3, 5.3.2.8.4, 5.3.2.8.7, 5.3.2.10, 5.3.2.8.8, 5.3.2.9 5.3.2.11, 5.3.3, 5.3.4, 5.3.4.1.1, 5.3.4.1.12, 5.3.4.2, 5.3.4.3, 5.3.4.4 Tables 5-1 – 5-18 Sections Updated: Figures 1, 3-8	

CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

1 PURPOSE

This document defines level IV subsystem requirements for the GLAST LAT power supply modules.

2 SCOPE

This specification captures the GLAST LAT requirements for subsystem power supply modules. This encompasses the subsystem level design requirements for electrical power.

3 DEFINITIONS

3.1 Acronyms

A

ACD	Anticoincidence Detector
ACD-PM	Anticoincidence Detector-Power Module

C

CAL	Calorimeter

D

DAQ-EM	Data Acquisition System – Electronics Module
DC	Direct Current

E

EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EOL	End of Life
EPE	Event Processor Electronics
EP-PM	Event Processor Power Module

G

GAS	**G**
GBM	Gamma-ray Burst Monitor
GLAST	Gamma-ray Large Area Space Telescope
GTE	Global Trigger Electronics
GT-PM	Global Trigger Power Module

I

ICD	Interface Control Document
IOC	Instrument Operations Center
IRD	Interface Requirements Document

L

LAT	Large Area Telescope
LV	Launch Vehicle

M

MAR	Mission Assurance Requirements

O

OPS	Operations

P

PIN	Positive Intrinsic Negative
PMT	Photo Multiplier Tube

R

RMS	Root Mean Square
RQMT	Requirements

S

SAS	Science Analysis Software
SC	Spacecraft
SIU	Spacecraft Interface Unit
SIU-PM	Spacecraft Interface Unit Power Module
SPEC	Specification
SRD	Science Requirements Document
SW	Software

T

T&DF	Trigger and Data Flow
TBD	To Be Determined
TBR	To Be Revised
TCD-PM	Tracker/Calorimeter/DAQ Power Module
T/C PS	TKR/CAL Power Supply
TEM	Tower Electronics Module
TKR	Tracker

3.2 Definitions

A

A, An	Analog
A	Analysis
Acc	Accuracy
adj	adjustable

C

cm	centimeter

D

D, Dg	Digital
D	Demonstration
DR	Data Rate

E

Eff	Efficiency

F

F	Functional
H	
Hz	Hertz, unit of frequency, s^{-1}
I	
I	Inspection
K	
kHz	kilohertz, 10^3 Hz
M	
MHz	Megahertz, 10^6 Hz
msec	millisecond, 10^{-3} s
mV	millivolt, 10^{-3} V
P	
P	Performance
p-p	peak-to-peak
P/F	Pass/Fail
S	
s, sec	seconds
T	
T	Test
Ti	Time
V	
V	Volt
W	
W	Watt

4 APPLICABLE DOCUMENTS

Documents that are relevant to the development of the LAT power supply module specification include the following:

LAT-PS-00010, "GLAST LAT Performance Specification", Sept 2000

GSFC 433-IRD-0001, "GLAST Science Instrument – Spacecraft Interface Requirements Document", Jan 29, 2001

GSFC 433-SPEC-0001, "GLAST Mission System Specification", Draft, Jan 31, 2001

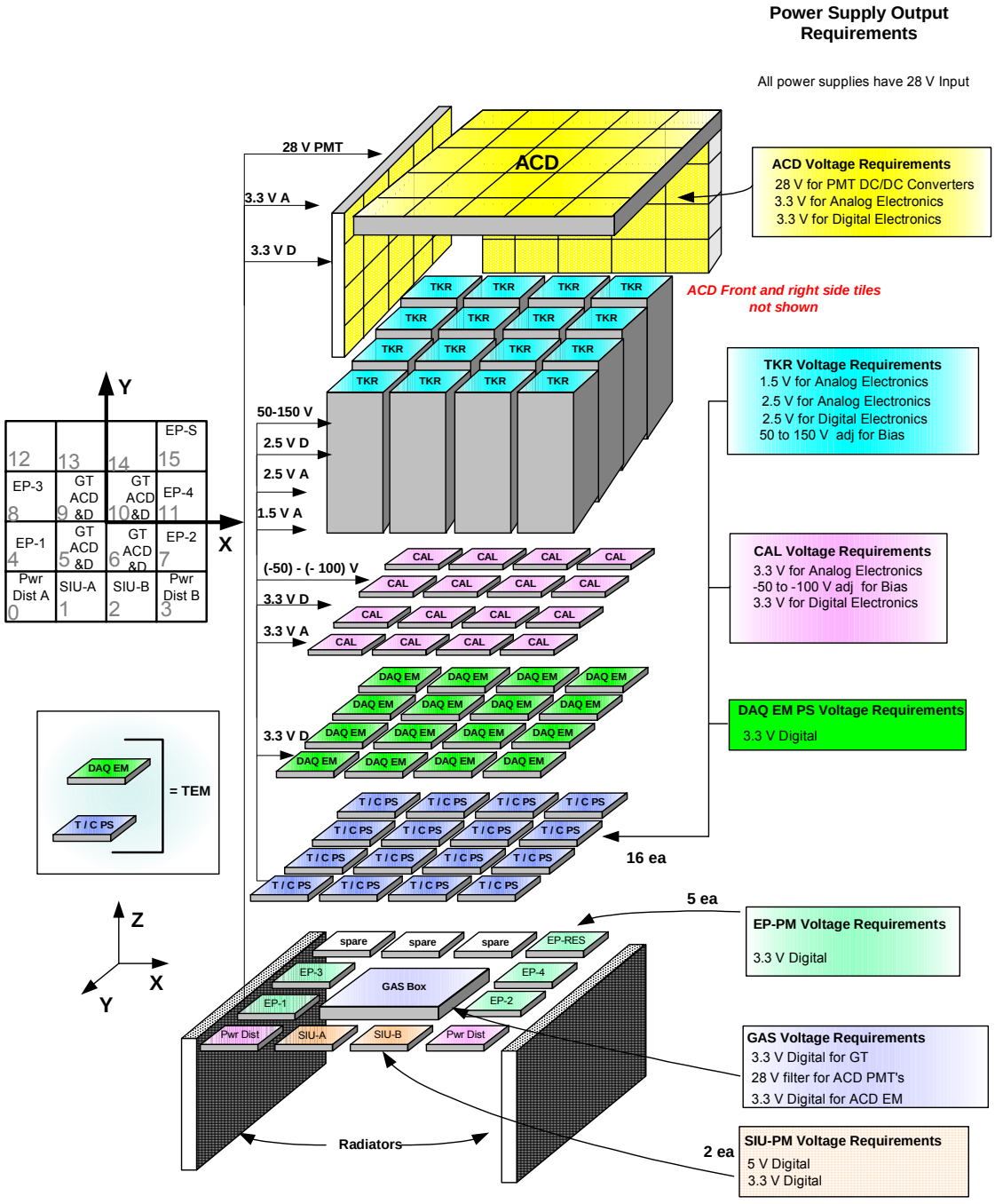
LAT-SS-00115 , "LAT Mechanical Systems Subsystem Specification"

LAT-SS-00136 , "LAT Electrical Power System Level 3 Specification"

5 REQUIREMENTS

LAT requires multiple sources of isolated power to support the operation of the instrument subsystems. These requirements as they are applied to the subsystems are shown in Figure 1.

Figure 1 LAT Power Requirements



5.1 Power Supply Modules

The LAT instrument is powered by distributed power supply modules. Each subsystem contains power supplies that provide that subsystem with appropriate electrical power. The collection of power supplies necessary for each subsystem is called a power supply module or power module. The LAT requires the following subsystem power modules to support instrument operation. The power requirements specified in the following sections are the module End of Life (EOL) requirements at the output side of the power modules.

5.1.1 GT, ACD and SIG Distribution Power Module (GAS-PM)

The LAT requires power supplies for each of the GAS box which contains the ACD, Global Trigger and Signal Distribution boards. The voltage and power requirements are shown in Table 5-1.

Table 5-1 GAS-PM Attributes

Supply Type	Voltage, V	Power, W
Analog	3.3	1.3
PMT/Analog	28	4.35
GAS EM Digital	3.3	16

5.1.2 Tracker/Calorimeter (TKR/CAL)/DAQ Power Module (TCD-PM)

The LAT requires 16 each of this module, 1 each in each tower. The voltage and power requirements are shown in Table 5-2.

Table 5-2 TCD-PM Attributes

Supply Type	Voltage, V	Power, W
CAL-Analog	3.3	2.15
CAL-Digital	3.3	3.7
CAL Bias	-50 to -100 adj	0.1
TKR-Analog	1.5	3.7
TKR-Analog	2.5	1.0
TKR -Digital	2.5	4.75
TKR Bias	50 to 150 adj	0.6
TEM -Digital	3.3	3.25

5.1.3 Event Processor Power Module (EP-PM)

The LAT requires 1 each of this module, in each of 5 Event Processor boxes, 4 of which are powered on at any one time. The voltage and power requirements are shown in Table 5-3.

