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DIGITAL TEMPERATURE SENSOR

PERFORMANCE ASSESSMENT REPORT

Job Order 39-129

Prepared By

Lockheed Electronics Company, Inc.
Aerospace Systems Division
Houston, Texas

Contract NAS 9-12200

For

CONTROL SYSTEMS DEVELOPMENT DIVISION

National Aeronautics and Space Administration

LYNDON B. JOHNSON SPACE CENTER

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1.0 INTRODUCTION

This report presents performance assessment data accumulated during exposure of the Digital Temperature Sensor to simulated Shuttle flight type environments.

The test parameters were specifically designed to check the sensor for its:

- Ability to resolve temperature relative to the design specifications.
- Ability to maintain accuracy after interchanging the temperature probes with each Electronics Interface Assembly (EIA).
- Stability (i.e., satisfactory operation and accuracy during and after exposure to flight environments).
- Repeatability, or its ability to produce the same output on subsequent exposures to the identical stimulus.

2.0 SCOPE

This document was written to delineate the outcome of environmental evaluation tests applied to the Digital Temperature Sensor system. The system is composed of two main items: a probe consisting of eight temperature sensitive ferrous cores; and a signal conditioning unit or EIA.

Equipment list, test descriptions, data summary, and conclusions are included as an aid to better understand the tests to which the sensors were exposed and the criteria to which the sensors were evaluated.

3.0 SYSTEM CONFIGURATION

3.1 COMPONENTS AND ACCURACIES

Table I identifies the various instruments, their application, and relative accuracies.

3.2 MECHANICAL

A Hallikainen Instrument Company constant temperature bath (NASA #50964) was used as the basic item to control and regulate the stimulus temperature. A chiller (NASA maintenance ID #009539) was connected to the bath's internal plumbing and was used for cooling to the required -10° C.

Several test runs were made on the bath without the Digital Temperature Sensor to determine the bath's response to control, change, and stability of temperature.

The bath temperature could be easily controlled to within 0.01° C as indicated by the digital readout on the quartz thermometer. After stabilizing the bath at a preset temperature, the differential temperatures in the bath were typically less than 0.005° C, and usually about 0.002° C. This confirmed a homogenous temperature about the sensors under test. The quartz thermometer probes were approximately four inches apart (±2 inches from the centerline) and submerged approximately 2 inches from the upper surface of the liquid medium.

The liquid medium used in the bath was ethylene glycol. This liquid was selected and used because it was inexpensive, readily available, and would function satisfactorily throughout the range of -15° C to 105° C.

TABLE I. — INSTRUMENT APPLICATION AND RELATIVE ACCURACY

Item	Instrument	NASA Number	Application	Accuracy
1.	Hallikainen Bath Model 1385	50964	Regulated temperature bath assembly	—
2.	Digital Voltmeter Dana 5600	4416	Voltage Measurement Resistance Measurement	0.1% F.S. Error 2.0% F.S. Error
3.	Digital Recorder Hewlett-Packard 562A	77384	Data Recorder	N.A.
4.	Oscilloscope Tektronix RM45A	53068	Data Monitor	N.A.
5.	Square Wave Gen. Hewlett-Packard 202AR	64367	Interrogation Pulse	0.5% Distortion Error
6.	Power Supply Lambda LEID2FM	64374	Regulated Power Source	0.1% Regulation Error
7.	Chiller Custom Assembly	009539	Low Temperature Source	
8.	Quartz Thermometer HP2800A	51335	Bath Temperature Indication	0.05° C absolute 0.001° C differential

Figure 1 is an outline drawing of the bath, sensors, and instruments.

3.3 ELECTRICAL

The digital temperature sensor tested is not a digital device in the literal sense. It is digital only in the fact that the discrete temperature sensing cores are "on" or "off".

Eight discrete ferrous cores comprise each sensor. Four sensors and associated electronics were to be tested simultaneously. This involved monitoring the status of 32 separate functions or possible events.

A status monitor panel was designed and fabricated which would sense the status of any or all of the 32 discrete functions. The Status Monitor Panel Layout is shown in figure 2.

The output selector switch selected the next temperature level to which the sensors were to be exposed. The output of the selector switch was conditioned by special circuitry as needed for compatibility with the digital printer. The printer provided a permanent, semi-automatic record of the data. The accumulated data were analyzed after completion of the test.

Wiring details and a technical discussion of the operation of the Digital Temperature Sensor are available in the OPERATIONS MANUAL, Digital Temperature Sensor, Model 71, by Mesa Instruments, Inc., Austin, Texas. Figure 3 is an electrical interconnection block diagram which is included here for convenience.

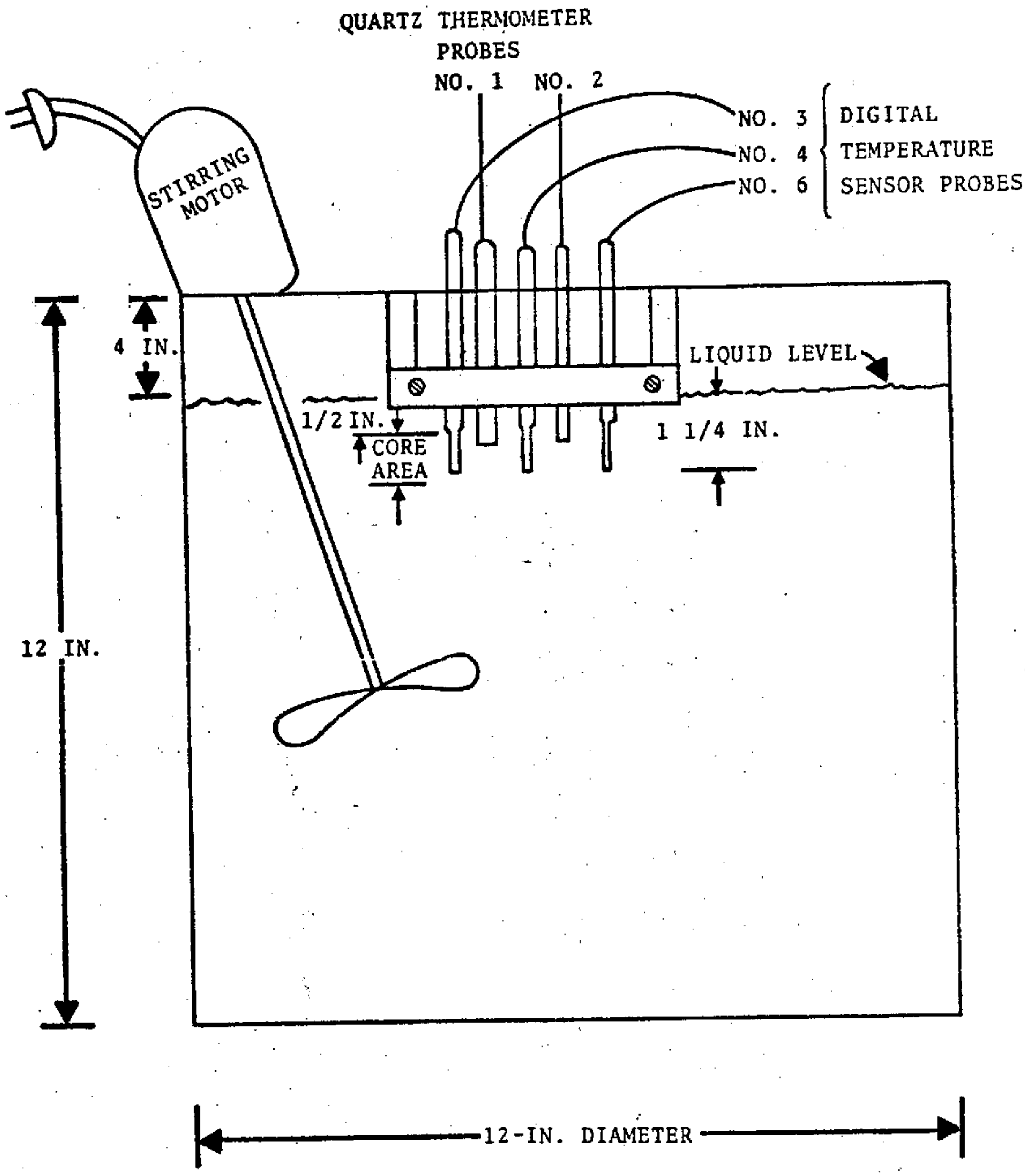

Figure 1. - Bath interior dimensions and sensor layout.

