LAT PROJECT DOCUMENT CHANGE NOTICE (DCN)

DCN No. LAT-XR-05837-01

SHEET 1 **OF** 1

ORIGINATOR: Dave Nelson	**PHONE:** 650-926-4652	**DATE:** 2/16/05
CHANGE TITLE: DCN for Tower Power Supply Specification and ICD		**ORG.:**

DOCUMENT NUMBER	TITLE	NEW REV.
LAT-SS-01281	Tower Power Supply Specification and ICD	03

CHANGE DESCRIPTION (FROM/TO):

Please see LAT-XR-05854-01 for changes made to this document

REASON FOR CHANGE:

ACTION TAKEN: ☒ **Change(s) included in new release** ☐ **DCN attached to document(s), changes to be included in next revision**
☐ **Other (specify):**

DISPOSITION OF HARDWARE (IDENTIFY SERIAL NUMBERS):	**DCN DISTRIBUTION:**
☒ **No hardware affected (record change only)**	
☐ **List S/Ns which comply already:**	
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☐	

SAFETY, COST, SCHEDULE, REQUIREMENTS IMPACT? ☐ **YES** ☒ **NO**
If yes, CCB approval is required. Enter change request number:

APPROVALS	DATE	OTHER APPROVALS (specify):	DATE
ORIGINATOR: D. Nelson (signature on file)	2/16/05		
ORG. MANAGER: G. Haller (signature on file)	2/16/05		
PSA- Darren Marsh (signature on file)	2/16/05		
DCC RELEASE: Natalie Cramar (signature on file)	2/16/05	Doc. Control Level: ☒ Subsystem ☐ LAT IPO ☐ GLAST Project	

	Document #	Date Effective
	LAT-SS-01281-03	10/22/04
	Responsible Engineer(s)	Supersedes
	Dave Nelson	LAT-SS-01281-02
	Subsystem/Office	
	Electronics and DAQ Subsystem	
Document Title		
Tower Power Supply Specification and ICD		

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes	DCN #
01	4 December 2003	original	
02	21 October 2004	Changes to Figure 1, paragraph 5.1, paragraph 10.3 and Table 1, Table 2 and Table 3	
03	14 February 2005	Changed Table 1, Tracker 1.5 volt accuracy from 5% t0 10%	

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1. SCOPE

The Tower Power Supply (TPS) provides nine independent regulated DC supply voltages to components of the Tower Assemblies. The Tower Assembly consists of the Calorimeter (CAL), Tracker (TRK), Tower Electronics Module (TEM), and the CAL and TRK front end electronics circuit card assemblies (CAL-AFEE and TKR MCM).

2. DEFINITIONS AND ACRONYMS

2.1 Definitions

An Analog

adj adjustable

cm centimeter

Dg Digital

MHz Megahertz, 10^6 Hz

msec millisecond, 10^{-3} s

mV millivolt, 10^{-3} V

p-p peak-to-peak

s, sec seconds

μ 10^{-6}

V Volt

W Watt

2.2 Acronyms

DAC − Digital to analog converter

EGSE − Electrical Ground Support Equipment

FOV – Field of View

GLAST – Gamma-ray Large Area Space Telescope

IRD – Interface Requirements Document

LAT – Large Area Telescope

PDU – Power Distribution Unit

TEM - Tower Electronics Module

3. REFERENCE

The following documents are relevant to the development of the Tower Power Supply:

LAT-SS-00010	GLAST LAT Performance Specification, August 2000
LAT-SS-00047	LAT Mechanical Performance Specification
LAT-SS-00291	Electrical Grounding and Shielding Plan
GSFC-433-RQMT	GLAST EMI/EMC Requirements Document
LAT-DS-01481	Tower Electronics Module Assembly
LAT-DS-01482	Tower Power Supply Assembly
LAT-DS-01652	Test Procedure, Tower Power Supply
LAT-DS-02388	Circuit Card Assembly, Tower Power Supply
LAT-DS-02389	Printed Wiring Board, Tower Power Supply
LAT-DS-02390	Schematic Diagram, Tower Power Supply

4. REQUIREMENTS

4.1 Warnings, Cautions, and Notes

The following SAFETY ALERTS are intended to create awareness of the potential safety hazards and the steps that must be taken to avoid accidents. These same alerts are used throughout this document to identify specific hazards that may endanger personnel and/or equipment. Identification of every conceivable hazardous situation is impossible. Therefore, all personnel have the responsibility to diligently exercise safe practices whenever exposed to this equipment.