Table 5-3 EP-PM Attributes

Supply Type	Voltage, V	Power, W
Digital	3.3	18

5.1.4 Spacecraft Interface Unit (SIU) Power Module (SIU-PM)

The LAT requires 2 each of this module in each of 2 SIU boxes, only 1 of which is powered on at any one time. The voltage and power requirements are shown in Table 5-5.

Table 5-4 SIU-PM Attributes (TBR)

Supply Type	Voltage, V	Power, W
Digital	5	5.6
Digital	3.3	20

5.2 Common Requirements

5.2.1 Configuration

The power modules will be applied in a one for one application except for the SIU where there will be two power modules for each electronics module.

5.2.2 Operating Conditions

All power modules are to be operable with both primary and redundant inputs powered concurrently. Furthermore, all power modules must be able to handle a situation in which both primary and redundant power modules are also powered concurrently.

5.2.3 Circuit Protection

Circuit protection for the primary power source will be provided at the power distribution module.

5.2.4 Margin

Each power supply module is to be designed with 50 % margin over the specified power per program design requirements.

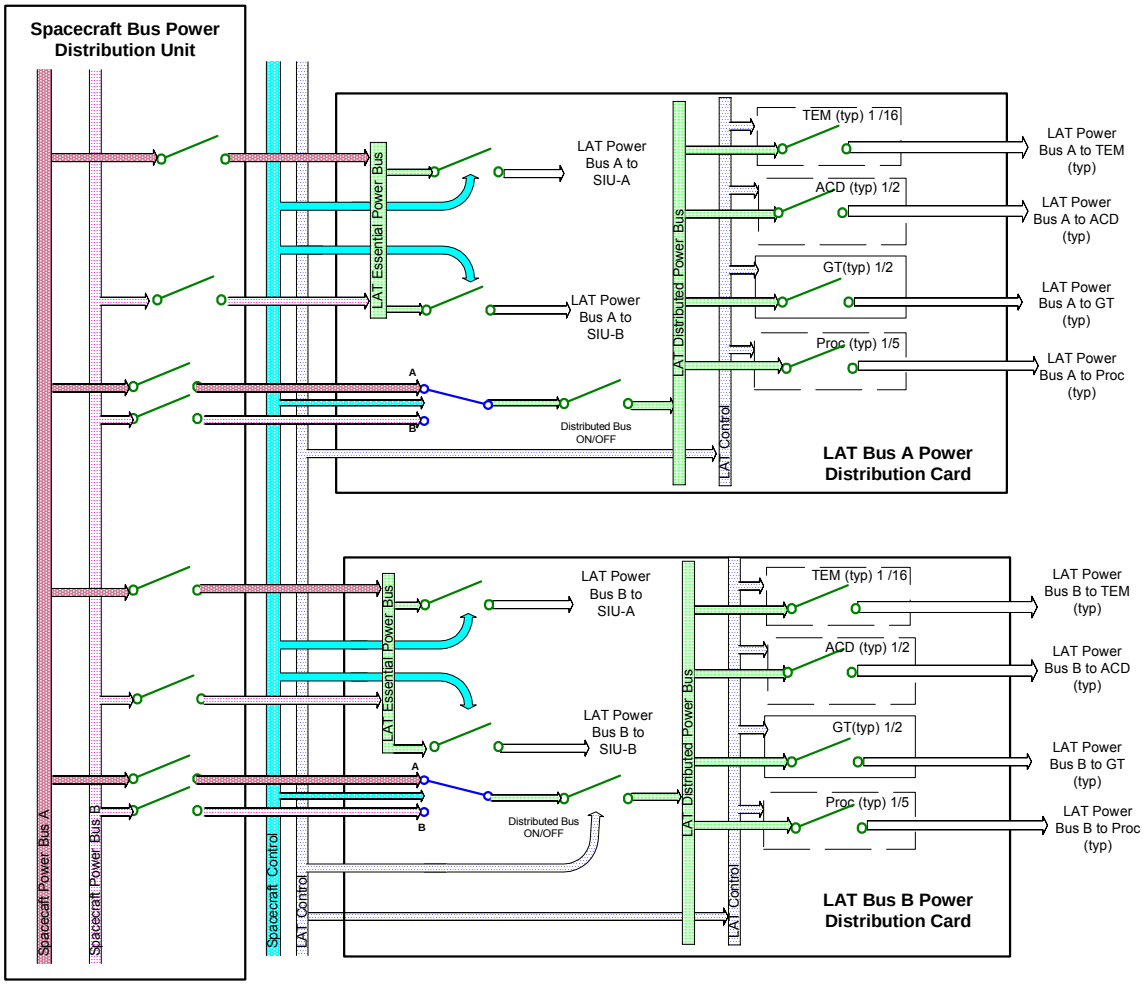
5.2.5 Input Power

The LAT power supply modules shall use 28 + 14/- 6 V DC as the primary input power. The LAT power distribution board will provide primary and redundant 28 V power to the power modules. All power supply modules shall interface to the LAT power distribution boards as shown in Figure 2.

5.2.5.1 Primary Power Bus Selection (TBR)

Each power supply module will be provided with a primary and redundant 28V DC source. Each power supply module must be capable of selecting which LAT distributed input power bus (primary or redundant) to use as the active power source bus.

Figure 2 LAT Power Distribution



5.2.6 Output

5.2.6.1 Isolated Output

Each power supply module shall provide isolated subsystem power per the subsystem requirements. No subsystem shall obtain power from another subsystem or subsystem power supply.

5.2.6.2 Load Variation

Each power supply module except for the PMT 28V filter, must be able to maintain its respective regulation requirements to a 10% variation in output to the active load.

5.2.6.3 Minimum Load

All power supply modules must accept a minimum load of 0 A current.

5.2.6.4 Maximum Load

All power supply modules other than CAL and TKR bias must have a maximum load rating of 50% more than the required load current. The CAL/TKR bias load rating must be 20% more than the required load.

5.2.7 Thermal Control

Each power module shall be cooled by passive flow of heat through its interface to the LAT thermal/mechanical interface.

5.2.8 Input Power Control

The power distribution module shall provide for control of source power bus selection for each individual power supply.

5.2.8.1 Temperature

Each power supply module is to provide a nominal power supply operating temperature signal as measured at the heat sink interface.

5.3 Detailed Requirements of Subsystem Power Modules

5.3.1 GAS-PM

The GAS-PM shall provide isolated power to the ACD, Global Trigger and Signal distribution subsystems. The ACD subsystem requires 3.3 V for analog electronics and 28 V to power the 1000 V DC/DC converters of the PMT components. An additional 3.3V Digital power supply for the ACD and Global Trigger digital electronics is also required. The GAS-PM power supply components are shown in Figure 3.

5.3.1.1 GAS 3.3 V ACD Analog Power

The GAS-PM shall provide an isolated output of 3.3 V to support ACD analog electronics. The specifications for this power are provided in Table 5-5.

Table 5-5 GAS 3.3 V ACD Analog Electronics Power Supply Requirements

Power, W	Target Eff %	Acc %	RMS Noise	Bandwidth	Noise Spikes
.05	84 (TBR)	± 5	0.1 mV	0 - 1 MHz	1 mV

5.3.1.1.1 Output Power

The maximum output power shall be .05 W.

5.3.1.1.2 Output Voltage

The nominal output voltage shall be 3.3 V.

5.3.1.1.3 Efficiency

Target efficiency shall be 84% at 28 V input and .05 W.

5.3.1.1.4 Output Voltage Accuracy

Output Voltage Accuracy shall be ± 5%.

