TIMED GENERAL INSTRUMENT INTERFACE SPECIFICATION

Section 4.0
Thermal Interface

TECHNICAL CONTENT APPROVAL (PAGE 1 OF 2)

D. Y. Kusnierkiewicz TIMED Spacecraft System Engineer	S. Brown SABER System Engineer (SDL)
K. J. Heffernan TIMED Science Payload System Engineer	B. Ogorzalek GUVI System Engineer
B. D. Williams TIMED Spacecraft Thermal Engineer	D. Mabry GUVI Program Manager (Aerospace)
M. D. Vanek SABER Instrument Manager (LaRC)	C. J. Ercol GUVI Thermal Engineer (APL)
W. Roettker SABER Thermal Engineer (LaRC)	G. Ucker SEE System Engineer (LASP)
J. C. Batty SABER Thermal Engineer (SDL)	C. J. Ercol SEE Thermal Engineer (APL)

TIMED GENERAL INSTRUMENT INTERFACE SPECIFICATION

Section 4.0
Thermal Interface

TECHNICAL CONTENT APPROVAL (PAGE 2 OF 2)

T. Clausen
TIDI System Engineer (SPRL)

J. Harvey
TIDI Thermal Engineer (SPRL)

TIMED GENERAL INSTRUMENT INTERFACE SPECIFICATION

Section 3.0
Command and Data Handling Interface

REVISION APPROVAL (PAGE 1 OF 5)

TIMED Spacecraft Approval Page

Rev #	Date	D. Kusnierkiewicz	K. Heffernan	B. Williams	A. El-Dinary
A					
B					
C					
D					
E					
F					
G					
H					
I					
J					

Rev #	Date				
A					
B					
C					
D					
E					
F					
G					
H					
I					
J					

TIMED GENERAL INSTRUMENT INTERFACE SPECIFICATION

Section 4.0
Thermal Interface

REVISION APPROVAL (PAGE 2 OF 5)

GUVI Instrument Approval Page

Rev #	Date	B. Ogorzalek	D. Mabry	J. Ercol	
A					
B					
C					
D					
E					
F					
G					
H					
I					
J					

TIMED GENERAL INSTRUMENT INTERFACE SPECIFICATION

Section 4.0
Thermal Interface

REVISION APPROVAL (PAGE 3 OF 5)

SABER Instrument Approval Page

Rev #	Date	M. Vanek	W. Roettker	J. Batty	S. Brown
A					
B					
C					
D					
E					
F					
G					
H					
I					
J					

TIMED GENERAL INSTRUMENT INTERFACE SPECIFICATION

Section 4.0
Thermal Interface

REVISION APPROVAL (PAGE 4 OF 5)

SEE Instrument Approval Page

Rev #	Date	G. Ucker	J. Oatley		
A					
B					
C					
D					
E					
F					
G					
H					
I					
J					

TIMED GENERAL INSTRUMENT INTERFACE SPECIFICATION

Section 4.0
Thermal Interface

REVISION APPROVAL (PAGE 5 OF 5)

TIDI Instrument Approval Page

Rev #	Date	T. Clausen	J Harvey		
A					
B					
C					
D					
E					
F					
G					
H					
I					
J					

4. INSTRUMENT THERMAL INTERFACE REQUIREMENTS

This section contains the thermal interface requirements for the TIMED spacecraft. The thermal control responsibilities, thermal mounting interfaces, temperature sensors and general heater bus information are described in this section. Much of the detailed thermal interface information (e.g., heater, thermostat, temperature sensor locations, thermal blanket, thermal control coatings, connector locations, etc.) will be defined in the particular SIIS.

The thermal part of the environmental specification includes ranges for the mounting surface temperature and the external thermal radiation environment. All temperatures specified refer to the interface unless otherwise stated. The final component temperature will depend on the connection to the interface, its internal dissipation, and heat leaks through the thermal blankets, radiator views to space, aperture loading, etc.

4.1 THERMAL CONTROL RESPONSIBILITIES

Thermal control of all mounting interfaces (including temperatures, and gradients and rate of change of temperature, if applicable) throughout all phases of the mission is the responsibility of APL. Control of the external thermal radiation environment (i.e. maintaining the orbit, attitude control, and the radiator clear field of view) is also the responsibility of APL. Internal thermal control of each instrument is the responsibility of the individual instrument developer. Requests for deviations for these requirements must be approved by the TIMED thermal engineer.