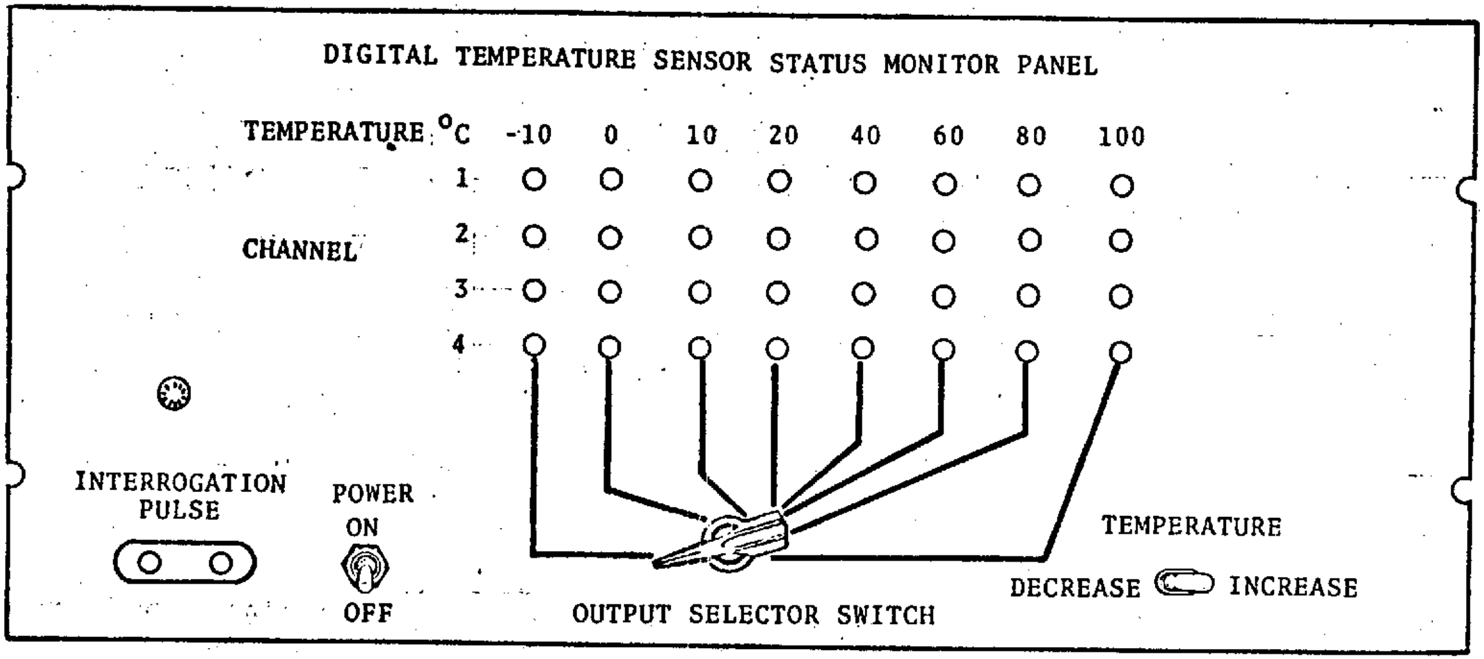

Figure 2. - Status monitor panel general layout.

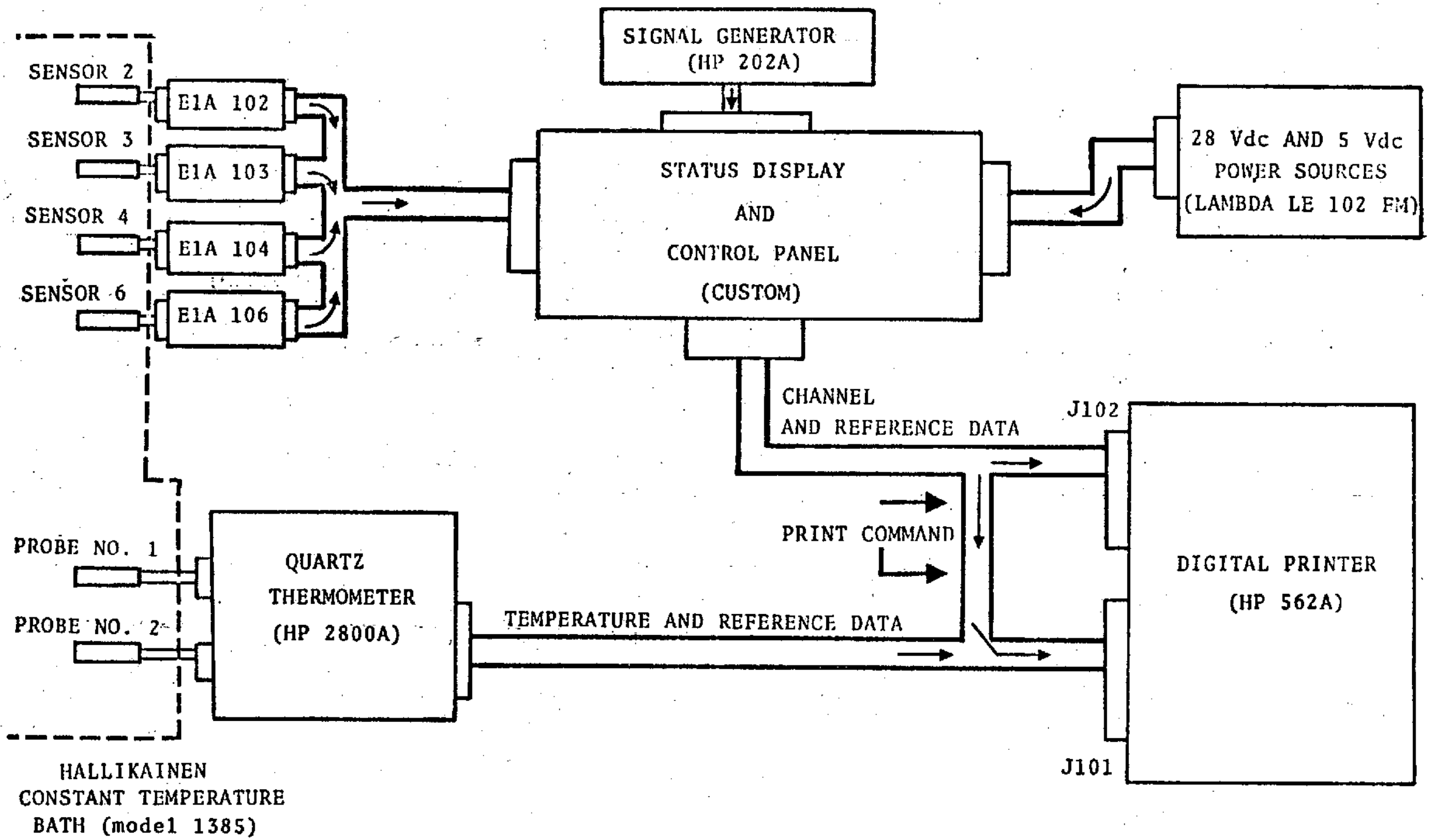

Figure 3. - System cable diagram.

4.0 TEST DESCRIPTION

4.1 PRETEST INSPECTION AND CHECKOUT

4.1.1 Visual Inspection

The sensors and signal conditioners were visually inspected for any readily apparent abnormalities. None were found.

4.1.2 Electrical Inspection and Checkout

The sensors were next electrically compared against the manufacturer's OPERATION MANUAL, Digital Temperature Sensor, Model 71. No anomalies were observed during either resistance or voltage measurements.

4.2 PHASE "A" TESTING

The first phase of the test program required general functional and systems checkout. The sensors were mounted in the bath as indicated in figure 1. The bath temperature was exercised throughout the extremes of the sensors designed specifications (-10° C through +100° C), obtaining recordings of the actual temperatures as the sensor environments changed. During the phase of testing the bath was also checked for small rates of change. The optimum rate of change was determined to be approximately 0.02° C per minute. At this rate, the sensor's thermal characteristics closely tracked that of the bath.

4.3 PHASE "B" TESTING

The next phase of the test program necessitated the establishment of suitable baseline data. These data were used throughout the remainder of the test programs for comparative purposes.

Eleven test runs were performed on the four sensors; serial numbers 2, 3, 4, and 6. EIA units numbered 102, 103, 104, and 105 were paired respectively with each of the above sensors (i.e., sensor number 2 paired with EIA 102, etc.). Six of the eleven test runs provided data primarily for increasing bath temperatures. The tests were alternated such that on any one day the data reflected an increasing temperature and the following day's data reflected decreasing temperature. These data are shown graphically in appendix A. The 11 test runs comprise reference points which were used as baseline data. See table II for the baseline data summary chart.

4.4 PHASE "C" TESTING

The next phase in the test program required repetition of the sensor and bath temperature excursions but with the sensors and EIA units interchanged. A temperature excursion included a temperature cycle from -10° C to +100° C and back to -10° C. Each sensor was coupled with a different EIA unit for each temperature excursion. Every effort was made to repeat the exact test conditions during each test phase.

The summary of errors attributable to interchangeability is included in tables III and IV.

TABLE II. — BASELINE DATA SUMMARY

(Numerical Average, $\overline{X}$, of 11 Runs)

C U R I E   P O I N T

Design	Actual (Oct/Nov 72)			
Sensor	2*	3	4	6
EIA	102	103	104	105
100	100.10	99.88	99.84	100.49
80	80.68	80.36	80.39	80.03
60	60.88	60.10	60.67	60.53
40	40.48	40.42	40.24	42.00
20	21.17	21.23	21.34	17.61
10	10.69	10.50	10.63	7.27
0	0.02	-0.17	-0.02	-0.16
-10	-8.97	-9.21	-9.17	-9.08

*This sensor failed during first phase of sensor/system checkout. Data shown is taken from early tests and is included for information only.