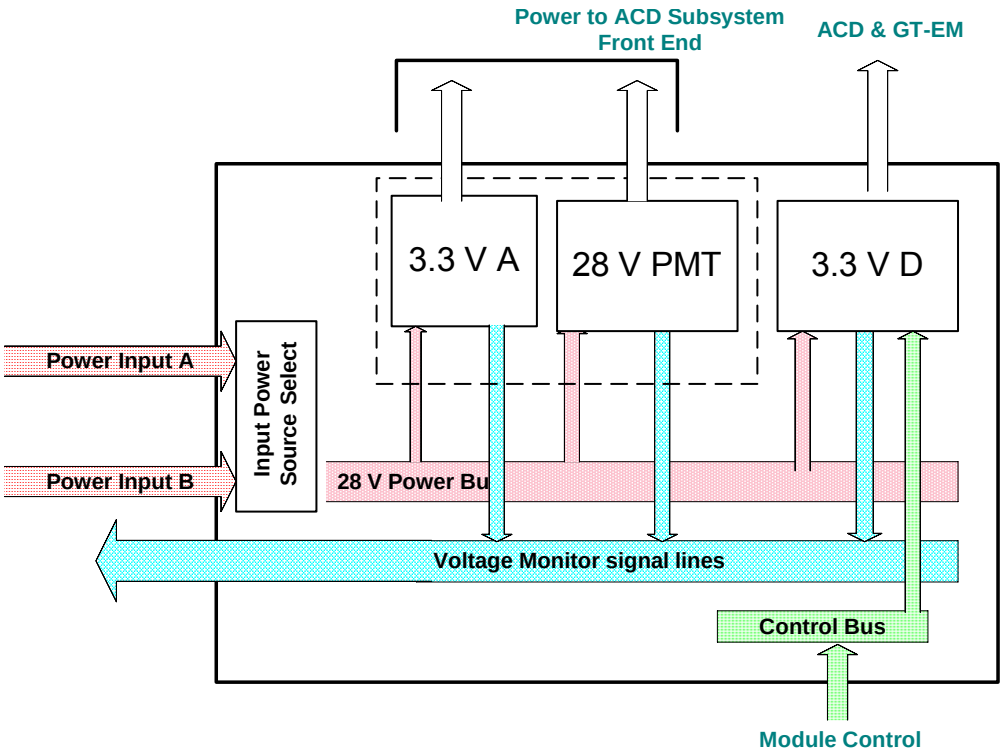
5.3.1.1.5 Line Regulation

Line Regulation shall be .1% over the input voltage range.

5.3.1.1.6 Load Regulation

Load regulation shall be .1% from 10% (.005 W) to 100% (.05 W) of full load.

Figure 3 GAS Power Supply Components



5.3.1.1.7 Noise Spikes (Ripple)

Maximum noise spikes at the switching frequency shall be ≤ 1 mV peak-to-peak.

5.3.1.1.8 RMS Noise

RMS noise between 0 and 1 MHz shall be ≤ .1 mV.

5.3.1.1.9 Survival Temperature Range

The survival temperature range shall be –20 to 50 ºC.

5.3.1.1.10 Operating Temperature Range

The operating temperature range shall be –10 to 25ºC.

5.3.1.1.11 Power Supply Rise/Fall Time

Power-up output voltage rise-time shall be > 1 msec/V.
Power-down output voltage fall-time shall be < 1 sec/V, > 10 msec/V.

5.3.1.1.12 Mechanical

Input connectors shall be TBD.
Output connectors shall be TBD.

5.3.1.2 GAS 28 V ACD Photo Multiplier Tube (PMT) Power

The GAS-PM shall provide a filtered output of 28 + 11/- 6 V power to the PMT 1000 V DC/DC converters within the ACD subsystem. The specifications for this power are provided in Table 5-7.

Table 5-7 GAS 28 V ACD PMT Power Supply Requirements

Power, W	Target Eff %	Acc %	RMS Noise	Bandwidth	Noise Spikes
4.5	N/A	N/A	10 mV	0 - 1 MHz	10 mV

5.3.1.2.1 Output Power

The maximum output power shall be 4.5 W.

5.3.1.2.2 Output Voltage

The nominal output voltage shall be 28 + 11/- 6 V.

5.3.1.2.3 Noise Spikes (Ripple)

Maximum noise spikes at the switching frequency shall be ≤10 mV peak-to-peak.

5.3.1.2.4 RMS Noise

RMS noise between 0 and 1 MHz shall be ≤ 10 mV.

5.3.1.2.5 Survival Temperature Range

The survival temperature range shall be –20 to 50 ºC.

5.3.1.2.6 Operating Temperature Range

The operating temperature range shall be –10 to 25ºC.

5.3.1.2.7 Mechanical

Input connectors shall be TBD.
Output connectors shall be TBD.

5.3.1.3 3.3 V GAS EM Digital Power

The GAS-3.3V digital PM shall provide an isolated output of 3.3 V to support GAS-EM digital electronics. The specifications for this power are provided in Table 5-6.

Table 5-6 3.3 V GAS EM Digital Electronics Power Supply Requirements

Power, W	Target Eff %	Acc %	RMS Noise	Bandwidth	Noise Spikes
.1	84 (TBR)	± 5	1.0 mV	0 - 1 MHz	5 mV

5.3.1.3.1 Output Power

The maximum output power shall be .1 W.

5.3.1.3.2 Output Voltage

The nominal output voltage shall be 3.3 V.

5.3.1.3.3 Efficiency

Target efficiency shall be 84% at 28 V input and .1 W.

5.3.1.3.4 Output Voltage Accuracy

Output Voltage Accuracy shall be ± 5%.

5.3.1.3.5 Line Regulation

Line Regulation shall be .1% over the input voltage range.

5.3.1.3.6 Load Regulation

Load regulation shall be .1% from 10% (.01 W) to 100% (.1 W) of full load.

5.3.1.3.7 Noise Spikes (Ripple)

Maximum noise spikes at the switching frequency shall be ≤ 5 mV peak-to-peak.

5.3.1.3.8 RMS Noise

RMS noise between 0 and 1 MHz shall be ≤ 1 mV.

5.3.1.3.9 Survival Temperature Range

The survival temperature range shall be –20 to 50 ºC.

5.3.1.3.10 Operating Temperature Range

The operating temperature range shall be –10 to 25ºC.

5.3.1.3.11 Power Supply Rise/Fall Time

Power-up output voltage rise-time shall be > 1 msec/V.
Power-down output voltage fall-time shall be < 1 sec/V, > 10 msec/V.

5.3.1.3.12 Mechanical

Input connectors shall be TBD.
Output connectors shall be TBD.

5.3.1.4 GAS-PM Mechanical Packaging

The GAS-PM is to be a module within the GAS box. The module is to be packaged within a TBD cm wide x TBD cm long x TBD cm high.

5.3.1.5 GAS-PM Command and Control Signals

The GAS-PM requires the following digital control signals:

- GAS-EM power ON/OFF

5.3.1.6 GAS-PM Monitor and Status Signals

The GAS-PM requires the following monitor and status signals:

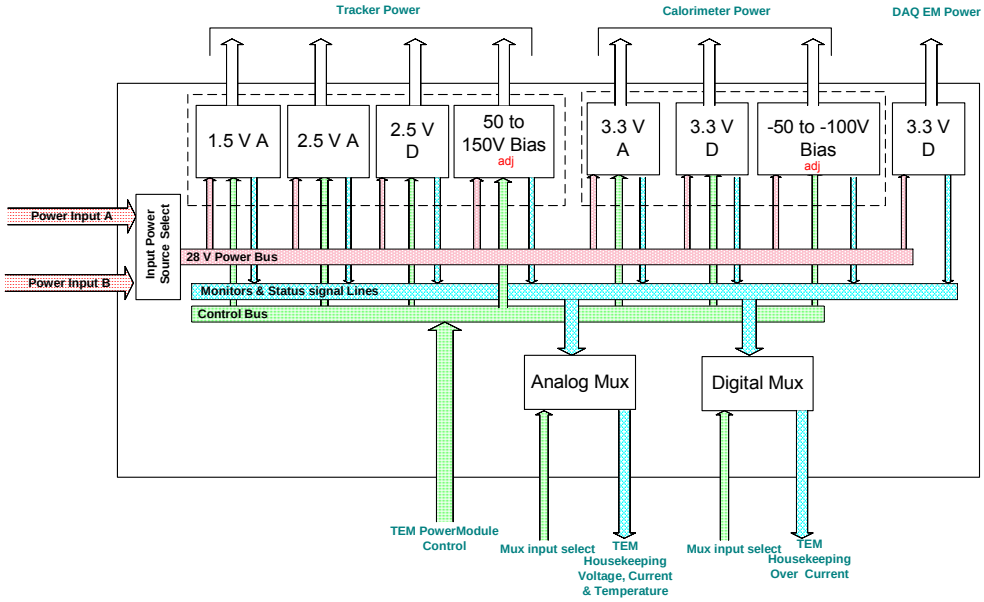
- Power supply voltages (3 ea)
- Power supply current (3 ea)
- Power supply temperature (2 ea)

A high impedance isolation resistor, nominally 10 kΩ (TBR) is required on both the signal and return lines of each monitor signal pair.

5.3.2 TCD-PM

The LAT electronic power supply modules shall provide all power supplies required by the TKR and CAL tower modules. This includes CAL PIN diode power supplies and TKR bias supplies. Configuration of the TCD-PM is shown in Figure 4.

Figure 4 TCD-PM Configuration



5.3.2.1 CAL 3.3 V Analog Power Supply

The TKR/CAL power supply module shall provide 3.3 V analog to each detector module of the CAL per Table 5-8.

Table 5-8 CAL 3.3 V Analog Electronics Power Supply Requirements

Power, W	Target Eff %	Acc %	RMS Noise	Bandwidth	Noise Spikes
1.5	75(TBR)	± 5	0.1 mV	0 - 500 kHz	1 mV

5.3.2.1.1 Output Power

The maximum output power shall be 1.5 W.