APL will provide telemetry for a small number (one to five) of "spacecraft-monitored" temperature sensors for each instrument. These will be used for both operational and survival mode temperature monitoring. This eliminates the need for each instrument to maintain a keep-alive mode to monitor survival temperatures. The instrument developer is responsible for providing telemetry for all "non-spacecraft-monitored" temperature sensors.

APL is responsible for providing and mounting all thermal control hardware (i.e. heaters, thermostats, temperature sensors, thermal blankets, thermal control coatings, radiators, etc.) located on the spacecraft panels and any thermal gaskets located between the spacecraft panels and the instrument. In addition, APL is responsible for providing all "spacecraft-monitored" temperature sensors located on the instruments. The instrument developer is responsible for mounting the spacecraft-monitored temperature sensors and for providing and mounting all other thermal control hardware located on the instrument. The instrument developer is also responsible for providing and mounting all thermal isolation hardware.

Power for the heaters will be provided via two separate power busses, the main bus (operational heaters) and the survival bus. The spacecraft is responsible for power switching these busses. The power for heaters (both operational and survival) located on the instruments is maintained as part of the instrument power allocation.

The spacecraft thermal engineer is responsible for providing a thermal model of the spacecraft with the environment included to the instrument developer. The instrument developer is responsible for providing a thermal model of the instrument to the spacecraft thermal engineer. Details of the model size (number of nodes, software package, etc.) are given within section 4.5.

Any exceptions to these responsibilities must be approved by the spacecraft thermal engineer, and will be documented in the appropriate SIIS.

4.2 THERMAL CONTROL CONCEPT

The thermal control concept and mounting of each of the individual instruments will be completely described within the appropriate SIIS.

4.3 MOUNTING INTERFACE

Instruments which are conductively mounted will be mounted flat to one of the spacecraft panels. The dimensions of each instrument mounting interface will be given in the SIIS's. The SIIS will also specify the average watt density and maximum temperature gradient across each of the instruments' mounting interfaces.

Instruments which are thermally isolated from the spacecraft will be mounted to the spacecraft using materials which will provide a total thermal resistance of approximately 20 degrees C per Watt across the entire instrument-spacecraft thermal interface.

4.3.1 Interface Surface

For a conductively-mounted instrument, a thermal gasket will be placed between the instrument component and the spacecraft structure to facilitate heat conduction. A pressure of at least 50 pounds per square inch (psi) is required over the entire mounting interface to ensure proper heat transfer. The entire component baseplate area shall be in contact with the conductive gasket. The instrument baseplate flatness requirement is defined in Section 5.1.4.3.

For a thermally-isolated instrument, washers with low thermal conductivity will be placed between the instrument baseplate and the spacecraft panel.

4.3.2 Mounting Interface Temperature Limits

APL will control the temperature of each instrument component's mounting interface to within a range specified within each instrument's SIIS. These limits shall include margin, as defined by the spacecraft thermal engineer. The IDT should use these temperature ranges as boundary conditions for their thermal analysis and for thermal testing.

4.3.3 Mounting Interface Temperature Rate of Change Limits

The maximum allowable mounting interface temperature rate of change is specified within each instrument's SIIS.

4.3.4 Temperature Gradient Requirements

The maximum allowable temperature gradient between any two locations on the instrument baseplate is specified within each instrument's SIIS.

4.3.5 Power Density Limits

The maximum average watt density allowed for each conductively-mounted instrument's baseplate is specified within each instrument's SIIS.

4.3.6 Internal Thermal Radiation Temperature Limits

The internal spacecraft thermal radiation environment will be maintained within the temperature limits given in Table 4.3.6-1. The instrument developers should use these temperatures as boundary conditions for their thermal analyses.