WARNING: Indicates a potential hazardous situation which, if not avoided, could result in death or injury.

CAUTION: Indicates a potential hazardous situation which, if not avoided, could result in damage to equipment.

Note: Indicates a notification of information that is important, but not hazard related.

5. SPECIFICATIONS

5.1 Functional Description

The Tower Power Supply consists of an input filter, two power switches, and five dc-to-dc converter modules that supply power to three subsystems of the Tower Assembly. These subsystems are the Calorimeter (CAL), Tracker (TRK) and the TEM. Figure 1 is a functional block diagram of the Tower Power Supply.

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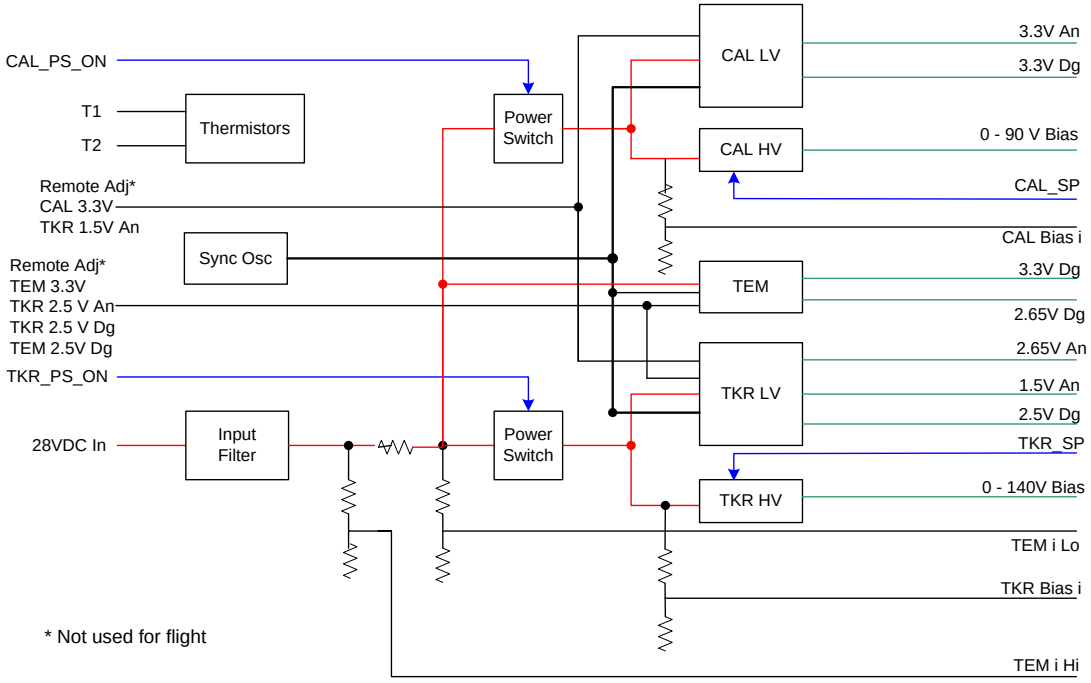

Figure 1. Tower Power Supply Block Diagram

Although the contents of the individual blocks in the block diagram are not illustrated in this document, the blocks are still described. Refer to the schematic of the circuit card for details.