5.3.2.1.2 Output Voltage

The nominal output voltage shall be 3.3 V.

5.3.2.1.3 Efficiency

Target efficiency shall be 75% at 28 V input and 1.5 W.

5.3.2.1.4 Output Voltage Accuracy

Output Voltage Accuracy shall be ± 5%.

5.3.2.1.5 Line Regulation

Line Regulation shall be .1% over the input voltage range.

5.3.2.1.6 Load Regulation

Load regulation shall be .1% from 10% (.15 W) to 100% (1.5 W) of full load.

5.3.2.1.7 Noise Spikes (Ripple)

Maximum noise spikes at the switching frequency shall be ≤ 1 mV peak-to-peak.

5.3.2.1.8 RMS Noise

RMS noise between 0 and 1 MHz shall be ≤ 0.1 mV.

5.3.2.1.9 Survival Temperature Range

The survival temperature range shall be –20 to 50 ºC.

5.3.2.1.10 Operating Temperature Range

The operating temperature range shall be –10 to 25ºC.

5.3.2.1.11 Power Supply Rise/Fall Time

Power-up output voltage rise-time shall be > 1 msec/V.
Power-down output voltage fall-time shall be < 1 sec/V, > 10 msec/V.

5.3.2.1.12 Mechanical

Input connectors shall be TBD.
Output connectors shall be TBD.

5.3.2.2 CAL 3.3 V Digital Power Supply

The TKR/CAL power supply module shall provide 3.3 V digital to each detector module of the CAL per Table 5-9.

Table 5-9 CAL 3.3 V Digital Electronics Power Supply Requirements

Power, W	Target Eff %	Acc %	RMS Noise	Bandwidth	Noise Spikes

1.3	75 (TBR)	± 5	1 mV	0 - 500 kHz	5 mV

5.3.2.2.1 Output Power

The maximum output power shall be 1.3 W.

5.3.2.2.2 Output Voltage

The nominal output voltage shall be 3.3 V.

5.3.2.2.3 Efficiency

Target efficiency shall be 75% at 28 V input and 1.3 W.

5.3.2.2.4 Output Voltage Accuracy

Output Voltage Accuracy shall be ± 5%.

5.3.2.2.5 Line Regulation

Line Regulation shall be .1% over the input voltage range.

5.3.2.2.6 Load Regulation

Load regulation shall be .1% from 10% (.13 W) to 100% (1.3 W) of full load.

5.3.2.2.7 Noise Spikes (Ripple)

Maximum noise spikes at the switching frequency shall be ≤5 mV peak-to-peak.

5.3.2.2.8 RMS Noise

RMS noise between 0 and 1 MHz shall be ≤ 1 mV.

5.3.2.2.9 Survival Temperature Range

The survival temperature range shall be –20 to 50 ºC.

5.3.2.2.10 Operating Temperature Range

The operating temperature range shall be –10 to 25ºC.

5.3.2.2.11 Power Supply Rise/Fall Time

Power-up output voltage rise-time shall be > 1 msec/V.
Power-down output voltage fall-time shall be < 1 sec/V, > 10 msec/V.

5.3.2.2.12 Mechanical

Input connectors shall be TBD.
Output connectors shall be TBD.

5.3.2.3 CAL - 50 to - 100 V PIN Diode Bias Power Supply Module

The TKR/CAL power supply module shall provide -50 to -100 V bias power to the calorimeter PIN diodes per Table 5-10.

Table 5-10 CAL - 50 to - 100 V Analog PIN Diode Power Supply Requirements

Power, W	Target Eff %	Acc %	RMS Noise	Bandwidth	Noise Spikes
0.1	TBD	± 0.5	1 mV	0 - 500 kHz	5 mV

5.3.2.3.1 Output Power

The maximum output power shall be 0.1 W.

5.3.2.3.2 Output Voltage

The nominal output voltage shall be –50 to -100 V.

5.3.2.3.3 Efficiency

Target efficiency shall be TBD% at 28 V input and 0.1 W.

5.3.2.3.4 Output Voltage Accuracy

Output Voltage Accuracy shall be ± .5%.

5.3.2.3.5 Line Regulation

Line Regulation shall be .1% over the input voltage range.

5.3.2.3.6 Load Regulation

Load regulation shall be .1%.

5.3.2.3.7 Noise Spikes (Ripple)

Maximum noise spikes at the switching frequency shall be ≤ 5 mV peak-to-peak.

5.3.2.3.8 RMS Noise

RMS noise between 0 and 1 MHz shall be ≤ 1 mV.

5.3.2.3.9 Survival Temperature Range

The survival temperature range shall be –20 to 50 ºC.

5.3.2.3.10 Operating Temperature Range

The operating temperature range shall be –10 to 25ºC.

5.3.2.3.11 Power Supply Rise/Fall Time

Power-up output voltage rise-time shall be > 1 msec/V.
Power-down output voltage fall-time shall be < 1 sec/V, > 10 msec/V.

5.3.2.3.12 Mechanical

Input connectors shall be TBD.
Output connectors shall be TBD.

The CAL PIN diode power supply module shall have the following additional specifications:

5.3.2.3.13 Programming Range

Voltage range -50 to -100 V programmable in ~ 1 V steps

5.3.2.3.14 Load

Minimum load	0.1 μA
Maximum load	0.1 mA

5.3.2.4 TKR 1.5 V Analog Power Supply Module

The TKR/CAL power supply module shall provide 1.5 V analog to the TKR per Table 5-11.

Table 5-11 TKR 1.5 V Analog Power Supply Module Requirements

Power, W	Target Eff %	Acc %	RMS Noise	Bandwidth	Noise Spikes
3.6	69 (TBR)	± 5	0.2 mV	0 - 1 MHz	1 mV

5.3.2.4.1 Output Power

The maximum output power shall be 3.6 W.

5.3.2.4.2 Output Voltage

The nominal output voltage shall be 1.5 V.

5.3.2.4.3 Efficiency

Target efficiency shall be 69% at 28 V input and 3.6 W.

5.3.2.4.4 Output Voltage Accuracy

Output Voltage Accuracy shall be ± 5%.

5.3.2.4.5 Line Regulation

Line Regulation shall be .1% over the input voltage range.

5.3.2.4.6 Load Regulation

Load regulation shall be .1% from 10% (.36 W) to 100% (3.6 W) of full load.

5.3.2.4.7 Noise Spikes (Ripple)

Maximum noise spikes at the switching frequency shall be < 1 mV peak-to-peak.

5.3.2.4.8 RMS Noise

RMS noise between 0 and 1 MHz shall be ≤ .2 mV.

5.3.2.4.9 Survival Temperature Range

The survival temperature range shall be –20 to 50 ºC.

5.3.2.4.10 Operating Temperature Range

The operating temperature range shall be –10 to 25ºC.

5.3.2.4.11 Power Supply Rise/Fall Time

Power-up output voltage rise-time shall be > 1 msec/V.
Power-down output voltage fall-time shall be < 1 sec/V, > 10 msec/V.

5.3.2.4.12 Mechanical

Input connectors shall be TBD.
Output connectors shall be TBD.

5.3.2.5 TKR 2.5 V Analog Power Supply Module

The TKR/CAL power supply module shall provide 2.5 V analog to the TKR per Table 5-12.

Table 5-12 TKR 2.5 V Analog Power Supply Module Requirements

Power, W	Target Eff %	Acc %	RMS Noise	Bandwidth	Noise Spikes
1.2	75 (TBR)	± 5	0.2 mV	0 - 1 MHz	1 mV

5.3.2.5.1 Output Power

The maximum output power shall be 1.2 W.

5.3.2.5.2 Output Voltage

The nominal output voltage shall be 2.5 V.

5.3.2.5.3 Efficiency

Target efficiency shall be 75% at 28 V input and 1.2 W.

5.3.2.5.4 Output Voltage Accuracy

Output Voltage Accuracy shall be ± 5%.

5.3.2.5.5 Line Regulation

Line Regulation shall be .1% over the input voltage range.

5.3.2.5.6 Load Regulation

Load regulation shall be .1% from 10% (.12 W) to 100% (1.2 W) of full load.

5.3.2.5.7 Noise Spikes (Ripple)

Maximum noise spikes at the switching frequency shall be ≤ 1 mV peak-to-peak.

5.3.2.5.8 RMS Noise

RMS noise between 0 and 1 MHz shall be ≤ .2 mV.

5.3.2.5.9 Survival Temperature Range

The survival temperature range shall be –20 to 50 ºC.

5.3.2.5.10 Operating Temperature Range

The operating temperature range shall be –10 to 25ºC.

5.3.2.5.11 Power Supply Rise/Fall Time

Power-up output voltage rise-time shall be > 1 msec/V.
Power-down output voltage fall-time shall be < 1 sec/V, > 10 msec/V.

5.3.2.5.12 Mechanical

Input connectors shall be TBD.
Output connectors shall be TBD.