(-)A negative sign preceding a data figure indicates that the actual (absolute) value is less than the design figure by the amount indicated. All other numbers are considered positive and therefore greater than the design figure as shown.

TABLE III. – INTERCHANGEABILITY DATA SUMMARY ELECTRONIC INTERFACE ASSEMBLY (EIA) VERSUS SENSORS

Curie Point (°C)	103			104			105		
	3	4	6	3	4	6	3	4	6
100	99.88	99.84	100.68	99.77	99.84	100.41	99.74	99.85	100.49
Δ%	---	-0.04	0.73	-0.06	---	0.52	-0.68	-0.58	---
80	80.36	80.44	80.19	80.22	80.39	79.97	80.15	80.41	80.03
Δ%	---	0.07	-0.15	-0.15	---	-0.38	0.11	0.35	---
60	60.10	60.66	60.19	60.05	60.67	60.43	59.75	60.67	60.53
Δ%	---	0.51	0.08	-0.56	---	-0.22	-0.71	-0.13	---
40	40.42	40.25	41.98	40.42	40.24	41.90	40.43	40.25	42.00
Δ%	---	-0.15	1.42	0.16	---	1.51	-1.43	-1.59	---
20	21.23	21.30	17.76	21.24	21.34	17.58	21.19	21.31	17.61
Δ%	---	-0.06	-3.15	-0.09	---	-3.42	3.25	3.36	---
10	10.50	10.62	7.24	10.50	10.63	7.26	10.50	10.62	7.27
Δ%	---	-0.11	-2.96	-0.12	---	-3.06	2.94	3.04	---
0	-0.17	-0.03	-0.11	-0.18	-0.02	-0.13	-0.26	-0.14	-0.16
Δ%	---	0.13	0.05	-0.15	---	-0.10	-0.09	0.02	---
-10	-9.21	-9.16	-9.10	-9.20	-9.17	-9.32	-9.20	-9.16	-9.08
Δ%	---	0.05	0.10	-0.03	---	-0.14	-0.11	-0.07	---

The upper number in each data block represents the actual temperature value recorded during testing, while the lower number represents the delta or difference in percent of full span between the norm (base data) and test data.

TABLE IV. — INTERCHANGEABILITY DATA SUMMARY SENSOR VERSUS ELECTRONIC INTERFACE ASSEMBLIES (EIA)

Curie Point (°C)	3			4			6		
	103	104	105	103	104	105	103	104	105
100	99.88	99.77	99.74	99.84	99.84	99.85	100.68	100.41	100.49
Δ%	---	-0.10	-0.13	0.0	---	0.01	0.17	-0.07	---
80	80.36	80.22	80.15	80.44	80.39	80.41	80.19	79.97	80.03
Δ%	---	-0.13	-0.19	0.05	---	0.02	0.15	-0.05	---
60	60.10	60.05	59.74	60.66	60.67	60.67	60.19	60.43	60.53
Δ%	---	-0.05	-0.33	-0.01	---	0.0	-0.31	-0.09	---
40	40.42	40.42	40.43	40.25	40.24	40.25	41.98	41.90	42.00
Δ%	---	0.0	0.01	0.01	---	0.01	-0.02	-0.09	---
20	21.23	21.24	21.19	21.30	21.34	21.31	17.76	17.58	17.61
Δ%	---	0.01	-0.04	-0.04	---	-0.03	0.14	-0.03	---
10	10.50	10.50	10.50	10.62	10.63	10.62	7.24	7.26	7.27
Δ%	---	0.0	0.0	-0.01	---	-0.01	-0.03	-0.01	---
0	-0.17	-0.18	-0.26	-0.03	-0.02	-0.14	-0.11	-0.13	-0.16
Δ%	---	0.01	-0.08	-0.01	---	-0.11	0.05	0.03	---
-10	-9.21	-9.20	-9.20	-9.16	-9.17	-9.16	-9.10	-9.32	-9.08
Δ%	---	0.01	0.01	0.01	---	0.01	-0.02	-0.22	---

The upper number in each data block represents the actual temperature values recorded during testing, while the lower number represents the delta or difference in percent of full span between the norm (base data) and test data.

4.5 PHASE "D" TESTING

This was the final phase of testing and included exposure of the sensor and EIA unit to various levels of environments as suggested in LEC Document 28-509-2005, Digital Temperature Sensor, Environmental Test Procedures. The test sequence is illustrated in table V, taken from the test procedure document.

In preparation for the environmental tests, EIA 103 was internally sealed with Sylgard 182 potting compound. This was necessary prior to any vibration tests because of the unsupported components assembled internal to the EIA. The effort to add potting material to the interior of the EIA is not intended to reflect upon the workmanship of the unit. The potting was added to minimize any perturbations outside of the electrical qualities of the sensor/EIA units.

After the test article was made ready and the test setup was completed, a preliminary test run was made to confirm data repeatability with that established in Phase B. Once this was confirmed and the EIA stabilized at ambient (24° C), the temperature test was started.

4.5.1 Temperature Environmental Test

The manufacturer's specification for operating temperature of the EIA is from 0° C to +70° C. In anticipation of harsh environmental circumstances, NASA requested that the EIA be tested at -18° C and +93° C. Figure 4 illustrates a general test setup showing the relationship of instrumentation, bath, and oven. Figure 5 shows the sensor/thermometer layout.

TABLE V. — TEST SEQUENCE

	Pre-Cal.	Environmental Test									Post-Cal.
		Temperature			Vibration		Vacuum		Salt Fog		
Sensor Temp.	-10° C to +100° C	-10° C to +100° C	-10° C to +100° C	Cal.	Ambient	Cal.	Ambient	Cal.	60° C	Cal.	-10° C to +100° C
EIA Temp.	Ambient	-18° C	+93° C	Cal.	Ambient	Cal.	Ambient	Cal.	60° C	Cal.	Ambient

NOTE: A brief calibration test was originally scheduled to follow each environmental test. This requirement was waived for the vibration test because of facility problems (lack of suitable pressure calibration equipment at the remote test site).

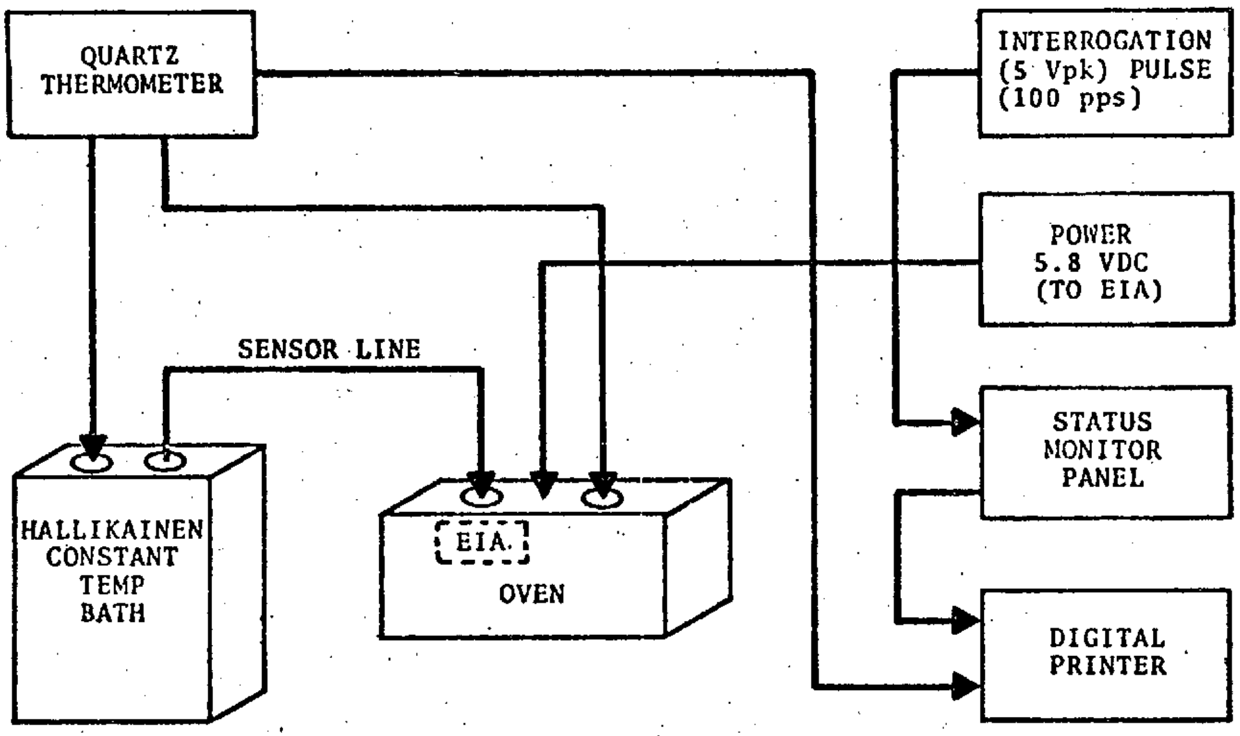

Figure 4. - Temperature test diagram.