TABLE 4.3.6-1

INTERNAL THERMAL RADIATION TEMPERATURE LIMITS

Component	Operate Temperature	Survival Temperature
Internal S/C environment	-20 to +50°C	-34 to +60°C

4.4 THERMAL CONTROL HARDWARE

All thermal control hardware for each instrument shall be documented in the respective SIIS. This description shall include the following as a minimum:

- radiator locations and sizes;
- MLI locations, attach points and grounding strap locations;
- heater and spacecraft monitored temperature sensor connector locations;
- operational and survival heater/thermostat locations;
- heater part number and resistance values;
- thermostat part number and set points;
- spacecraft and instrument monitored temperature sensor locations and types;
- thermal control coatings;
- thermal isolation hardware; and
- operate, survival, and test temperature specifications for individual box, major

subassembly, and critical components.

4.4.1 Heaters/Thermostats

Operational and survival heaters shall be sized by assuming operation at 75 per cent duty cycle, +26 V bus voltage and cold-case thermal conditions.

4.4.1.1 Operational Heaters

Power for the operational heaters is supplied by the main bus. The location, size, and designation of the operational heaters and location and designation of the operational thermostats on each instrument are given in the SIIS. The schematic showing the electrical hookup of the operational heaters and thermostats, including the heater part number and resistance and thermostat part number, open and close temperatures, etc. for the each instrument are also given in the SIIS. Each IDT is responsible for providing this hardware up to and including the interface connector.

4.4.1.2 Survival Heaters

Power for the survival heaters is supplied by the survival bus. The location, size, and designation of the survival heaters and location and designation of the survival thermostats for each instrument are given in the SIIS. The schematic showing the electrical hookup of the survival heaters and thermostats, including the heater part number and resistance and the thermostat part number, open and close temperatures, etc. for each instrument are also given in the SIIS. Each IDT is responsible for providing and mounting this hardware up to and including the interface connector.

Survival heaters will be powered whenever the instrument is turned off.

4.4.2 Temperature Sensors

4.4.2.1 Spacecraft-Monitored Temperature Sensors

APL will monitor through the spacecraft Command and Data Handling (C&DH) system a number of temperature sensors located on each instrument. At a minimum, the temperature sensors will cover the range from -70 to +100 °C. APL is responsible for providing the temperature sensors. The IDT is responsible for installing the temperature sensors and for providing and installing the harness up to and including the interface connector.

The nomenclature, type, and location of the spacecraft-monitored temperature sensors located on each instrument is given in the appropriate SIIS. The schematic which details the electrical hookup of the spacecraft-monitored operational temperature sensors located on each instrument, including the electrical part number, wiring information, etc. is also given in the SIIS.

4.4.2.2 Instrument-Monitored Temperature Sensors

Each instrument developer is responsible for providing, mounting, and monitoring any additional temperature sensors required over and above the “spacecraft-monitored” temperature sensors. The nomenclature, type, and location of the instrument-monitored temperature sensors for each instrument is given in the appropriate SIIS.

4.4.3 Radiators

For those instruments using radiators to dissipate heat, the radiator's dimensions, location, mounting and mechanical interface to the instrument will be specified in the SIIS. The appropriate IDT is responsible for providing the radiator.

4.4.4 Thermal Control Coatings

Thermal control coatings for each instrument are the responsibility of the appropriate IDT. Details of the thermal control coatings will be given in the appropriate SIIS and must be approved by the spacecraft thermal engineer.

4.4.5 Thermal Blankets

The design and manufacturing of all thermal blankets is the responsibility of the appropriate IDT. Details of the thermal blanket sizes, locations and grounding points can be found in the particular SIIS.

4.5 GEOMETRY AND THERMAL MODEL

A geometry and thermal model of the spacecraft and the radiation environment will be provided by APL to the instrument developers. These models will use both TRASYS and SINDA 85 codes and will contain a minimum of 10 and a maximum of 300 nodes.

A geometry and thermal model of each instrument will be provided to APL by the instrument developer. These models will use both TRASYS and SINDA 85 codes and will contain a minimum of 10 and a maximum of 100 nodes.

A correlation between the spacecraft and instrument thermal models will be completed after delivery of the instrument models to the Spacecraft Thermal Engineer.

For electronics boxes containing circuit boards, IDT's must show by analysis that all junction temperatures are below 100 °C at the maximum operational test temperature.

FSCM NO.	SIZE	DWG. NO.	
88898	A	7363-9050	
SCALE		DO NOT SCALE PRINT 11/11/97	SHEET 4-15