5.3.2.6 TKR 2.5 V Digital Power Supply Module

The TKR/CAL power supply module shall provide 2.5 V digital to the TKR per Table 5-13.

Table 5-13 TKR 2.5 V Digital Power Supply Module Requirements

Power, W	Target Eff %	Acc %	RMS Noise	Bandwidth	Noise Spikes
5.9	75 (TBR)	± 5	1 mV	0 - 1 MHz	5 mV

5.3.2.6.1 Output Power

The maximum output power shall be 5.9 W.

5.3.2.6.2 Output Voltage

The nominal output voltage shall be 2.5 V.

5.3.2.6.3 Efficiency

Target efficiency shall be 75% at 28 V input and 5.9 W.

5.3.2.6.4 Output Voltage Accuracy

Output Voltage Accuracy shall be ± 5%.

5.3.2.6.5 Line Regulation

Line Regulation shall be .1% over the input voltage range.

5.3.2.6.6 Load Regulation

Load regulation shall be .1% from 10% (.59 W) to 100% (5.9 W) of full load.

5.3.2.6.7 Noise Spikes (Ripple)

Maximum noise spikes at the switching frequency shall be ≤ 5 mV peak-to-peak.

5.3.2.6.8 RMS Noise

RMS noise between 0 and 1 MHz shall be ≤ 1 mV.

5.3.2.6.9 Survival Temperature Range

The survival temperature range shall be –20 to 50 ºC.

5.3.2.6.10 Operating Temperature Range

The operating temperature range shall be –10 to 25ºC.

5.3.2.6.11 Power Supply Rise/Fall Time

Power-up output voltage rise-time shall be > 1 msec/V.
Power-down output voltage fall-time shall be < 1 sec/V, > 10 msec/V.

5.3.2.6.12 Mechanical

Input connectors shall be TBD.
Output connectors shall be TBD.

5.3.2.7 TKR 50 to 150 V Analog Power Supply Module

The TKR silicon strip bias power supply module shall provide 50 to 150 V analog power to the TKR per Table 5-14.

Table 5-14 TKR 50 to 150 V Analog Power Supply Module Requirements

Power, W	Target Eff %	Acc %	RMS Noise	Bandwidth	Noise Spikes
1.2	TBD	± 0.5	10 mV	0 - 1 MHz	10 mV

5.3.2.7.1 Output Power

The maximum output power shall be 1.2 W.

5.3.2.7.2 Output Voltage

The nominal output voltage shall be 50 to 150 V.

5.3.2.7.3 Efficiency

Target efficiency shall be TBD% at 28 V input and 1.2 W.

5.3.2.7.4 Output Voltage Accuracy

Output Voltage Accuracy shall be ± .5%.

5.3.2.7.5 Line Regulation

Line Regulation shall be .1% over the input voltage range.

5.3.2.7.6 Load Regulation

Load regulation shall be .1% from 10% (.12 W) to 100% (1.2 W) of full load.

5.3.2.7.7 Noise Spikes (Ripple)

Maximum noise spikes at the switching frequency shall be ≤ 10 mV peak-to-peak.

5.3.2.7.8 RMS Noise

RMS noise between 0 and 1 MHz shall be ≤ 10 mV.

5.3.2.7.9 Survival Temperature Range

The survival temperature range shall be –20 to 50 ºC.

5.3.2.7.10 Operating Temperature Range

The operating temperature range shall be –10 to 25ºC.

5.3.2.7.11 Power Supply Rise/Fall Time

Power-up output voltage rise-time shall be > 1 msec/V.
Power-down output voltage fall-time shall be < 1 sec/V, > 10 msec/V.

5.3.2.7.12 Mechanical

Input connectors shall be TBD.

Output connectors shall be TBD.

The TKR Bias power supply module shall have the following additional specifications:

5.3.2.7.13 Programming Range

Voltage range 50 to 150 V programmable in ~ 1 V steps

5.3.2.7.14 Load

Minimum load	0.1 μA
Maximum load (TBR)	0.1 mA

5.3.2.8 DAQ-EM 3.3 V Digital Power Supply Module

The DAQ-EM power supply module shall provide 3.3 V digital to the DAQ-EM per Table 5-15.

Table 5-15 DAQ-EM 3.3 V Digital Power Supply Module Requirements

Power, W	Target Eff %	Acc %	RMS Noise	Bandwidth	Noise Spikes
2.9	84%	± 5	10 mV	0-1 MHz	10 mV

5.3.2.8.1 Output Power

The maximum output power shall be 2.9 W.

5.3.2.8.2 Output Voltage

The nominal output voltage shall be 3.3 V.

5.3.2.8.3 Efficiency

Target efficiency shall be 84% at 28 V input and 2.9 W.

5.3.2.8.4 Output Voltage Accuracy

Output Voltage Accuracy shall be ± 5%.

5.3.2.8.5 Line Regulation

Line Regulation shall be .1% over the input voltage range.

5.3.2.8.6 Load Regulation

Load regulation shall be .1% from 10% (.29 W) to 100% (2.9 W) of full load.

5.3.2.8.7 Noise Spikes (Ripple)

Maximum noise spikes at the switching frequency shall be ≤ 10 mV peak-to-peak.

5.3.2.8.8 RMS Noise

RMS noise between 0 and 1 MHz shall be ≤ 10 mV.

5.3.2.8.9 Survival Temperature Range

The survival temperature range shall be –20 to 50 ºC.

5.3.2.8.10 Operating Temperature Range

The operating temperature range shall be –10 to 25ºC.

5.3.2.8.11 Power Supply Rise/Fall Time

Power-up output voltage rise-time shall be > 1 msec/V.
Power-down output voltage fall-time shall be < 1 sec/V, > 10 msec/V.

5.3.2.8.12 Mechanical

Input connectors shall be TBD.
Output connectors shall be TBD.

5.3.2.9 TCD-PM Mechanical Packaging

The TCD-PMs are to be housed in a TKR/CAL tower electronics tray. A TKR/CAL DAQ-EM power supply board has 2 power modules on it. Each TKR/CAL tower has its own power supply mounted below the DAQ electronics module. This pair becomes a TEM set. This constrains the TKR/CAL DAQ-EM power supply module to the same physical dimensions as a TEM electronics board. The TKR/CAL DAQ-EM power supply, consisting of 2 modules is to be packaged within a volume 25 cm wide x 25 cm long x 5 cm high.

5.3.2.10 TCD-PM Command and Control Signals

The TCD-PM requires the following control signals as shown in Figure 5:

- Power supply output ON/OFF, 1 ACU for TKR 2.5 V, CAL 3.3 V, TKR bias, CAL bias
- CAL Bias Voltage Set, analog voltage, CMOS digital
- TKR Bias Voltage Set, analog voltage
- Mux select address, 5 digital CMOS signals for monitors
- Mux select address, over current signal, 5 digital CMOS