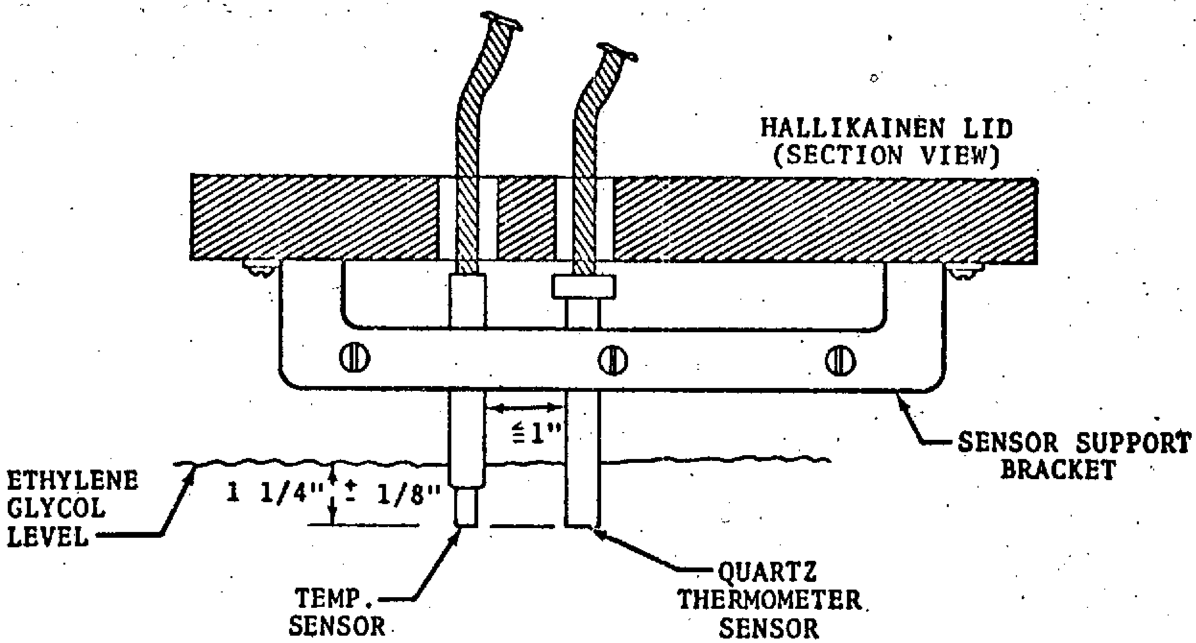

Figure 5. - Sensor/thermometer layout.

Data from the three sensors and corresponding EIA's were compared in order to determine the best representative unit. Sensor 3 and EIA 103 were chosen. These two items were the only units subjected to the temperature tests.

4.5.1.1 Low temperature test. The low temperature test was run first. The initial temperature of the EIA was established as 24° C. The oven containing the EIA was then chilled to -18° C according to the test procedures. The bath temperature containing the sensor was then decreased to -11° C. The bath temperature rate was increased at 0.02° C per minute to within a half degree beyond the appropriate switching (detection) point of the sensor. Upon confirming the data printout to be satisfactory, the bath temperature rate was changed rapidly to -2° C. A 20 minute stabilizing period was required — or until the temperature differences of the quartz thermometer was less than 0.05° C. At this time the temperature of the bath was increased at 0.02° C per minute to a half degree beyond the switching point of the sensor.

This same procedure was followed throughout the testing. The data results are contained in paragraph 5.3 of this document.

4.5.1.2 High temperature test. The high temperature test was run next. The oven containing the EIA was increased to +93° C in accordance to the test procedures. This temperature was then maintained at +93° C ±3° C throughout the remainder of this test.

4.5.1.3 Post temperature test. The temperature tests were followed by a calibration phase — the Post Temperature

Test. The purpose of this test is to determine the effects of the environmental test upon the sensor. The data was obtained during a test run identical to the pre-test calibration series.

Results of the post temperature test are depicted in paragraph 5.3, of this report.

4.5.2 Vibration

The vibration phase of testing was a passive test. The sensor and EIA was not active or operating during the test. The sensor and EIA were subjected to 6.0 gRMS for 15 minutes in each of three mutually perpendicular axes.

Appendix B lists the specific random vibration spectrum, including levels, to which the sensor and EIA were tested. The appendix also contains a pictorial presentation of the sensor and EIA including the axes identification. The details of the test sequence are described on the Test Preparation Sheet, appendix B.

Post vibration calibration was not performed because of facility problems, including lack of precision pressure calibration equipment at the test site.

4.5.3 Vacuum

During the vacuum phase of testing, the sensors were exposed to a pressure change approximating the pressure changes during a flight of the space shuttle vehicle. The system was de-energized for this test. The sensors were exposed to the vacuum environment for seven days; including reduced chamber vacuum throughout the weekend.

The data results are contained in paragraph 5.3 of this document.

4.5.4 Salt Fog

The Digital Temperature sensor and the EIA were exposed to a salt fog environment as suggested in Mil-Std 810, Method 509. At NASA's request, the salt spray consisted of 1 percent salt solution for 12 hours total exposure at 60° C (140° F). The sensor and EIA were de-energized for this test.

The results are contained in paragraph 5.3 of this document.

5.0 TEST RESULTS

5.1 GENERAL

The overall performance of the Digital Temperature Sensor is summarized in table VI. The sensor's transition temperatures were confirmed through repeatability tests. The manufacturer's specification states that the transition temperatures shall be within ±5° C of the following temperatures: -10°, 0°, 10°, 20°, 40°, 60°, 80°, and 100° C. In actuality, one Digital Temperature sensor (sensor 6, EIA 105) deviated +2.0° C and -2.73° C from the design points of 40° C and 10° C, respectively.

5.2 INTERCHANGEABILITY

Tables III and IV, respectively, provide arrays of data summarizing the results of interchanging the sensors with the EIA's, and the EIA's with the sensors. Worst case data was taken from these two tables and used to depict the sensor performance summary. See table VI.

5.3 ENVIRONMENTAL TEST PERFORMANCE SUMMARY

Calibration tests were performed after each of the following environmental tests:

- Low Temperature
- High Temperature
- Vacuum
- Salt Fog

TABLE VI. — SENSOR PERFORMANCE SUMMARY

Parameter	Manufacturer's Specification	Actual Performance (Worst Cases)	Remarks
Transistors Temperatures (°C)	-10°, 0°, 10°, 20°, 40°, 60°, 80°, 100°, each within ±5° C.	+2.00° C -2.73° C	Relative to Designed Values (40°, 60°, 80°, etc.)
Sensor Interchangeability	±0.5° C	+3.70° C -3.26° C	Relative to Base Data (10.50, 17.61, 42.00, etc.)
EIA Interchangeability	±0.1° C	+0.19° C -0.36° C	Relative to Base Data (60.10, 80.36, etc.)
Repeatability	0.0	0.64° C	Determined while establishing base data

These tests were performed to investigate the possibility of sensor/EIA being degraded through the effects of environmental testing. Tabulated results are listed in table VII. Both the actual temperature values as well as the calculated percent differences (relative to full span) are included in the table.

The greatest change was noticed after the High Temperature Test. The change was 0.29° C or 0.26 percent of full span (F.S.). The shift was observable on seven of the eight subelements which comprise the sensor element. By the time of post testing, six of the eight subelements had returned to a value of less than 0.1° C of the pre-test conditions. The remaining two indicated a change of less than 0.2° C relative to the pre-test conditions.

TABLE VII. — ENVIRONMENTAL TEST PERFORMANCE SURVEY

CURIE POINT (°C)	PRETEST CALIBRATION* (3 Months after re-peatability test) February 1973	EIA TEMPERATURE**		POST TEMPERATURE**	POST VIBRATION**	POST VACUUM**	POST SALT FOG**	POST TEST**
		Lo Temp (-18° C)	Hi Temp (93° C)					
Sensor	3	3	3	3	3	3	3	3
EIA	103	103	103	103	103	103	103	103
100	99.85	99.79	99.80	99.73	NR	99.77	99.77	99.95
Δ%	0.03	0.05	0.05	0.11		0.07	0,07	0.09
80	80.30	80.24	80.31	80.28	NR	80.13	80.13	80.15
Δ%	0.05	0.05	0.01	0.02		0.15	0.15	0.14
60	60.10	60.08	59.97	59.81	NR	59.83	59.87	59.93
Δ%	0.0	0.02	0.12	0.26		0.25	0.21	0.16
40	40.39	40.37	40.32	40.24	NR	40.25	40.31	40.30
Δ%	0.03	0.02	0.06	0.14		0.13	0.07	0.08
20	21.17	21.14	21.11	21.00	NR	21.01	21.05	21.13
Δ%	0.05	0.03	0.05	0.15		0.15	0.11	0.04
10	10.43	10.41	10.37	10.29	NR	10.32	10.34	10.46
Δ%	0.06	0.02	0.05	0.13		0.10	0.08	0.03
0	-0.19	-0.22	-0.27	-0.34	NR	-0.35	-0.34	-0.22
Δ%	0.02	0.03	0.07	0.14		0.15	0.14	0.03
-10	-9.24	-9.23	-9.41	-9.46	NR	-9.45	-9.43	-9.25
Δ%	0.03	0.01	0.15	0.20		0.19	0.22	0.01

*The "Δ" figures in this column expresses the difference in repeatability data after a 3-month time lapse.

