

**ACIS Verification Summary Report****Specification:**

AXAF Observatory to Science Instrument ICD (IF1-20)

**Requirement Number/Title:**

3.3.1.1.1.1.5 ACIS DA Thermal Interfaces (VRSD 3.3.1.1.1.1.5)

**Requirement Statement:** Aperture of ACIS at the SIM I/F shall be assumed as a black body radiator at 16 °C for the hot case and -38°C for the cold case when HRC in viewing position.**Verification Method:****Analysis and Test****Procedure Number:** Verification Report LMA Report # ACIS-500-77-01VR**Configuration:**

ACIS Instrument installed in ISIM

**Cycle Time:** N/A**Verification Discussion/Results:**

This requirement was verified by both analysis and test as documented in the Thermal Control System Thermal Test Report (ACIS-500-77-01VR). For hot case conditions the telescope was conservatively tested and analysed to be a black body radiator at +17.4°C (See Attachment 1). For cold case conditions, the telescope was conservatively tested and analysed to be a black body radiator at -61.9°C (See Attachment 2). Since both of these temperatures are beyond the required temperature range, then the requirements of paragraph 3.3.1.1.1.5 have been satisfied with a conservative analysis and test.

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*5/28/97*  
Date

### 3.2.3.3 Test 3 and 3a-Hot Case Operating

Test 3 consisted of setting the boundary conditions to the maximum SIM on-orbit operating temperatures with margins. Test 3a was performed to determine how focal plane temperature varied with focal plane power and also increase the SIM translation table by 10°C to determine temperature sensitivity. The power was set at .25 Watts to simulate the expected CCD dissipation. For this test, the sun shade was controlled to its maximum on-orbit temperature with margins using heaters mounted to the back side of the panel. With active thermal control the shade stabilized very quickly. In the math model correlations, the setpoint temperatures are used as boundary conditions. The boundary temperatures are listed in the As-Run Procedure. The transient test data plots for this test have been included in Appendix D. The measured steady state temperatures and math model predictions are shown in table 3.2-3 and table 3.2-4 for each thermal measurement location. The model correlates within +/-5°C (except in areas where there are high gradients) for all thermocouples and within +/-2°C at critical areas like the focal plane, camera body, and radiators. The average delta for all thermocouples is within 1.2°C. In general, the temperatures were on the high or conservative side. The heater power required to hold the camera body at temperature (-60°C) was within 4 percent of the measured data. In summary, the measured data correlated very well with the math model and should be considered acceptable for verification of thermal requirements.