5.3.2.11 TCD-PM Monitor and Status Signals

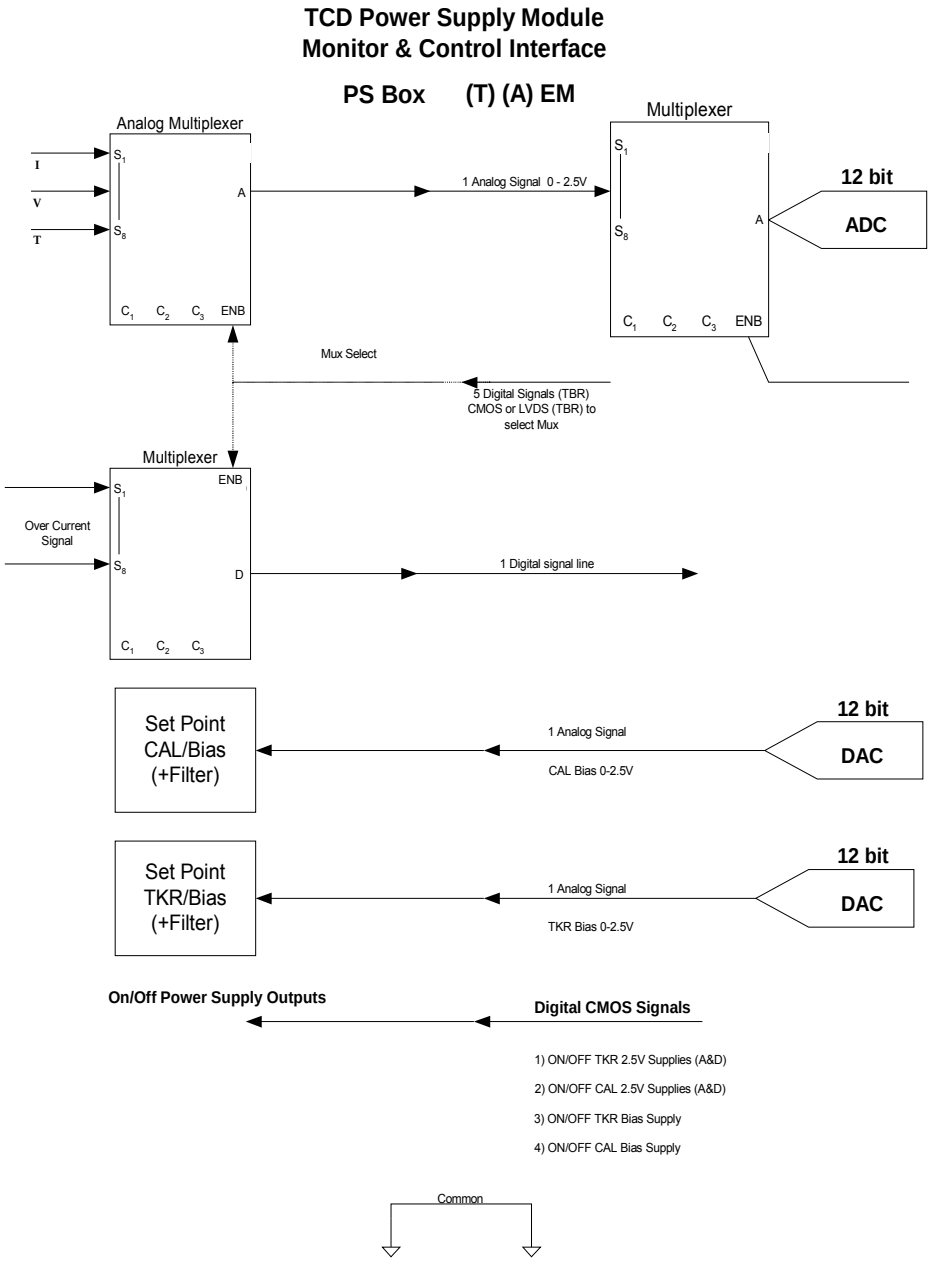
The TCD-PM requires the following monitor and status signals for each power supply:

- Power supply voltage via on-board mux
- Power supply current via on-board mux
- Power supply temperature via on-board mux
- Over-current signal

Note: Analog voltage ranges for reporting is to be are 0 – 2.5 V. Signals do not need to span the full range (to be agreed upon during the design phase).

These are shown in Figure 5. The power supply module must provide an on-board monitor of over-current conditions. A digital CMOS-compatible alarm signal through a digital mux shall be provided. A high impedance isolation resistor, nominally 10 kΩ (TBR) is required on both the signal and return lines of each monitor signal pair.

Figure 5 TCD Power Module Monitor and Control Interface



5.3.3 EP-PM

The EP-PM shall have separate, isolated power supply modules for each EPE module. The EPE modules are the processors of the processor farm. This power module is shown in Figure 6.

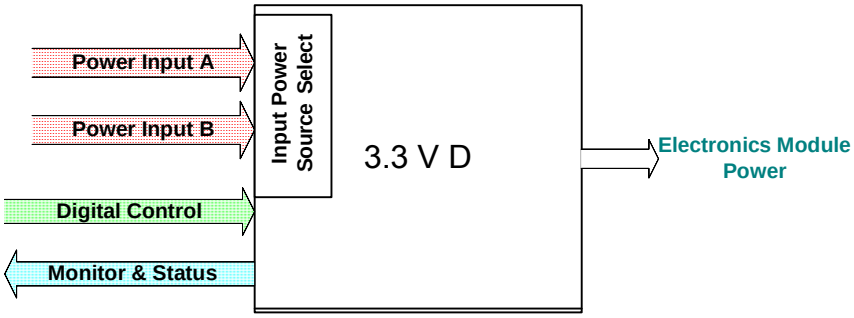
5.3.3.1 EPE 3.3 V Digital Power Supply Module

The EPE power supply module shall provide 3.3 V digital logic power to each tower module and each stand-alone EPE module per Table 5-16. Also required is an over current monitor signal. This signal will be from an externally controlled digital signal mux as shown in Figure 5.

Table 5-16 EPE 3.3 V Digital Power Supply Module Requirements

Power, W	Target Eff %	Acc %	RMS Noise	Bandwidth	Noise Spikes
20	84 (TBR)	± 5	10 mV	0 - 1 MHz	10 mV

Figure 6 EPE Power Module



5.3.3.1.1 Output Power

The maximum output power shall be 20 W.

5.3.3.1.2 Output Voltage

The nominal output voltage shall be 3.3 V.

5.3.3.1.3 Efficiency

Target efficiency shall be 84% at 28 V input and 20 W.

5.3.3.1.4 Output Voltage Accuracy

Output Voltage Accuracy shall be ± 5%.

5.3.3.1.5 Line Regulation

Line Regulation shall be .1% over the input voltage range.

5.3.3.1.6 Load Regulation

Load regulation shall be .1% from 10% (2 W) to 100% (20 W) of full load.

5.3.3.1.7 Noise Spikes (Ripple)

Maximum noise spikes at the switching frequency shall be ≤ 10 mV peak-to-peak.

5.3.3.1.8 RMS Noise

RMS noise between 0 and 1 MHz shall be ≤ 10 mV.

5.3.3.1.9 Survival Temperature Range

The survival temperature range shall be –20 to 50 ºC.

5.3.3.1.10 Operating Temperature Range

The operating temperature range shall be –10 to 25ºC.

5.3.3.1.11 Power Supply Rise/Fall Time

Power-up output voltage rise-time shall be > 1 msec/V.
Power-down output voltage fall-time shall be < 1 sec/V, > 10 msec/V.

5.3.3.1.12 Mechanical

Input connectors shall be TBD.
Output connectors shall be TBD.

5.3.3.2 EPE Power Module Mechanical Packaging

The EPE power module is to be a companion module to the EPE processor electronics modules. This constrains the EPE processor power supply to being mounted on the EPE processor electronics board. The module is to be packaged within a volume of TBD cm wide x TBD cm long x TBD cm high.

5.3.3.3 EPE Power Module Monitor and Status Signals

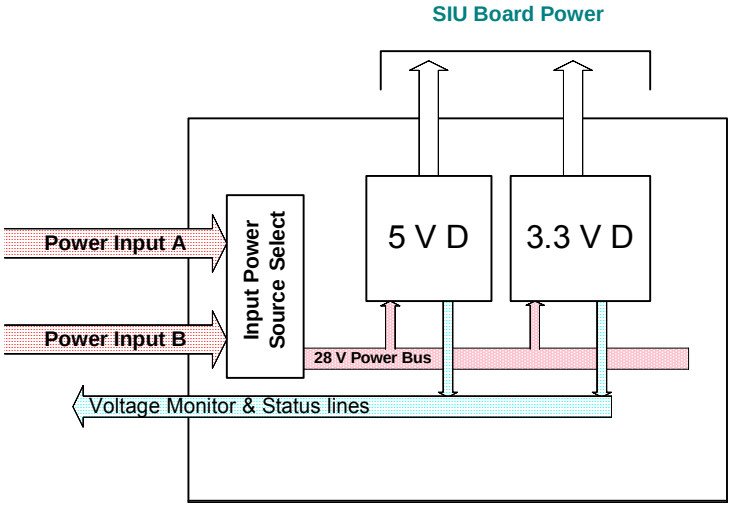
The EPE power module requires the following monitor signals:

- Power supply voltage
- Power supply current
- Power supply temperature

5.3.4 SIU-PM

The SIU-PM shall provide 5 and 3.3 V power to the SIU electronics. The SIU power module is shown in Figure 8.

Figure 8 SIU Power Module



5.3.4.1 SIU 5V Power Supply Module

The SIU power supply module shall provide 5 V digital logic power to the SIU electronics per Table 5-17.

5.3.4.1.1 Output Power

The maximum output power shall be 5 W.

5.3.4.1.2 Output Voltage

The nominal output voltage shall be 5 V.

5.3.4.1.3 Efficiency

Target efficiency shall be 84% at 28 V input and 5 W.

5.3.4.1.4 Output Voltage Accuracy

Output Voltage Accuracy shall be ± 5%.

5.3.4.1.5 Line Regulation

Line Regulation shall be .1% over the input voltage range.

5.3.4.1.6 Load Regulation

Load regulation shall be .1% from 10% (.5 W) to 100% (5 W) of full load.

5.3.4.1.7 Noise Spikes (Ripple)

Maximum noise spikes at the switching frequency shall be ≤ 10 mV peak-to-peak.

5.3.4.1.8 RMS Noise

RMS noise between 0 and 1 MHz shall be ≤ 10 mV.

5.3.4.1.9 Survival Temperature Range

The survival temperature range shall be –20 to 50 ºC.

5.3.4.1.10 Operating Temperature Range

The operating temperature range shall be –10 to 25ºC.

5.3.4.1.11 Power Supply Rise/Fall Time

Power-up output voltage rise-time shall be > 1 msec/V.
Power-down output voltage fall-time shall be < 1 sec/V, > 10 msec/V.

