



TIROS SEM-2
Flight Model DPU/SN 0014
Calibration Report

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Prepared for

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1.0 INTRODUCTION

This Calibration Report, for the SEM-2 Flight Model (FM) DPU, SN 0014, provides the coefficients necessary to convert DPU outputs into appropriate internal voltages and temperatures. Section 2.0 contains calibration data for the DPU portion of the SEM-2 analog monitors, the Digital A monitors and the Bi-Level outputs.

All TED and MEPED data is obtained, by the spacecraft, through the DPU, except for heater information. TED and MEPED calibration data are detailed in their respective calibration reports.

2.0 MONITOR CALIBRATION

The DPU provides analog monitors indicating the state of health of all three SEM-2 components, the TED, the MEPED and the DPU. The TED and the MEPED provide the DPU with electrical signals that are electrically scaled to represent the monitor entity. The MEPED provides the DPU with 19 monitor signals, two of which are temperature monitoring circuits that are electrically isolated from the DPU and not examined by the DPU. The TED provides the DPU with 14 monitor signals, one of which is a temperature monitor circuit that is electrically isolated from the DPU and not examined by the DPU. The DPU provides monitors for 11 signals of its own, one of which is a temperature monitoring circuit that is electrically isolated from signals generated within the DPU. All the isolated temperature monitoring circuits in the SEM-2 are read directly by the spacecraft.

Of the 44 analog monitoring circuits, thirteen are provided to the spacecraft as direct analog outputs. The 40 non-isolated signals are digitized in the DPU and reported to the spacecraft in the Digital A telemetry stream.

Scaling of each DPU monitor is verified during DPU Printed Circuit Board (PCB) assembly testing. Data necessary for DPU monitor calibration is collected during testing of the EM TED Data PCB and recorded in TIR-RTP-116 (Ref. 2).

2.1 Analog Monitors

Analog monitor information is delivered to the spacecraft in three different ways:

- (1) Isolated Temperature monitors provide temperature information regardless of the powered state of the SEM-2,
- (2) Direct Analog monitors provide an analog signal that is available to the spacecraft as long as the SEM-2 is powered,
- (3) 40 analog signals are digitized and reported in Digital A telemetry.

Thirteen direct analog monitors and four electrically isolated temperature sensors are provided to the spacecraft via the DPU-J4 connector. The four isolated signals are powered by the spacecraft's 28 volt ATM bus (Analog Telemetry) and can be read by the spacecraft whenever the ATM bus is powered.

2.1.1 Isolated Temperature Monitor - polynomial data fit

Calibration results for the TED isolated temperature monitor is given in TIR-ENG-156 (Ref. 4). Calibration results for the two MEPED isolated temperature monitors is given in TIR-ENG-157 (Ref. 5). Calibration results for the DPU isolated temperature monitor is given herein.

Calibration of the DPU isolated temperature monitor (DITHERM) is given in Table 2.1. The polynomial fit is for the 28V ATM bus being precisely 28.0 V. For different 28V ATM bus voltages the telemetered monitor voltage value (DITHERM V)_{TM} must first be corrected by eqn. (2.1) shown below.

$$(DITHERM V)_{corr} = (DITHERM V)_{TM} \times 28.0 / (\text{Actual } 28V \text{ ATM } V) \quad (2.1)$$

The corrected value (DITHERM V)_{corr} is then used in the Table 2.1 polynomial fit with eqn. (2.2) below.

$$DITHERM \text{ Temp} = \sum_{i=0}^8 A_i \times (DITHERM V)_{corr}^i \text{ (}^\circ\text{C)} \quad (2.2)$$

Table 2.1 DPU Isolated Temperature Monitor (DITHERM) Fit	
Polynomial Term i (Power of (DITHERM V))	Eq. (2.2) A _i Polynomial Coefficient
0	86.043939
1	-74.384817
2	26.691091
3	4.805859
4	-10.648079
5	5.130014
6	-1.236963
7	0.153214
8	-0.007788

2.1.2 Digital A Temperature Monitor - polynomial data fit

The DPU has a temperature monitor that is digitized and transmitted in the Digital A telemetry stream. Also, the DPU receives a temperature monitor input from the TED and MEPED that is digitized and transmitted in the Digital A telemetry stream. These monitors are separate from the isolated temperature monitors discussed in Section 2.1.1.