**The "Δ" figures in these columns indicate a change in performance caused by the respective environmental test and are relative to the latest pre-test calibration, and expressed in percent of full span.

NR: Data was not required. The sensor and associated equipment performed satisfactorily.

6.0 CONCLUSION

Using the manufacturer's specifications as criteria for performance, the interchangeability and repeatability characteristics of the Digital Temperature sensor must be rated unsatisfactory. The largest contributor to the interchangeability error was sensor 6, relative to sensors 3 and 4. Discarding sensor 6 data would decrease the interchangeability error appreciably but the error would still exceed the manufacturer's value of ±0.5° C.

The Digital Temperature Sensors and associated Electronic Interface Assemblies performed satisfactorily throughout all environmental testing. The worst case deviated only 0.26 percent, as observed during the post temperature testing. Even this sensor returned to within 0.16 percent of the pre-test data after the environmental testing was complete.

This Digital Temperature Sensor offers a reasonable approach to the measurement of temperature parameters where the output signal may be on/off; go-no-go' or step functions. Applications might include alarms, process control, temperature monitor, temperature control, etc.

Although the particular units tested did not meet the desired specifications, it is felt that additional development would produce an acceptable set of sensors. High accuracies, approaching that of Resistance Temperature Devices (RTD's), as well as resolution of one degree celsius, may be feasible if the measurement justifies the cost.

Resolution, being chiefly limited by the quantity of elements within the sensor probe, will have a direct relationship to the cost of the system.

APPENDIX A

SENSOR TEST POINT VERSUS DEVIATION

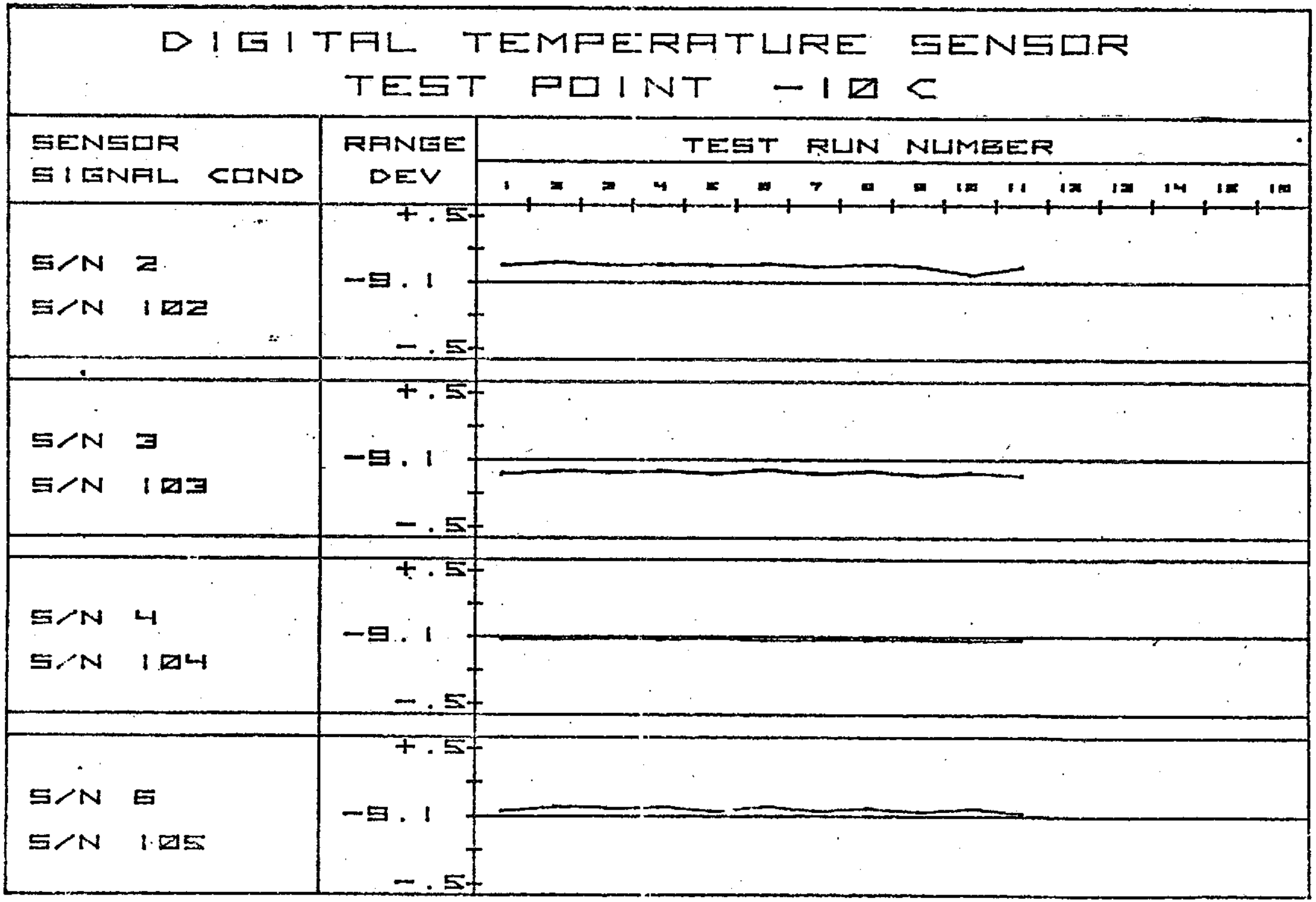

Figure A-1. — Digital temperature sensor test result. (Page 1 of 8)

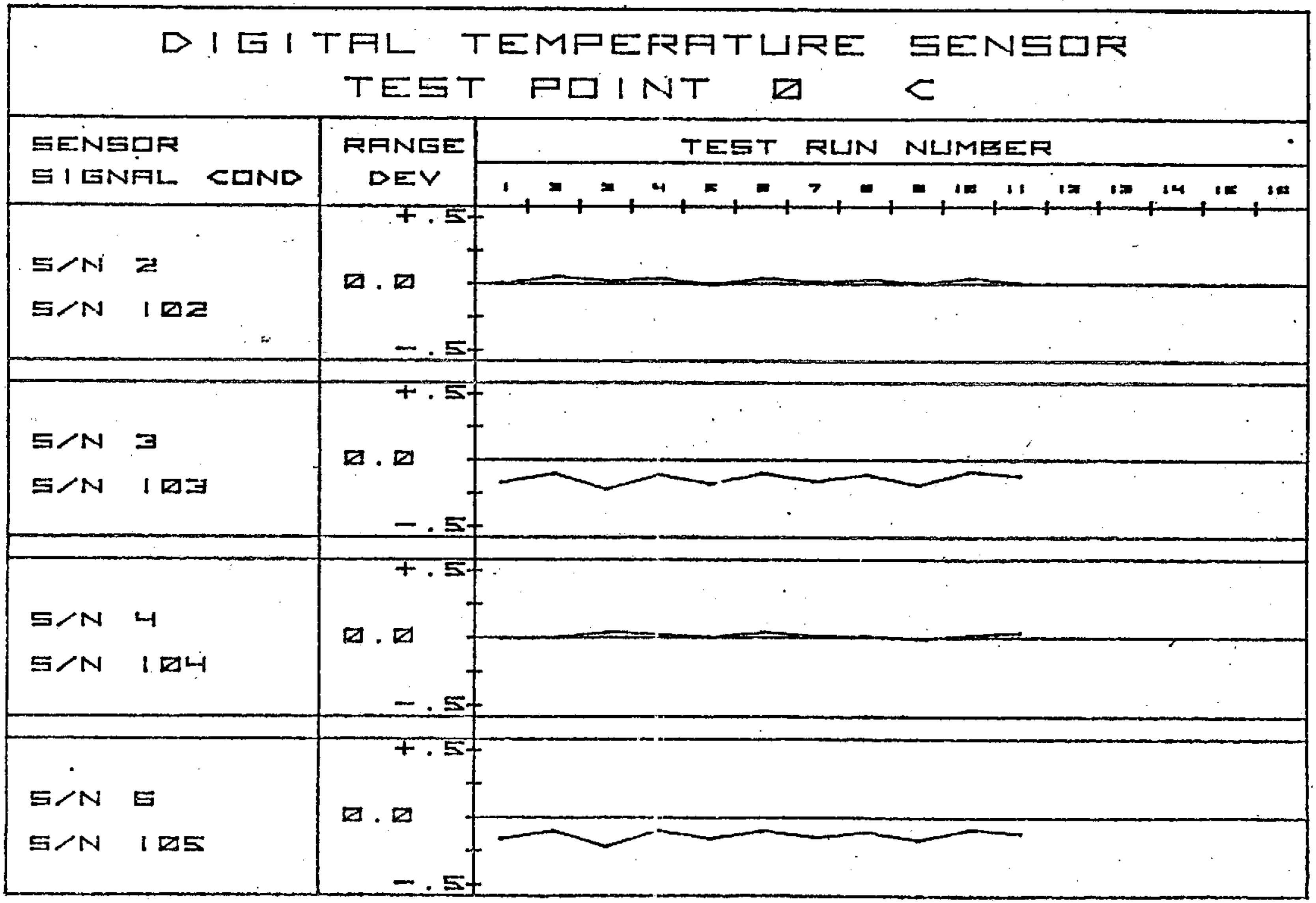

Figure A-1. – Digital temperature sensor test result. (Page 2 of 8)