Table 3.2-3 Test 3 Predicted and Measured Data

TEST 3	THERMOCOUPLE DESCRIPTION	Predicted (deg. C)	Measured (deg. C)	DELTA (deg. C)
TC1	+Z COLLIMATOR FOOT	-0.80	-3.30	2.50
TC2	+Y COLLIMATOR FOOT	-3.72	-2.30	-1.42
TC3	MECHANSIM ACCESS COVER	-18.78	-26.60	7.82
TC4	ACTUATOR COVER -X	-18.71	-26.00	7.30
TC5	ACTUATOR COVER +X	-18.71	-26.40	7.70
TC6	+Z SIDE OF COLLIMATOR-CENTERED	-18.53	-37.60	19.07
TC11	-Y COLD STRAP FLANGE AT CAMERA	-124.73	-125.50	0.77
TC12	+Y COLD STRAP FLANGE AT CAMERA	-124.72	-125.90	1.18
TC13	+Z CAMERA BODY-CENTERED	-61.39	-61.40	0.01
TC14	-Z CAMERA BODY-CENTERED	-60.00	-59.90	-0.10
TC15	-X CAMERA BACK PLATE-CENTERED	-60.59	-61.10	0.51
TC16	SNORKEL TUBE-CENTERED		-38.60	
TC17	SNORKEL TUBE-AT BELLOWS		-24.90	
TC18	LARGE VENT VALVE BODY		-16.40	
TC21	-Y COLD STRAP FLANGE AT RADIATOR	-128.61	-128.90	0.29
TC22	+Y COLD STRAP FLANGE AT RADIATOR	-128.61	-129.00	0.39
TC23	+X +Y CORNER OF COLD RADIATOR	-131.65	-131.30	-0.35
TC24	-Y WARM STRAP FLANGE AT RADIATOR	-79.27	-77.30	-1.97
TC25	+Y WARM STRAP FLANGE AT RADIATOR	-79.16	-79.40	0.24
TC26	+X +Y CORNER OF WARM RADIATOR	-90.26	-90.60	0.34
TC31	TELESCOPE SHADE -Y,-X CENTERED	-72.10	-79.40	7.30
TC32	TELESCOPE SHADE-Y,+XCENTERED	-69.93	-61.80	-8.13
TC33	TELESCOPE SHADE +Y,-X CENTERED	-72.13	-65.70	-6.43
TC34	SUN SHADE -Y,+X CENTERED	-39.70	-37.70	-2.00
TC35	SUN SHADE -Y,-X CENTERED	-39.84	-34.70	-5.14
TC36	SUN SHADE +Y,+XCENTERED	-39.69	-41.30	1.61
TC37	+Y SHADE SUPPORT POST-CENTERED	-84.63	-85.90	1.27
TC38	-Y SHADE SUPPORT POST-CENTERED	-84.63	-87.20	2.57
TC41	SIM SIMULATOR NEAR +Z FOOT	7.50	7.20	0.30
TC42	SIM SIMULATOR NEAR +Y FOOT	7.50	7.50	0.00
TC43	+Z SIDE OF SUPPORT STRUCT. SIM.	36.00	36.00	0.00
TC44	+Z SIDE OF SUPPORT STRUCT. SIM.	36.00	35.10	0.90
TC45	-X SIDE OF SUPPORT STRUCT. SIM.	36.00	35.80	0.20
TC46	TELESCOPE SIMULATOR PLATE	17.40	17.40	0.00
TC47	-Y HALF OF +Z PANEL	26.00	26.10	-0.10
TC48	+Y HALF OF +Z PANEL	26.00	26.20	-0.20
TC49	LN2 SHROUD NEAR TCS	-193.00	-193.90	0.90
HTR1	CAMERA BODY HEATER 1(WATTS)	3.69	3.56	0.13
HTR2	FOCAL PLANE HEATER 2 (WATTS)	0.00	0.00	0.00
HTR3	FOCAL PLANE HEATER 3 (WATTS)	0.00	0.00	0.00
RTD1	RTD 1 ON FOCAL PLANE -Y +Z FOOT	-121.91	-123.40	1.49
RTD2	RTD 2 ON FOCAL PLANE +Y +Z FOOT	-121.91	-123.40	1.50
RTD3	RTD 3 ON FOCAL PLANE -Y -Z FOOT	-121.59	-122.90	1.31
RTD4	RTD 4 ON FOCAL PLANE +Y -Z FOOT	-121.57	-122.80	1.23
			Average	1.13

### 3.2.3.2 Test 2 and 2a-Cold Case Operating

Test 2 consisted of setting the boundary conditions to the minimum SIM on-orbit operating temperatures with margins. Test 2a was performed to determine how focal plane temperature varied with focal plane power. The power was set at .25 Watts to simulate the expected CCD dissipation. For this test, the sun and telescope shades were considered quasi-static and acceptable for math model correlations. Math model correlations can still occur since the parasitics to the warm and cold radiators are very small at cold temperatures (i.e.  $-100^{\circ}\text{C}$ ). In the math model correlations, the actual temperatures are used as boundary conditions in the thermal model. The boundary temperatures are listed in the As-Run Procedure. The transient test data plots for this test have been included in Appendix C. The measured steady state temperatures and math model predictions are shown in table 3.2-3 and 3.2-4 for each thermal measurement location. The model correlates within  $\pm 4^{\circ}\text{C}$  for all thermocouples and within  $\pm 1^{\circ}\text{C}$  at critical areas like the focal plane, camera body, and radiators. The average delta for all thermocouples is within  $\pm 0.2^{\circ}\text{C}$  for both tests. The heater power required to hold the camera body at temperature ( $-76^{\circ}\text{C}$  and  $-60^{\circ}\text{C}$  respectively) was within 3 percent of the measured data. In summary, the measured data correlated very well with the math model and should be considered acceptable for verification of thermal requirements.