5.1 Functional Description (continued)

28VDC is received from the PDU and is applied to an input filter which contains a MIL461 filter component. Filtered 28 VDC is fused via resettable poly-switches and applied to two power switch blocks, containing inrush current limiting and to the TEM power supply module, which provides 3.3V and 2.65V digital voltages to the TEM circuit card assembly. The TEM block contains MAXIM724/726 converters to generate the 3.3V and 2.65V. In addition it contains a power-delay circuit to implement the ACTEL suggested power-on sequencing. Two resistor networks allow measurement of the current drain (TEM i Hi and TEM i Lo) on the Tower power supply module. The voltage levels are routed to the TEM connector and are digitized and read out via the TEM. The readings will be calibrated to yield corrected measurement results.

Two CMOS control signals, TKR_PS_ON and CAL_PS_ON enable power switches that provide filtered 28VDC to the Tracker and Calorimeter power supply modules respectively. Zero volts on the switches disconnect the 28V input to the supplies. 3.3 V enables the 28V. TKR_PS_ON thus controls the Tracker low voltage and high voltage power supplies while CAL_PS_ON controls the Calorimeter low voltage and high voltage power supplies. All voltages of a given sub-system are turned on and off together.

The Tracker low voltage power supply module provides 2.65V analog, 2.65V digital, and 1.5V analog voltages to the Tracker subsystem via the TEM.

5.1 Functional Description (continued)

The Calorimeter low voltage power supply module provides 3.3V analog and 3.3V digital voltages to the Calorimeter subsystem via the TEM. The voltages are generated by MAXIM DC/DC converters.

The adjustable bias power supplies, 0 – 90 V (CAL_BIAS) and 0 – 140 V (TKR_BIAS) are programmable in <1 V increments by analog 0 – 2 V control signals (CAL_SP and TRK_SP) supplied by two DACs on the TEM. Two resistor networks allow measurement of the current drain (TRK_BIAS_CURR and CAL_BIAS_CURR) on the bias power supply modules.

A 100 kHz Buck sync oscillator is provided as a master oscillator for the low voltage supplies. Synchronizing the dc-to-dc converters allows frequency and phase synchronization thus reducing EMI/EMC to acceptable levels. Whether this block is used/loaded depends on the results of the measurement tests.

The Remote Adj. signals are used to remotely adjust the individual output voltages of the three low voltage dc-to-dc converters (see also Connector J2 Pin Assignments, Tower Power Supply to PDU, pin 21-25). These signals are only used when this module is employed in EGSE to CAL/TKR/TEM Subsystems. Not used for flight.

5.2 Environmental

The Tower Power Supply shall operate within the requirements of LAT-SS-00778, LAT Environmental specification.

5.3 Electrical

Table 1 describes the specified voltage, current, and power requirements of the Tower Power Supply Assembly.

The power supply will operate within specification with a voltage range of 28 V ±1.5V.

Table 1. Tower PS Electrical Specifications

CAL 3.3 V An		CAL 3.3 V Dg	
Item	Value	Item	Value
Voltage	3.3 V	Voltage	3.3 V
Current	0.33 A	Current	1.0 A
Power	1.1 W	Power	3.3 W
Efficiency	75%	Efficiency	75%
V Accuracy	±5%	V Accuracy	±5%
RMS Noise	0.1 mV	RMS Noise	1 mV
Line Regulation	0.5 %	Line Regulation	0.5 %
Load Regulation	2.5 %	Load Regulation	2.5 %
Pwr Up output voltage rise time	>1 msec/V	Pwr Up output voltage rise time	>1 msec/V
Pwr down output voltage fall time	<1msec/V >10 msec/V	Pwr down output voltage fall time	<1msec/V >10 msec/V
Bandwidth	1 MHz	Bandwidth	1 MHz