5.3.4.1.12 Mechanical

Input connectors shall be TBD.
Output connectors shall be TBD.

5.3.4.2 SIU 3.3 V Digital Power Supply Module

The SIU power supply module shall provide 3.3 V digital logic power to the SIU electronics per Table 5-17.

5.3.4.2.1 Output Power

The maximum output power shall be 6 W.

5.3.4.2.2 Output Voltage

The nominal output voltage shall be 3.3 V.

5.3.4.2.3 Efficiency

Target efficiency shall be 84% at 28 V input and 6 W.

5.3.4.2.4 Output Voltage Accuracy

Output Voltage Accuracy shall be ± 5%.

5.3.4.2.5 Line Regulation

Line Regulation shall be .1% over the input voltage range.

5.3.4.2.6 Load Regulation

Load regulation shall be .1% from 10% (.6 W) to 100% (6 W) of full load.

5.3.4.2.7 Noise Spikes (Ripple)

Maximum noise spikes at the switching frequency shall be ≤ 10 mV peak-to-peak.

5.3.4.2.8 RMS Noise

RMS noise between 0 and 1 MHz shall be ≤ 10 mV.

5.3.4.2.9 Survival Temperature Range

The survival temperature range shall be –20 to 50 ºC.

5.3.4.2.10 Operating Temperature Range

The operating temperature range shall be –10 to 25ºC.

5.3.4.2.11 Power Supply Rise/Fall Time

Power-up output voltage rise-time shall be > 1 msec/V.
Power-down output voltage fall-time shall be < 1 sec/V, > 10 msec/V.

5.3.4.2.12 Mechanical

Input connectors shall be TBD.
Output connectors shall be TBD.

Table 5-17 SIU Electronics Power Supply Requirements

Voltage	Power, W	Target Eff %	Acc %	RMS Noise	Bandwidth	Noise Spikes	Regulation		
							Line	Load	Temp.
5	5	84 (TBR)	±5	10 mV	0 - 1 MHz	10 mV	.1 % (TBR)	.1 % (TBR)	-10 – 25 °C
3.3	6	84 (TBR)	±5	10 mV	0 - 1 MHz	10 mV	.1 % (TBR)	.1 % (TBR)	-10 – 25 °C

5.3.4.3 Switched Power

SIU power will be switched by command from the spacecraft bus power control unit. This will occur through the LAT power distribution board.

5.3.4.4 SIU Power Supply Module Mechanical Packaging

The SIU power supply module is to be a companion module to the SIU electronics module. This constrains the SIU power supply to being mounted on the SIU electronics board. The module is to be packaged within a volume TBD cm wide x TBD cm long x TBD cm high.

5.3.4.5 SIU Power Module Command and Control Signals

The SIU power module requires the following command and control signals:

- Power supply ON/OFF

5.3.4.6 SIU Power Module Monitor and Status Signals

The SIU power module requires the following monitor and status signals for each supply:

- Power supply voltage
- Power supply current
- Power supply temperature

A high impedance isolation resistor, nominally 10 kΩ (TBR) is required on both the signal and return lines of each monitor signal pair.

6 GROUNDING

Per LAT Grounding Plan.

7 ENVIRONMENTAL

All power supply modules shall meet the structural and thermal environment requirements defined in the LAT Mechanical Performance Specification, LAT-SS-TBR.

8 RELIABILITY

The probability that any of the power modules will experience a complete loss of operation due to the failure of any of its components shall be less than TBD % in 5 years. No single failure is to bring the LAT below the science requirements.

9 OPERABILITY

The power modules shall be designed such that the failure or degradation of components at the predicted rate shall not result in a loss of more than 10% (TBR) of effective power in 5 years. A power module shall be capable of normal operation after being subjected to the environmental conditions given in LAT-SP-00010, Section 5.3.12, Environmental.

10 SAFETY

Per Program Safety Policy (TBR).

11 PERFORMANCE VERIFICATION MATRIX

The Performance Verification Matrix for the LAT power supply modules is shown in Table 5-18 This indicates how the desired performance of elements of this specification will be verified. The basic concepts underlying the verification matrix are as follows. An element of the specification can be verified at the highest level in 1 of 4 ways: Test (T), Inspection (I), Analysis (A) or Demonstration (D). In the latter 3 cases the verification metric is Pass/Fail (P/F). In the case of Test, there are 2 possibilities. The element can be verified by means of a Functional (F) Test in which some feature either functions or does not. In this case the test metric is P/F. If, on the other hand, the element needs to be verified in a quantitative manner in a Performance (P) Test the test metric will be some measurable item such as Time (Ti), Data Rate (DR), or an Analog (An) or Digital (Dg) measurement.

Table 5-18 Power Supply Performance Verification Matrix

Key: T: Test; I: Inspection; A: Analysis; D: Demonstration
F: Functional; P/F: Pass/Fail; P: Performance; Ti: Time; DR: Data Rate; An: Analog; Dg: Digital

Item	Value	Verification	Test Type	Metric
5.3.1.1 GAS 3.3 V ACD An				
Power Provided	1.3 W	A		P/F
Target Efficiency	84 % (TBR)	A		P/F
Accuracy	± 5 %	T	P	An
RMS Noise	≤ 0.1 mV	T	P	An
Bandwidth	0 - 1 MHz	T	P	An
Noise Spikes	≤ 1 mV	T	P	An
Line Regulation	≤ 0.1 % (TBR)	T	P	An
Load Regulation	≤ 0.1 % (TBR)	T	P	An
Survival Temperature Range	-20 – 50 °C	T	P	An
Operating Temperature Range	-10 – 25 °C	T	P	An
Power-up output voltage rise-time	> 1 msec/V	T	P	An
Power-down output voltage fall-time	< 1 sec/V, > 10 msec/V	T	P	An
Input Connectors	TBD	I		P/F
Output Connectors	TBD	I		P/F
5.3.1.2 GAS 28 V ACD PMT/An				
Power Provided	4.35 W	A		P/F
RMS Noise	≤ 10 mV	T	P	An
Bandwidth	0 - 1 MHz	T	P	An
Noise Spikes	≤ 10 mV	T	P	An
Survival Temperature Range	-20 – 50 °C	T	P	An
Operating Temperature Range	-10 – 25 °C	T	P	An
Input Connectors	TBD	I		P/F
Output Connectors	TBD	I		P/F

Table 5-18 (Continued)

Item	Value	Verification	Test Type	Metric
5.3.1.3 GAS EM Dg 3.3 V				
Power Provided	16 W	A		P/F
Target Efficiency	84 % (TBR)	A		P/F
Accuracy	± 5 %	T	P	Dg
RMS Noise	≤ 1.0 mV	T	P	Dg
Bandwidth	0 - 1 MHz	T	P	Dg
Noise Spikes	≤ 5 mV	T	P	Dg
Line Regulation	≤ 0.1 % (TBR)	T	P	Dg
Load Regulation	≤ 0.1 % (TBR)	T	P	Dg
Survival Temperature Range	-20 – 50 °C	T	P	An
Operating Temperature Range	-10 – 25 °C	T	P	An
Power-up output voltage rise-time	> 1 msec/V	T	P	An
Power-down output voltage fall-time	< 1 sec/V, > 10 msec/V	T	P	An
Input Connectors	TBD	I		P/F
Output Connectors	TBD	I		P/F
5.3.2.1 CAL An 3.3 V				
Power Provided	2.15 W	A		P/F
Efficiency	75 % (TBR)	A		P/F
Accuracy	±5 %	T	P	An
RMS Noise	≤ 0.1 mV	T	P	An
Bandwidth	0 - 500 kHz	T	P	An
Noise Spikes	≤ 1 mV	T	P	An
Line Regulation	≤ 0.1 % (TBR)	T	P	An
Load Regulation	≤ 0.1 % (TBR)	T	P	An
Survival Temperature Range	-20 – 50 °C	T	P	An
Operating Temperature Range	-10 – 25 °C	T	P	An
Power-up output voltage rise-time	> 1 msec/V	T	P	An
Power-down output voltage fall-time	< 1 sec/V, > 10 msec/V	T	P	An
Input Connectors	TBD	I		P/F
Output Connectors	TBD	I		P/F

Table 5-18 (Continued)