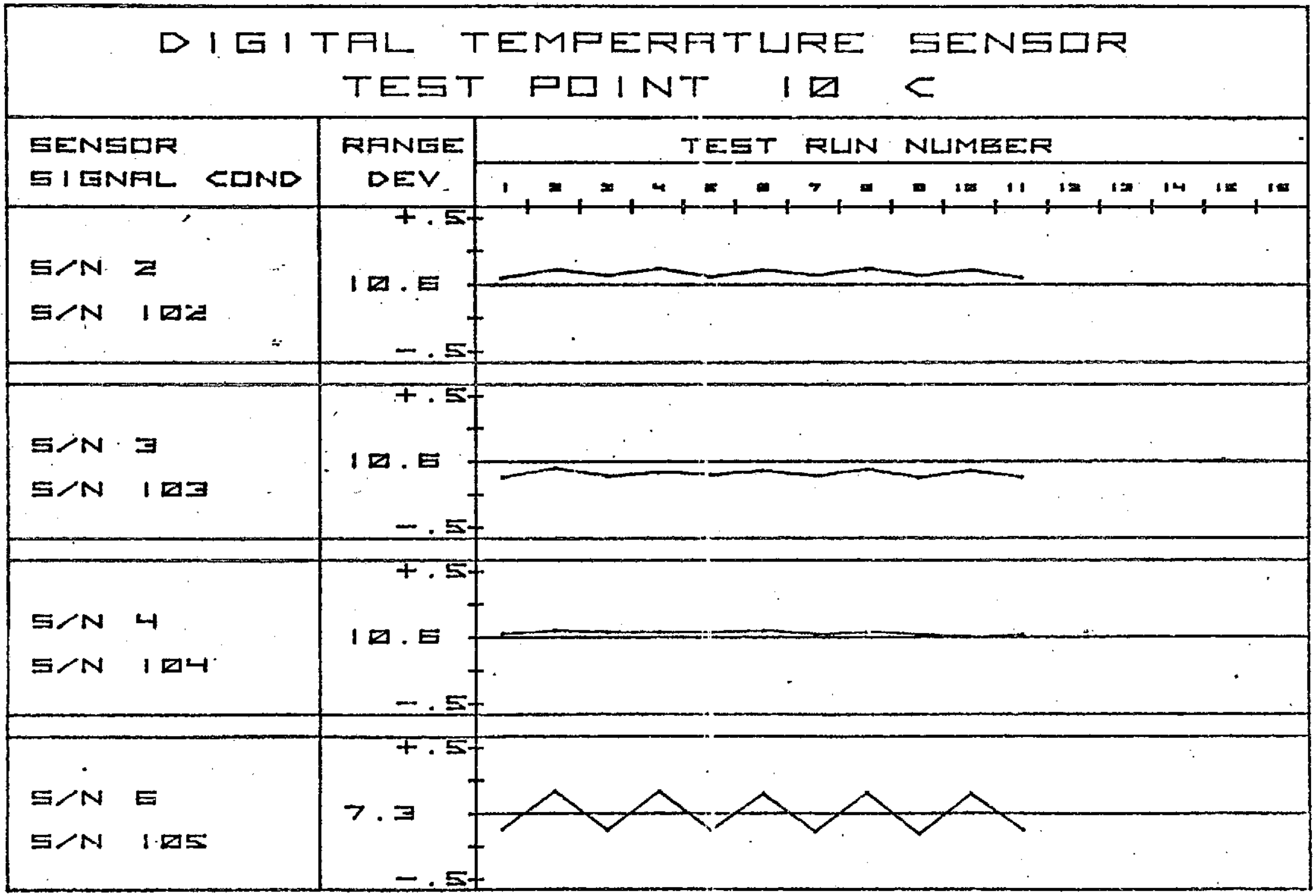

Figure A-1. — Digital temperature sensor test result. (Page 3 of 8)

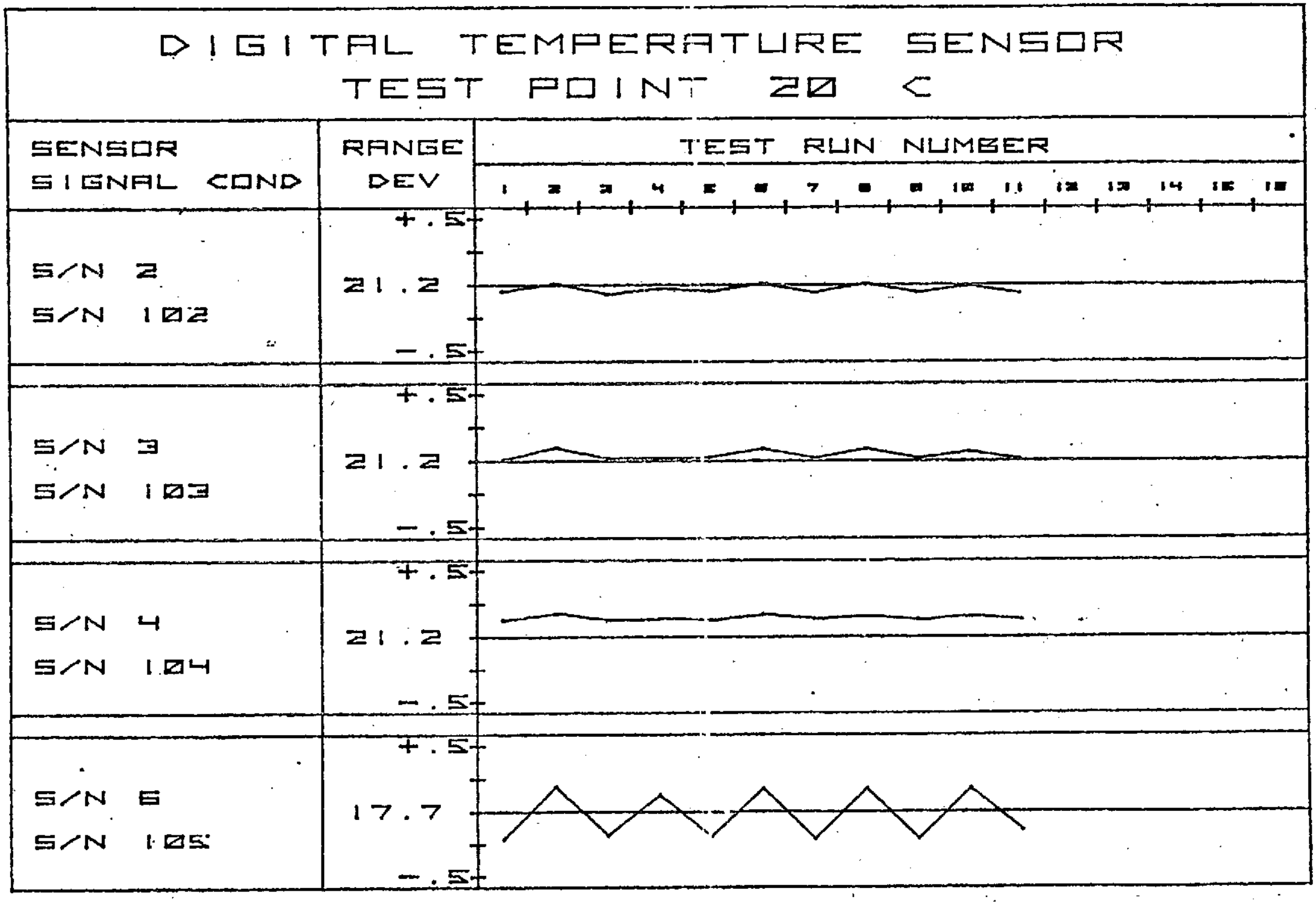

Figure A-1. — Digital temperature sensor test result. (Page 4 of 8)