The DPU Temperature monitor in Digital A (DPU TEMP) provides a voltage to the DPU's digitizer from which the temperature is calculated. The voltage to the digitizer depends on the DPU -6 volt supply which is also digitized and reported in the Digital A telemetry. The DPU Temperature monitor value must be corrected using the value reported for the -6 volt supply. The corrected (DPU TEMP V)_{corr} is obtained from the Digital A voltage (DPU TEMP V)_{TM} by eqn. (2.3) below.

$$(DPU\ TEMP\ V)_{corr} = (DPU\ TEMP\ V)_{TM} \times (-6.0 / (\text{Actual } -6V)) \quad (2.3)$$

The corrected value (DPU TEMP V)_{corr} is then used in the Table 2.2 polynomial fit with eqn. (2.4) below.

$$DPU\ TEMP = \sum_{i=0}^8 A_i \times (DPU\ TEMP\ V)_{corr}^i \text{ (}^\circ\text{C)} \quad (2.4)$$

Table 2.2 DPU Digital A Temperature Monitor (DPU TEMP) Fit	
Polynomial Term i (Power of (DPU TEMP))	Eq. (2.4) A _i Polynomial Coefficient
0	-61.163413
1	86.661572
2	-89.907755
3	69.222079
4	-34.130876
5	10.615717
6	-2.003220
7	0.208955
8	-0.009209



2.1.3 Digital A Analog Monitors - linear data fit

The TED has thirteen (13) analog monitors that are reported in Digital A, four (4) of which are buffered and sent to the spacecraft as direct analog monitors. Calibration data for the TED monitors is given in TIR-ENG-149 (Ref. 4).

The MEPED has seventeen (17) analog monitors that are reported in Digital A, two (2) of which are buffered and sent to the spacecraft as direct analog monitors. Calibration data for the MEPED monitors is given in TIR-ENG-150 (Ref. 5).

The DPU has ten (10) analog monitors that are reported in Digital A. Each monitor is scaled to provide a signal range that spans the worst case measurement interval. Each monitor output is calibrated in V/V (Volts input/Volts output), but this is not directly used for the Digital A outputs, since the DPU digitizer provides another level of monitor scaling before the data is placed in the telemetry stream. All Digital A monitor signals are converted to Digital A calibrations using the Analog Digitizer Calibration shown below.

The DPU Digital A monitor calibration factors are given in Table 2.3. The monitors are read once per major frame, or are subcommutated, as described in Ref. 1.

Table 2.3 DPU Digital A Analog Monitor Calibrations					
Digitization Calibration (V input)/(count output)					
Analog Digitizer 0.019926 ± 0.001 (the V Input intercept is 0V)					
Ref. 1 DPU Monitor Description	Analog Line Mnemonic	Digital A Calibration Cal (V/V)	Ref. 1 Analog (V/count)	Subcom	Source
Microprocessor A power	μP Sys A +5V	1.2502	0.024911	1	Ref 2
Microprocessor B power	μP Sys B +5V	1.2507	0.024932	1	Ref 2
DPU +5 Volt	DPU +5V	1.2555	0.024958	1	Ref 2
DPU +10 Volt	DPU +10V	2.6407	0.052618	1	Ref 2
DPU +6 Volt	DPU +6V	1.5087	0.030064	1	Ref 2
DPU -6 Volt	DPU -6V	-1.5181	-0.030246	1	Ref 2
DPU Temperature	DPU TEMP	1.0	0.019926	1	Ref 2
DPU Reference Voltage	DPU REF	1.241	0.0247	1	Ref 2
			Ref. 1 Bi-Level Subcom		
DPU Analog Mux Lo Z	AD LO Z CAL	1.0	0.019926	1	Ref 2
DPU Analog Mux Lo Z	AD HI Z CAL	1.0	0.019926	1	Ref 2

2.1.4 Direct Analog Monitors - linear data fit

The DPU has ten (10) analog monitors reported in Digital A, three (3) of which are also direct analog monitors to the spacecraft. The direct voltage outputs of these monitors is calibrated in V/V (Volts input/Volts output) as shown in the table below.