Table 1 Cont'd

CAL Bias 0 – 90 adj		TKR 1.5 V An	
Item	Value	Item	Value
Voltage	0- 90 V adj	Voltage	1.5 V
Current	3 mA	Current	2.0 A
Power	0.3 W	Power	3.0 W
Efficiency	80%	Efficiency	69%
V Accuracy	±0.5 %	V Accuracy	±10 %
RMS Noise	1 mV	RMS Noise	0.2 mV
Line Regulation	0.5 %	Line Regulation	0.5 %
Load Regulation	5 %	Load Regulation	7.5 %
Pwr Up output voltage rise time	>1 msec/V	Pwr Up output voltage rise time	>1 msec/V
Pwr down output voltage fall time	<1msec/V >10 msec/V	Pwr down output voltage fall time	<1msec/V >10 msec/V
Bandwidth	1 MHz	Bandwidth	1 MHz

Table 1 Cont'd

TKR 2.65 V Dg		TKR 2.65 V An	
Item	Value	Item	Value
Voltage	2.65 V	Voltage	2.65 V
Current	2.0 A	Current	0.6 A
Power	5.0 W	Power	1.5 W
Efficiency	75 %	Efficiency	75 %
V Accuracy	±5 %	V Accuracy	±5 %
RMS Noise	1 Mv	RMS Noise	0.2 Mv
Line Regulation	0.5 %	Line Regulation	0.5 %
Load Regulation	5 %	Load Regulation	2.5 %
Pwr Up output voltage rise time	>1 msec/V	Pwr Up output voltage rise time	>1 msec/V
Pwr down output voltage fall time	<1msec/V >10 msec/V	Pwr down output voltage fall time	<1msec/V >10 msec/V
Bandwidth	1 MHz	Bandwidth	1 MHz

Table 1 Cont'd

TKR 0 – 140 V Bias		TEM CCA 3.3 V Dg	
Item	Value	Item	Value
Voltage	0 – 140 V adj	Voltage	3.3 V
Current	4 mA	Current	0.9 A
Power	0.6 W	Power	2.9 W
Efficiency	75 %	Efficiency	75 %
V Accuracy	0.5 %	V Accuracy	±5 %
RMS Noise	10 mV	RMS Noise	1 mV
Line Regulation	0.5 %	Line Regulation	0.5 %
Load Regulation	15 %	Load Regulation	2.5 %
Pwr Up output voltage rise time	>1 msec/V	Pwr Up output voltage rise time	>1 msec/V
Pwr down output voltage fall time	<1msec/V >10 msec/V	Pwr down output voltage fall time	<1msec/V >10 msec/V
Bandwidth	1 MHz	Bandwidth	1 MHz

Table 1 Cont'd

TEM CCA 2.65 V Dg			
Item	Value		
Voltage	2.65 V		
Current	1.2 A		
Power	2.9 W		
Efficiency	75 %		
V Accuracy	±5 %		
RMS Noise	1 mV		
Line Regulation	0.5 %		
Load Regulation	2.5 %		
Pwr Up output voltage rise time	>1 msec/V		
Pwr down output voltage fall time	<1msec/V >10 msec/V		
Bandwidth	1 Mhz		

6. ELECTRICAL INTERFACE

The LAT Tower Power Supply electrically interfaces to the Tower Electronics Module on the positive Z side through a chassis-to-chassis 78-pin high density D connector, J2. A 26-pin high density D connector, J1 interfaces the Tower Power Supply to the Power Distribution Unit.

6.1 Tower Power Supply to Power Distribution Unit Interface

The 26-Pin connector, J2, on the Tower Power Supply, provides the electrical interface to the PDU.

6.1.1 Connector, (Receptacle), J2

This connector is a 26 pin high density D bulk head receptacle. The connector part number is 311P407-2S-B-12. This connector is listed on the NASA Parts Selection List (NPSL) under the title of GSFC S-311-P-4/07 D-Subminiature Connectors High Density Size 22D Crimp Contacts, -55°C to +125°C and data may also be found at the following website:

http://nepp.nasa.gov/npsl/Connectors/311p407/407list.htm.

6.1.2 Connector Pin Assignments

A list of the signals between the Tower Power Supply and the PDU is provided in Table 2.