**Table 3.2-3 Test 2 Predicted and Measured Data**

TEST 2	THERMOCOUPLE DESCRIPTION	Predicted (deg. C)	Measured (deg. C)	DELTA (deg. C)
TC1	+Z COLLIMATOR FOOT	-58.12	-58.30	0.18
TC2	+Y COLLIMATOR FOOT	-58.27	-57.60	-0.67
TC3	MECHANSIM ACCESS COVER	-59.28	-61.00	1.72
TC4	ACTUATOR COVER -X	-59.12	-59.60	0.48
TC5	ACTUATOR COVER +X	-59.12	-59.80	0.68
TC6	+Z SIDE OF COLLIMATOR-CENTERED	-59.25	-61.30	2.05
TC11	-Y COLD STRAP FLANGE AT CAMERA	-134.04	-132.50	-1.54
TC12	+Y COLD STRAP FLANGE AT CAMERA	-134.04	-132.70	-1.34
TC13	+Z CAMERA BODY-CENTERED	-62.27	-62.80	0.53
TC14	-Z CAMERA BODY-CENTERED	-60.01	-60.00	-0.01
TC15	-X CAMERA BACK PLATE-CENTERED	-61.17	-62.30	1.13
TC16	SNORKEL TUBE-CENTERED		-63.20	
TC17	SNORKEL TUBE-AT BELLOWS		-65.40	
TC18	LARGE VENT VALVE BODY		-67.80	
TC21	-Y COLD STRAP FLANGE AT RADIATOR	-137.52	-135.60	-1.91
TC22	+Y COLD STRAP FLANGE AT RADIATOR	-137.51	-135.80	-1.71
TC23	+X +Y CORNER OF COLD RADIATOR	-139.96	-137.70	-2.26
TC24	-Y WARM STRAP FLANGE AT RADIATOR	-81.45	-81.30	-0.15
TC25	+Y WARM STRAP FLANGE AT RADIATOR	-81.32	-83.80	2.48
TC26	+X +Y CORNER OF WARM RADIATOR	-93.01	-95.70	2.69
TC31	TELESCOPE SHADE -Y,-X CENTERED	-89.94	-92.90	2.96
TC32	TELESCOPE SHADE-Y,+XCENTERED	-89.42	-84.40	-5.02
TC33	TELESCOPE SHADE +Y,-X CENTERED	-89.95	-86.00	-3.95
TC34	SUN SHADE -Y,+X CENTERED	-118.43	-120.20	1.77
TC35	SUN SHADE -Y,-X CENTERED	-118.46	-116.70	-1.76
TC36	SUN SHADE +Y,+XCENTERED	-118.43	-118.40	-0.03
TC37	+Y SHADE SUPPORT POST-CENTERED	-114.68	-115.20	0.52
TC38	-Y SHADE SUPPORT POST-CENTERED	-114.68	-117.40	2.72
TC41	SIM SIMULATOR NEAR +Z FOOT	-57.50	-57.90	0.40
TC42	SIM SIMULATOR NEAR +Y FOOT	-57.50	-56.80	-0.70
TC43	+Z SIDE OF SUPPORT STRUCT. SIM.	-26.00	-25.50	-0.50
TC44	+Z SIDE OF SUPPORT STRUCT. SIM.	-26.00	-26.10	0.10
TC45	-X SIDE OF SUPPORT STRUCT. SIM.	-26.00	-25.60	-0.40
TC46	TELESCOPE SIMULATOR PLATE	-61.90	-61.90	0.00
TC47	-Y HALF OF +Z PANEL	-30.00	-30.00	0.00
TC48	+Y HALF OF +Z PANEL	-30.00	-29.90	-0.10
TC49	LN2 SHROUD NEAR TCS	-193.00	-192.20	-0.80
HTR1	CAMERA BODY HEATER 1(WATTS)	11.28	11.03	0.25
HTR2	FOCAL PLANE HEATER 2 (WATTS)	0.00	0.00	0.00
HTR3	FOCAL PLANE HEATER 3 (WATTS)	0.00	0.00	0.00
RTD1	RTD 1 ON FOCAL PLANE -Y +Z FOOT	-131.05	-130.10	-0.95
RTD2	RTD 2 ON FOCAL PLANE +Y +Z FOOT	-131.05	-130.20	-0.85
RTD3	RTD 3 ON FOCAL PLANE -Y -Z FOOT	-130.72	-129.60	-1.12
RTD4	RTD 4 ON FOCAL PLANE +Y -Z FOOT	-130.69	-129.50	-1.19
			Average	-0.17