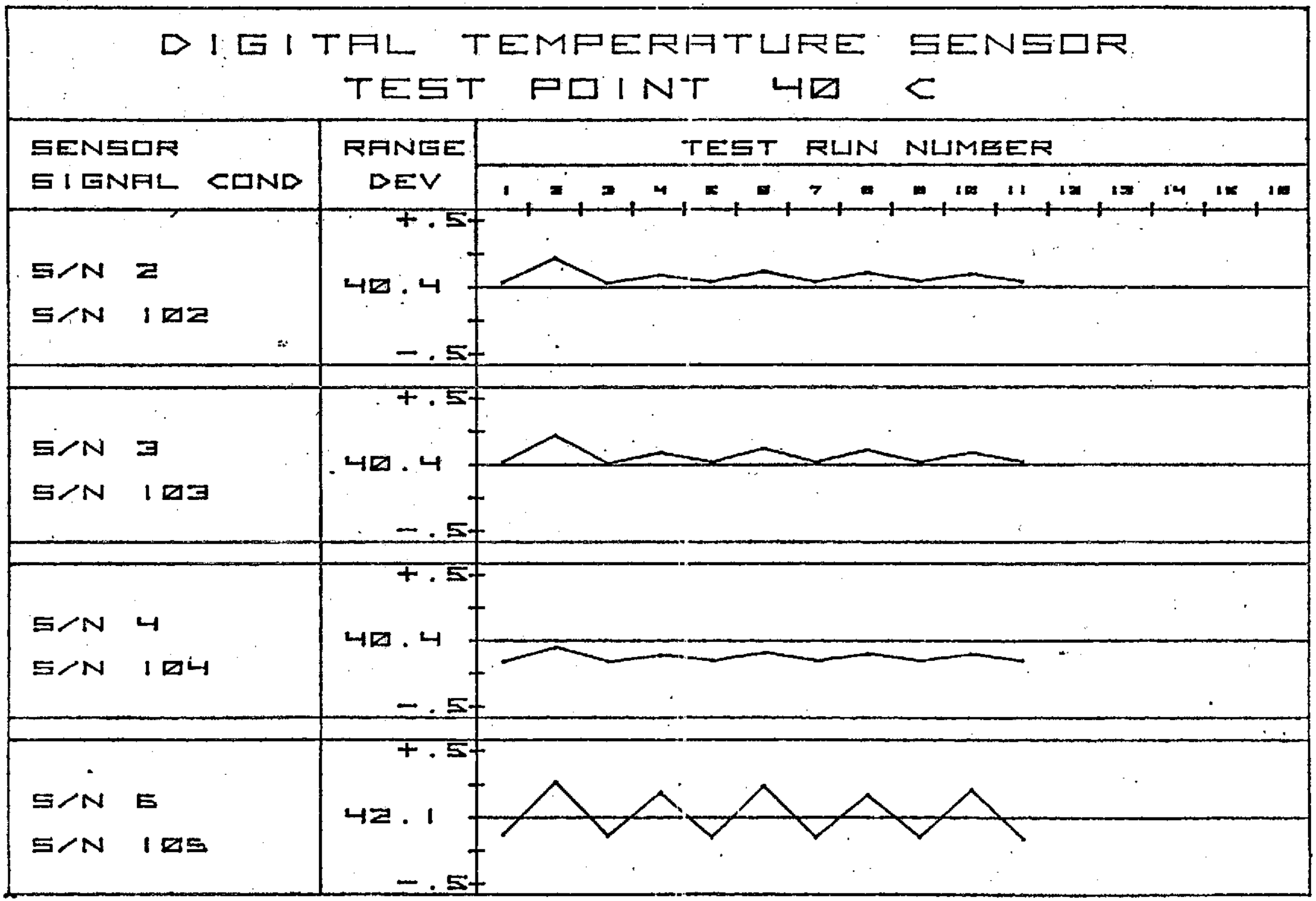

Figure A-1. — Digital temperature sensor test result. (Page 5 of 8)

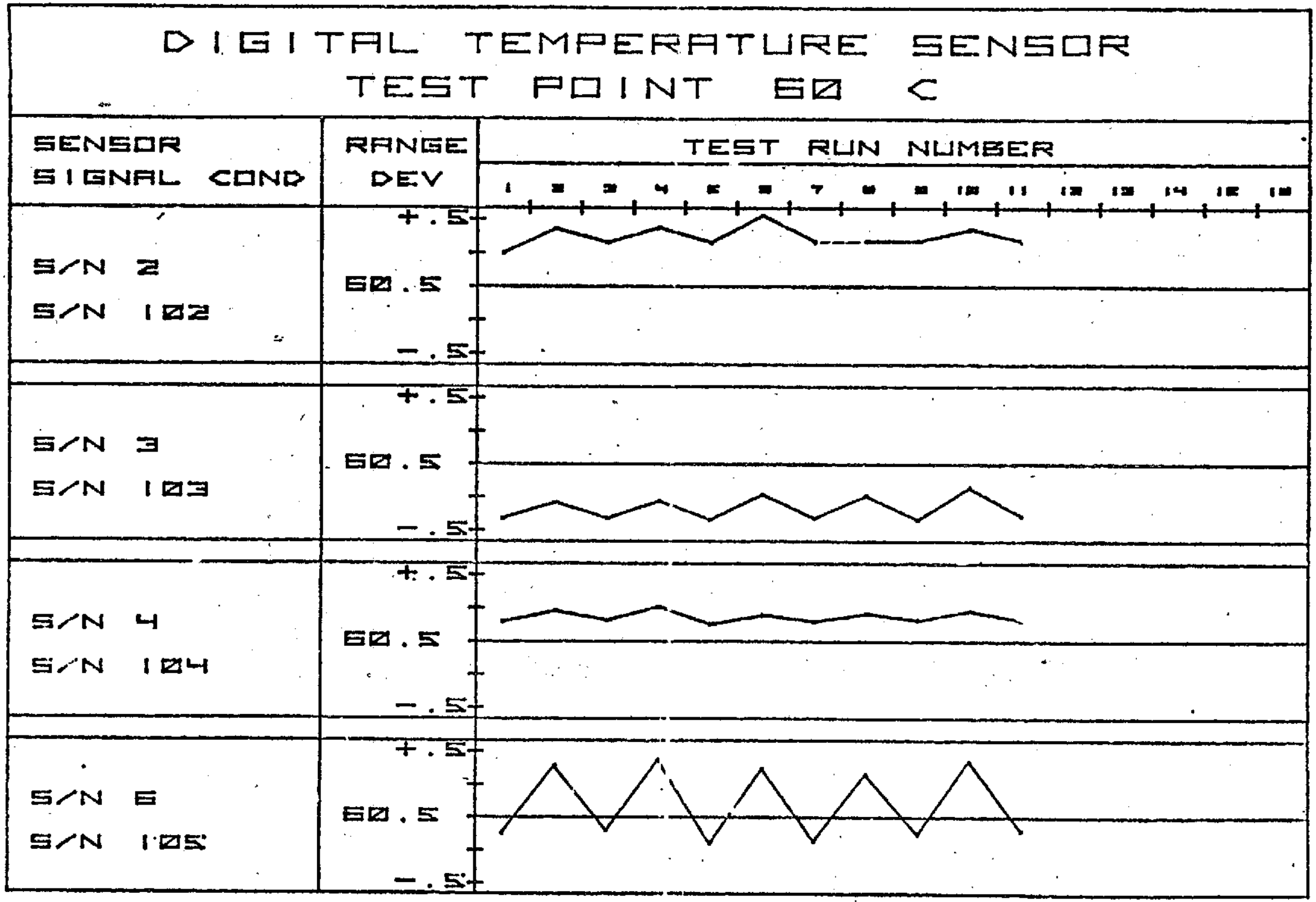

Figure A-1. – Digital temperature sensor test result. (Page 6 of 8)