Table 2. Connector J2 Pin Assignments, Tower Power Supply to PDU

Pin No.	Function	Signal Type	Signal Name
1	28 Volt Power	Power	TEM_28V
2	28 Volt Power	Power	TEM_28V
3	28 Volt Power	Power	TEM_28V
4	28 Volt Power	Power	TEM_28V
5	28 Volt Return	Power	28VRET
6	28 Volt Return	Power	28VRET
7	28 Volt Return	Power	28VRET
8	28 Volt Return	Power	28VRET
9	TEM VDD MONITOR A	Monitor	TEM_V1_N
10	POWER SUPPLY TEMP SENSOR A	Monitor	TEM_PS_T1_P
11	POWER SUPPLY TEMP SENSOR A	Monitor	TEM_PS_T1_N
12	POWER SUPPLY TEMP SENSOR B	Monitor	TEM_PS_T2_P
13	POWER SUPPLY TEMP SENSOR B	Monitor	TEM_PS_T2_N
14	TEM TEMP SENSOR A	Monitor	TEM_T1_P
15	TEM TEMP SENSOR A	Monitor	TEM_T1_N
16	TEM TEMP SENSOR B	Monitor	TEM_T2_P
17	TEM TEMP SENSOR B	Monitor	TEM_T2_N
18	TEM VDD MONITOR A	Monitor	TEM_V1_P
19	TEM VDD MONITOR B	Monitor	TEM_V2_P
20	TEM VDD MONITOR B	Monitor	TEM_V2_N
21	REMOTE ADJUST TEM 3.3 V1	Control	TEM_ADJ_33
22	REMOTE ADJUST TKR 2.65 V AN[1]	Control	TKR_ADJ_25A

Figure 1.

Pin No.	Function	Signal Type	Signal Name
23	REMOTE ADJUST TKR 2.65 V DG AND TEM 2.65 DG[1]	Control	TKR_ADJ_25D
24	REMOTE ADJUST TKR 1.5 V AND CAL 3.3 V AN[1]	Control	TKR _ADJ_15
25	REMOTE ADJUST CAL 3.3 V[1]	Control	CAL_ADJ_33
26	GROUND	Power	TEM_ADJ_RET

[1] These signals are only used when this module is employed as EGSE to CAL/TKR/TEM Subsystems. Their purpose is to remotely vary the output supply voltage levels. Some of the signals are used simultaneously for several subsystems. Not used for flight.

6.2 Tower Power Supply to Tower Electronics Module Interface

78-Pin connector, J1, on the Tower Power Supply, provides the electrical interface to the TEM.

6.2.1 Connector, (Receptacle J1)

This connector is a 78 pin high density D bulk head receptacle. The connector part number is 311P407-5S-B-12. This connector is listed on the NASA Parts Selection List (NPSL) under the title of GSFC S-311-P-4/07 D-Subminiature Connectors High Density Size 22D Crimp Contacts, -55°C to +125°C and data may also be found at the following website:

http://nepp.nasa.gov/npsl/Connectors/311p407/407list.htm

6.2.2 Connector Pin Assignments

A list of the signals between the Tower Power Supply and the TEM CCA is shown in Table 3.

Table 3. Connector J1 Pin Assignments, Tower Power Supply to TEM CCA.