Item	Value	Verification	Test Type	Metric
5.3.2.2 CAL Dg 3.3 V				
Power Provided	3.7 W	A		P/F
Efficiency	75 % (TBR)	A		P/F
Accuracy	± 5 %	T	P	An
RMS Noise	≤ 1 mV	T	P	An
Bandwidth	0 – 500 kHz	T	P	An
Noise Spikes	≤ 5 mV	T	P	An
Line Regulation	≤ 0.1 % (TBR)	T	P	An
Load Regulation	≤ 0.1 % (TBR)	T	P	An
Survival Temperature Range	-20 – 50 °C	T	P	An
Operating Temperature Range	-10 – 25 °C	T	P	An
Power-up output voltage rise-time	> 1 msec/V	T	P	An
Power-down output voltage fall-time	< 1 sec/V, > 10 msec/V	T	P	An
Input Connectors	TBD	I		P/F
Output Connectors	TBD	I		P/F
5.3.2.3 CAL Bias -50 to -100 V adj				
Power Provided	0.1 W	A		P/F
Efficiency	TBD	A		P/F
Accuracy	± 0.5 %	T	P	An
RMS Noise	≤ 1 mV	T	P	An
Bandwidth	0 - 500 kHz	T	P	An
Noise Spikes	≤ 5 mV	T	P	An
Line Regulation	≤ 0.1 % (TBR)	T	P	An
Load Regulation	≤ 0.1 % (TBR)	T	P	An
Survival Temperature Range	-20 – 50 °C	T	P	An
Operating Temperature Range	-10 – 25 °C	T	P	An
Power-up output voltage rise-time	> 1 msec/V	T	P	An
Power-down output voltage fall-time	< 1 sec/V, > 10 msec/V	T	P	An
Input Connectors	TBD	I		P/F
Output Connectors	TBD	I		P/F
Programming Range	-50 to –100 V in ~ 1 V steps	T	P	An
Minimum Load	0.1 µA	T	P	An
Maximum Load	0.1 mA	T	P	An

Table 5-18 (Continued)

Item	Value	Verification	Test Type	Metric
5.3.2.4 TKR An 1.5 V				
Power Provided	3.7 W	A		P/F
Efficiency	69 % (TBR)	A		P/F
Accuracy	± 5 %	T	P	An
RMS Noise	≤ 0.2 mV	T	P	An
Bandwidth	0 – 1 MHz	T	P	An
Noise Spikes	≤ 1 mV	T	P	An
Line Regulation	≤ 0.1 % (TBR)	T	P	An
Load Regulation	≤ 0.1 % (TBR)	T	P	An
Survival Temperature Range	-20 – 50 °C	T	P	An
Operating Temperature Range	-10 – 25 °C	T	P	An
Power-up output voltage rise-time	> 1 msec/V	T	P	An
Power-down output voltage fall-time	< 1 sec/V, > 10 msec/V	T	P	An
Input Connectors	TBD	I		P/F
Output Connectors	TBD	I		P/F
5.3.2.5 TKR An 2.5 V				
Power Provided	1.0 W	A		P/F
Efficiency	75 % (TBR)	A		P/F
Accuracy	± 5 %	T	P	An
RMS Noise	≤ 1 mV	T	P	An
Bandwidth	0 - 1 MHz	T	P	An
Noise Spikes	≤ 1 mV	T	P	An
Line Regulation	≤ 0.1 % (TBR)	T	P	An
Load Regulation	≤ 0.1 % (TBR)	T	P	An
Survival Temperature Range	-20 – 50 °C	T	P	An
Operating Temperature Range	-10 – 25 °C	T	P	An
Power-up output voltage rise-time	> 1 msec/V	T	P	An
Power-down output voltage fall-time	< 1 sec/V, > 10 msec/V	T	P	An
Input Connectors	TBD	I		P/F
Output Connectors	TBD	I		P/F

Table 5-18 (Continued)

Item	Value	Verification	Test Type	Metric
5.3.2.6 TKR Dg 2.5 V				
Power Provided	4.75 W	A		P/F
Efficiency	75 % (TBR)	A		P/F
Accuracy	± 5 %	T	P	An
RMS Noise	≤ 1 mV	T	P	An
Bandwidth	0 – 1 MHz	T	P	An
Noise Spikes	≤ 5 mV	T	P	An
Line Regulation	≤ 0.1 % (TBR)	T	P	An
Load Regulation	≤ 0.1 % (TBR)	T	P	An
Survival Temperature Range	-20 – 50 °C	T	P	An
Operating Temperature Range	-10 – 25 °C	T	P	An
Power-up output voltage rise-time	> 1 msec/V	T	P	An
Power-down output voltage fall-time	< 1 sec/V, > 10 msec/V	T	P	An
Input Connectors	TBD	I		P/F
Output Connectors	TBD	I		P/F
5.3.2.7 TKR Bias 50 to 150 V				
Power Provided	0.6 W	A		P/F
Efficiency	TBD	A		P/F
Accuracy	± 0.5 %	T	P	An
RMS Noise	≤ 10 mV	T	P	An
Bandwidth	0 - 1 MHz	T	P	An
Noise Spikes	≤ 10 mV	T	P	An
Line Regulation	≤ 0.1 % (TBR)	T	P	An
Load Regulation	≤ 0.1 % (TBR)	T	P	An
Survival Temperature Range	-20 – 50 °C	T	P	An
Operating Temperature Range	-10 – 25 °C	T	P	An
Power-up output voltage rise-time	> 1 msec/V	T	P	An
Power-down output voltage fall-time	< 1 sec/V, > 10 msec/V	T	P	An
Input Connectors	TBD	I		P/F
Output Connectors	TBD	I		P/F
Programming Range	50 to 150 V in ~ 1 V steps	T	P	An
Minimum Load 0.1μA		T	P	An
Maximum Load 0.1 mA		T	P	An

Table 5-18 (Continued)

Item	Value	Verification	Test Type	Metric
5.3.2.8 DAQ-EM Dg 3.3 V				
Power Provided	3.25 W	A		P/F
Efficiency	84%	A		P/F
Accuracy	± 5 %	T	P	An
RMS Noise	≤ 10 mV	T	P	An
Bandwidth	0 – 1 MHz	T	P	An
Noise Spikes	≤ 10 mV	T	P	An
Line Regulation	≤ 0.1 % (TBR)	T	P	An
Load Regulation	≤ 0.1 % (TBR)	T	P	An
Survival Temperature Range	-20 – 50 °C	T	P	An
Operating Temperature Range	-10 – 25 °C	T	P	An
Power-up output voltage rise-time	> 1 msec/V	T	P	An
Power-down output voltage fall-time	< 1 sec/V, > 10 msec/V	T	P	An
Input Connectors	TBD	I		P/F
Output Connectors	TBD	I		P/F
5.3.3.1 EPE Dg 3.3 V				
Power Provided	18 W	A		P/F
Efficiency	84 % (TBR)	A		P/F
Accuracy	± 5 %	T	P	An
RMS Noise	≤ 10 mV	T	P	An
Bandwidth	0 - 1 MHz	T	P	An
Noise Spikes	≤ 10 mV	T	P	An
Line Regulation	≤ 0.1 % (TBR)	T	P	An
Load Regulation	≤ 0.1 % (TBR)	T	P	An
Survival Temperature Range	-20 – 50 °C	T	P	An
Operating Temperature Range	-10 – 25 °C	T	P	An
Power-up output voltage rise-time	> 1 msec/V	T	P	An
Power-down output voltage fall-time	< 1 sec/V, > 10 msec/V	T	P	An
Input Connectors	TBD	I		P/F
Output Connectors	TBD	I		P/F

Table 5-18 (Continued)

Item	Value	Verification	Test Type	Metric
5.3.4.1 SIU Dg 5 V				
Power Provided	5.6 W	A		P/F
Efficiency	84 % (TBR)	A		P/F
Accuracy	± 5 %	T	P	An
RMS Noise	≤ 10 mV	T	P	An
Bandwidth	0 - 1 MHz	T	P	An
Noise Spikes	≤ 10 mV	T	P	An
Line Regulation	≤ 0.1 % (TBR)	T	P	An
Load Regulation	≤ 0.1 % (TBR)	T	P	An
Survival Temperature Range	-20 – 50 °C	T	P	An
Operating Temperature Range	-10 – 25 °C	T	P	An
Power-up output voltage rise-time	> 1 msec/V	T	P	An
Power-down output voltage fall-time	< 1 sec/V, > 10 msec/V	T	P	An
Input Connectors	TBD	I		P/F
Output Connectors	TBD	I		P/F
5.3.4.2 SIU Dg 3.3 V				
Power Provided	20 W	A		P/F
Efficiency	84 % (TBR)	A		P/F
Accuracy	± 5 %	T	P	An
RMS Noise	≤ 10 mV	T	P	An
Bandwidth	0 – 1 MHz	T	P	An
Noise Spikes	≤ 10 mV	T	P	An
Line Regulation	≤ 0.1 % (TBR)	T	P	An
Load Regulation	≤ 0.1 % (TBR)	T	P	An
Survival Temperature Range	-20 – 50 °C	T	P	An
Operating Temperature Range	-10 – 25 °C	T	P	An
Power-up output voltage rise-time	> 1 msec/V	T	P	An
Power-down output voltage fall-time	< 1 sec/V, > 10 msec/V	T	P	An
Input Connectors	TBD	I		P/F
Output Connectors	TBD	I		P/F

APPENDIX A, TBD/TBR ITEMS