Monitor Description	Monitor Calibration Mnemonic	(V/V)	Source
Microprocessor A power	μ P Sys A +5V	1.2498	Ref 2
Microprocessor B power	μ P Sys B +5V	1.2499	Ref 2
DPU +5 Volt	DPU +5V	1.2656	Ref 2

2.2 Bi-Level Monitors - Digital B

The DPU provides nine bi-level status indicators to the spacecraft via the DPU-J3 connector, detailed in Table 5.1 of TIR-ENG-101 (Ref. 1). Seven of the bi-level indicators are included in the Digital A telemetry stream.

The DPU receives two bi-level indicators from the MEPED; MEPED IFC Status and MEPED IFC Phase. The state of both signals is reported in the Digital A Telemetry stream. The MEPED IFC Status is also reported to the spacecraft as a Digital B bi-level monitor. The DPU examines the MEPED IFC Status signal every 0.2 seconds then sets the logic state of the bi-level output.

The DPU receives an IFC Pulser Status bi-level indicator from the TED. The TED IFC Status and TED IFC Pulser Status are generated by the DPU and reported in the Digital A Telemetry stream. Note that the TED IFC Status that is reported to the spacecraft is different from the signal received from TED. The duration of the TED IFC cycle is approximately 101 minutes and the DPU will maintain the TED IFC Status in the active state as long as the TED IFC is running. If the TED IFC is commanded to terminate by the spacecraft then the TED IFC Status will be set inactive by the DPU. The TED IFC Pulser Status bi-level signal received by the DPU is only active for the first 32 seconds in the TED IFC cycle. The remainder of the TED IFC cycle is controlled by the DPU.

The DPU generates four bi-level output signals to indicate the commanded level of the TED electron and TED positive ion discriminators. For each discriminator, two bi-level signals encode which of four discriminator levels have been commanded by the spacecraft.



The DPU generates three Digital B bi-level status indicators to report the DPU status to the spacecraft. One bi-level indicator (μ P SYS ID) reports which of the redundant microprocessors is controlling DPU functions, μ PA or μ PB.

μ P SYS ID	Active Microprocessor System ID	0 = μ P A active 1 = μ P B active
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The final two Digital B outputs indicate the relative health of each microprocessor system with the watchdog status monitor, WDA STAT and WDB STAT. In normal operation the watchdog status monitors are in the inactive state.

WDA STAT	μ P System A Watchdog Status	0 = not active 1 = active (fault)
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WDB STAT	μ P System B Watchdog Status	0 = not active 1 = active (fault)
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All Digital B bi-level outputs are listed in Table 5.1 of Ref 1.



REFERENCES

1. Commands, Housekeeping and Status Monitors and Data Output Format for the NOAA K, L and M TIROS SEM-2, TIR-ENG-101, Rev. C, Panametrics, Inc., February 28, 1996.
2. DPU TED Printed Circuit Board Test Procedure, TIR-RTP-116, Rev. (B), Panametrics Inc., March 19, 1997.
3. TIROS SEM-2 - Interface Connections List - Rev. A, Panametrics, Inc., June 22, 1990.
4. Flight Model TED (SN0014) Calibration Report, TIR-ENG-156, Rev. (-), Panametrics, Inc., December 1999.
5. Flight Model MEPED (SN0014) Calibration Report, TIR-ENG-157, Rev. (-), Panametrics, Inc., December 1999.