Pin No.	Function	Signal Type	Signal Name
1	TEM 2.65 V Supply	Power	2_5_Digital_0
2	TEM 2.65 V Supply	Power	2_5_Digital_1
3	TEM 2.65 V Supply	Power	2_5_Digital_3
4	TRK DIGITAL 2.65 V Supply	Power	TRK_DVDD_XYP0
5	CAL DIGITAL 3.3 V Supply	Power	CAL_DVDD_XYP0
6	TEM+3.3V Supply	Power	TEM_VDD0
7	TRK supply on(1)/off(0)	Control	TRK_PS_ON1
8	TEM GND	Power	TEM_GND0
9	TEM TEMP SENSOR A	Monitor	TEMP0A
10	TEM TEMP SENSOR B	Monitor	TEMPB0
11	CAL DIGITAL +3.3V Supply	Power	CAL_DVDD_XYP1
12	CAL BIAS	Power	CAL_BIAS_XYN0
13	CAL BIAS SET POINT	Control	CAL_BIAS_SP_C1
14	CAL ANALOG GND	Power	CAL_AGND0
15	TRK ANALOG +1.5V GND	Power	TRK_AGNDA0
16	TRK ANALOG +2.65V GND	Power	TRK_AGNDB0
17	TRK ANALOG +2.65V GND	Power	TRK_AGNDB1
18	TRK BIAS SET POINT	Control	TRK_BIAS_SP_C0
19	TRK DIGITAL +2.65 SUPPLY	Power	TRK_DVDD_XYP1
20	TRK DIGITAL +2.65 SUPPLY	Power	TRK_DVDD_XYN0
21	TEM CURRENT MONITOR HIGH	Monitor	TEM_CURR_H
22	TEM CURRENT MONITOR LOW	Monitor	TEM_CURR_L
23	CAL BIAS	Power-	CAL_BIAS_XYP0
24	CAL BIAS	Power-	CAL_BIAS_XYP1

Pin No.	Function	Signal Type	Signal Name
25	TRK ANALOG 2.65 V SUPPLY	Power	TRK_AVDDB_XYP0
26	TRK supply on(1)/off(0)	Control	TRK_PS_ON0
27	TEM GND	Power	TEM_GND1
28	TEM TEMP SENSOR A	Monitor	TEMP1A
29	TEM TEMP SENSOR B	Monitor	TEMPB1
30	CAL DIGITAL +3.3V Supply	Power	CAL_DVDD_XYN0
31	CAL BIAS	Power	CAL_BIAS_XYN1
32	CAL BIAS SET POINT	Control	CAL_BIAS_SP_C0
33	CAL ANALOG GND	Power	CAL_AGND1
34	TRK ANALOG +1.5V GND	Power	TRK_AGNDA1
35	TRK ANALOG +1.5V GND	Power	TRK_AGNDA2
36	TRK ANALOG +2.65V SUPPLY	Power	TRK_AVDDB_XYP1
37	TRK ANALOG +2.65V GND	Power	TRK_AGNDB2
38	TRK BIAS SET POINT	Control	TRK_BIAS_SP_C1
39	TRK DIGITAL +2.65 SUPPLY	Power	TRK_DVDD_XYN1
40	TRK BIAS CURRENT	Monitor	TRK_BIAS-CURR
41	TRK BIAS	Power	TRK_DET_BIAS_YN0
42	TRK BIAS	Power	TRK_DET-BIAS_YN1
43	CAL ANALOG 3.3 V SUPPLY	Power	CAL_AVD0_XYP0
44	TRK ANALOG 1.5 V SUPPLY	Power	TRK_AVDDA_XYP0
45	TEM+3.3V SUPPLY	Power	TEM_VDD1
46	CAL SUPPLY ON(1)/OFF(0)	Control	CAL_PS_ON0
47	TEM GND	Power	TEM_GND2
48	TEM VOLTAGE SENSE A	Monitor	VDD_A
49	CAL DIGITAL GND	Power	CAL_DGND0
50	CAL DIGITAL +3.3V SUPPLY	Power	CAL_DVDD_XYN1
51	CAL BIAS GND	Power	CAL_BIAS_GND0
52	CAL ANALOG +3.3V SUPPLY	Power	CAL_AVDD_XYP1

Pin No.	Function	Signal Type	Signal Name
53	CAL ANALOG GND	Power	CAL_AGND2
54	TRK ANALOG +1.5V SUPPLY	Power	TRK_AVDDA_XYP1
55	TRK ANALOG +2.65V SUPPLY	Power	TRK_AVDDB_XYN0
56	TRK ANALOG +2.65V SUPPLY	Power	TRK_AVDDB_XYN1
57	TRK BIAS	Power	TRK_DET_BIAS_XP0
58	TRK DIGITAL GND	Power	TRK_DGND0
59	TRK DIGITAL GND	Power	TRK_DGND1
60	CAL BIAS CURRENT	Monitor	CAL_BIAS_CURR
61	TRK BIAS	Power	TRK_DET_BIAS_XN0
62	TRK BIAS	Power	TRK_DET_BIAS_XN1
63	TRK BIAS	Power	TRK_DET_BIAS_YP0
64	TRK BIAS	Power	TRK_DET_BIAS_YP1
65	TEM+3.3V SUPPLY	Power	TEM_VDD2
66	CAL SUPPLY ON(1)/OFF(0)	Control	CAL_PS_ON1
67	TEM VOLTAGE SENSE B	Monitor	VDD_B
68	CAL DIGITAL GND	Power	CAL_DGND1
69	CAL DIGITAL GND	Power	CAL_DGND2
70	CAL BIAS GND	Power	CAL_BIAS_GND1
71	CAL ANALOG +3.3V SUPPLY	Power	CAL_AVDD_XYN0
72	CAL ANALOG +3.3V SUPPLY	Power	CAL_AVDD_XYN1
73	TRK ANALOG +1.5V SUPPLY	Power	TRK_AVDDA_XYN0
74	TRK ANALOG +1.5V SUPPLY	Power	TRK_AVDDA_XYN1
75	TRK BIAS GND	Power	TRK_BIAS_AGND0
76	TRK BIAS GND	Power	TRK_BIAS_AGND1
77	TRK BIAS	Power	TRK_DET_BIAS_XP1
78	TRK DIGITAL GND	Power	TRK_DGND2

7. GROUNDING AND SHIELDING

Grounding and shielding of the Tower Power Supply shall conform to all requirements of LAT-SS-00219, GLAST LAT Grounding & Shielding Plan.

8. EMI/EMC

The EMI/EMC performance is specified in GSFC-433-RQMT-005, the GLAST EMI/EMC Requirements Document. The maximum emission values allocated to the Tower Power Supply are 14dB (20%) of the maximum values specified in GSFC-433-RQMT-005..

9. THERMAL INTERFACE AND HEAT TRANSFER

The Tower Power Supply has two thermal interfaces. First, the Tower Power Supply-EPU/SIU/GASU interface is the primary means for conductive heat transfer. The second interface is the conductive heat transfer from the TEM through the Tower Power Supply, to the one of the following Electronics Units: SIU, EPU, GASU. The heat conduction is then transferred to the LAT Cross LAT Plates that transfer the heat to the LAT radiator via heat pipes.

10. TOWER POWER SUPPLY TEMPERATURE REQUIREMENTS

The Tower Power Supply acceptance test temperature range is -30°C to +45°C.

10.1 Temperature Rate of Change

Temperature transitioning of a component or its mounting interface may induce or subject a component to harmful stresses. Temperature transitioning is caused by the on-orbit environment, component startup and operation. In addition, temperature transition is induced during component and observatory thermal vacuum testing. The maximum rate of change of any component or mounting interface when integrated to the observatory shall be no greater than 30°C/hr during integration and testing.

10.2 Power Dissipation

The maximum heat dissipated in the Tower Power Supply during normal operating conditions shall be no greater than 16 watts. The maximum orbit-average heat dissipated in the Tower Power Supply during normal operating conditions shall be no greater than 11 watts. The heat dissipation within the Tower Power Supply shall be stable to within ± 2 watts of the nominal during operations.

10.3 Tower Power Supply Bolted Joint Interface

The bolted joint interface shall be the primary mechanism for transferring heat into and out of the Tower Power Supply. This is done through a total of 40 8-32 bolts. The contact surface area is 24.5 in^2. The net heat transfer from the Tower Power Supply to the LAT will be: Qnet-hot = -5W Qnet-cold = -25W.