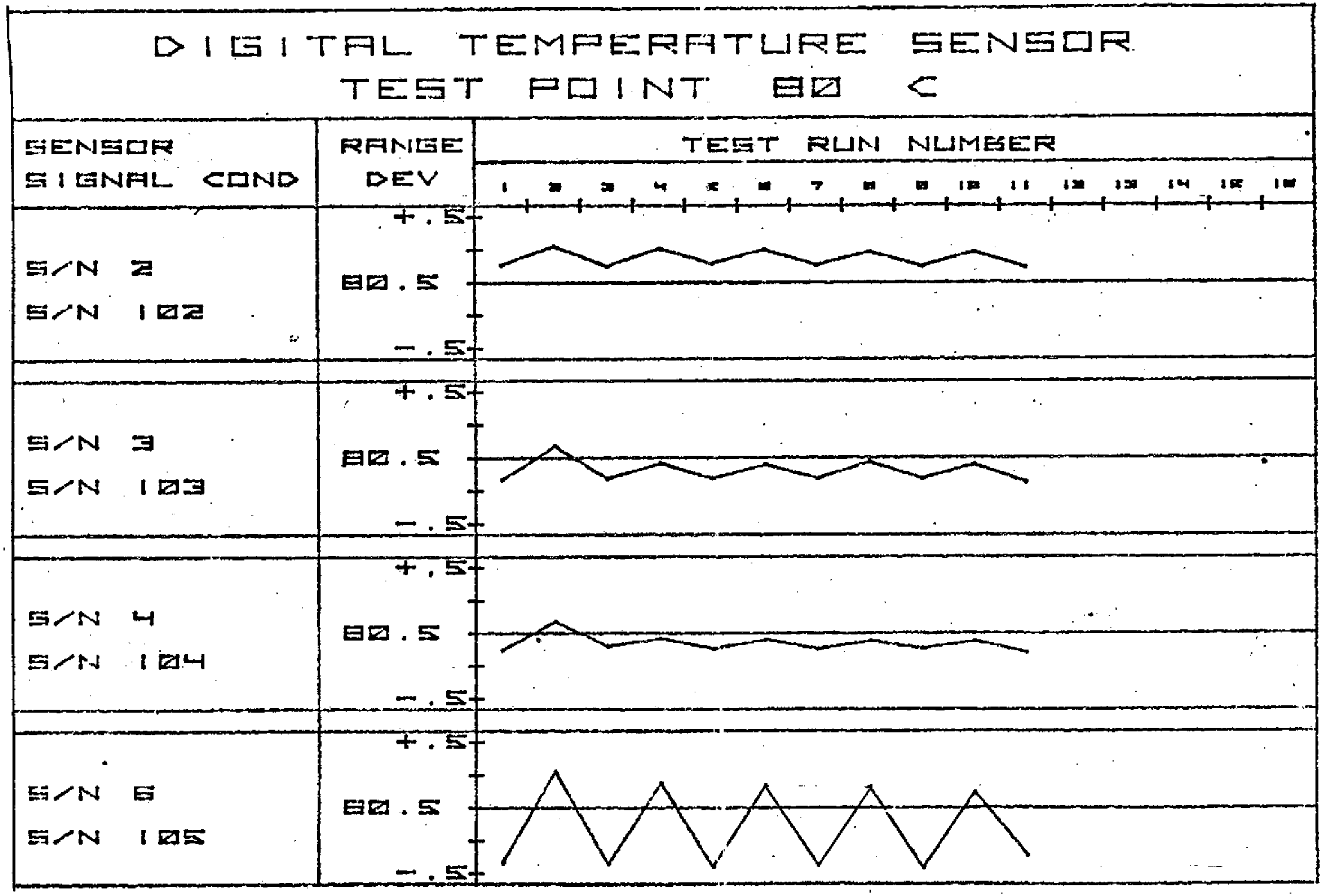

Figure A-1. — Digital temperature sensor test result. (Page 7 of 8)

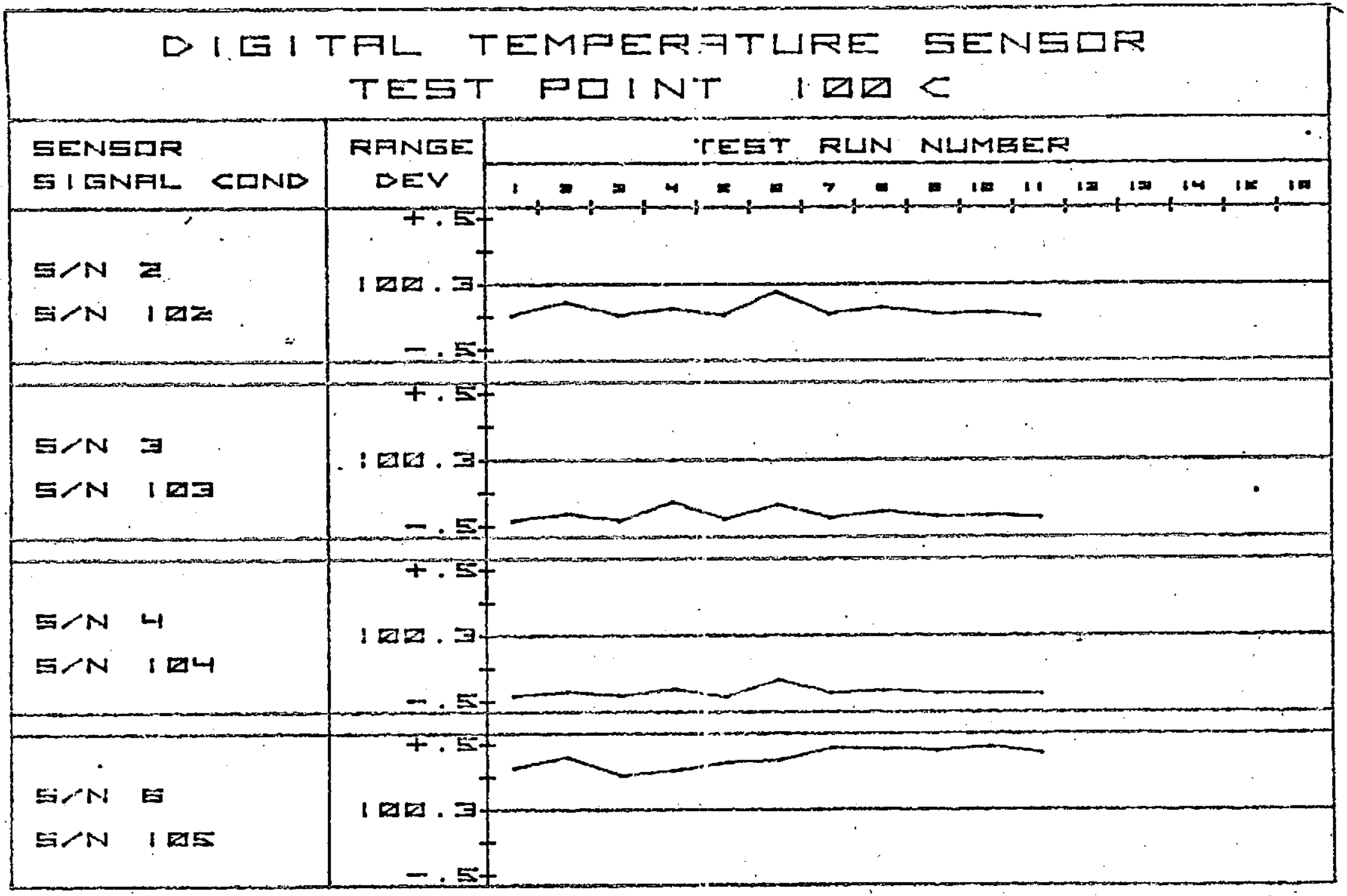

Figure A-1. – Digital temperature sensor test result. (Page 8 of 8)

APPENDIX B

VIBRATION ENVIRONMENT

- TEST SEQUENCE
- VIBRATION SPECTRUM VERSUS
- VIBRATION LEVELS
- AXES DESIGNATIONS

PLEASE PRESS HARD

1. TYPE A Configuration Change		
B Non-Configuration Change	X	
TEST PREPARATION SHEET NASA - MANNED SPACECRAFT CENTER		
2. TPS No.	V-GEB-086	
3. S/C	Cat.	No.
4. Mod. Sheet Number		
5. Page 1 of 4		
6. S/C No./Model No.	7. Date 12 March 1973	8. Time
9. Need Date 12 March 1973		
10. Drawings, Documents, Ocp's, & Part Number(s) Action Memo 40-601-001, LEC-28-609-2005	11. Contract Number	
	12. Serial Number	
13. System GVL, A249 Shaker and Dual 310 Slideplate	14. Ref. E. O. Number	
15. TPS Short Title Digital Temperature Transducer Engineering Evaluation	16. Wt. Req.	

17. Reason for Work: To evaluate the electrical and mechanical integrity of the MESA Instruments Digital Temperature Transducer during exposure to vibration environments of the Space Shuttle Program.

	18. DESCRIPTION (Print or Type)	21. Tech.	Insp. 22. CONT.	23. NASA
	GENERAL NOTES:			
	A. This test will expose two modules; a temperature probe (Model 71, S/N 3) and an electronic module (Model 71, S/N 103). Units will be electrically passive during all testing.			
	B. Documentation Required			
	1. Random PSD plots			
	2. Equipment list			
	TEST SEQUENCE			
1	Prepare the GVL excitation and control systems for random testing utilizing the A249 shaker and the Dual 310 slideplate.			
2	Install the test fixture as supplied by requester on the Dual 310 slideplate for Z axis excitation (Ref. Figure 1) and mount a piezoelectric accelerometer adjacent to a test article input point for level control.			
3	Dynamically shape the following random spectrum per standard VATF test tolerances (Ref. Figure 2):			

19. Prepared By Larry G. Sullivan		20. Final Acceptance Date	
REFER TO PROCEDURES FOR REQUIRED SIGNATURES		REFER TO PROCEDURES FOR REQUIRED SIGNATURES	
Contractor NORTHROP	Date	NASA	Date
Larry G Sullivan	12 MAR 73	S M Adams	12 Mar 73

Figure B-1. – Test preparation sheet (page 1 of 2).

PLEASE PRESS HARD

TEST PREPARATION SHEET CONTINUATION SHEET NASA - MANNED SPACECRAFT CENTER	TPS No. V-GEB-086 S/C	Cat.	No. Page 2 of 4		
	DESCRIPTION (Print or Type)	Tech.	Insp. Cont. / NASA
	50Hz @ 1.0 mg²/Hz		
	50Hz to 200Hz @ +9.0 dB/oct		
	200Hz to 500Hz @ 63 mg²/Hz		
	500Hz To 1500Hz @ -9.0 dB/oct		
	1500Hz @ 2.3 mg²/Hz		
	Overall Level @ 6.00 g rms		
4	Install the test articles and expose to the random spectrum for 15 min (+5 -0 sec).		
5	Reorient all test assemblies for Y axis excitation and expose to the random spectrum for 15 min (+5 -0 sec).		
6	Move all test assemblies to the A249 shaker for X-axis excitation and expose to the random spectrum for 15 min (+5 -0 sec).		
	END OF TEST		

Figure B-1. – Test preparation sheet (page 2 of 2).

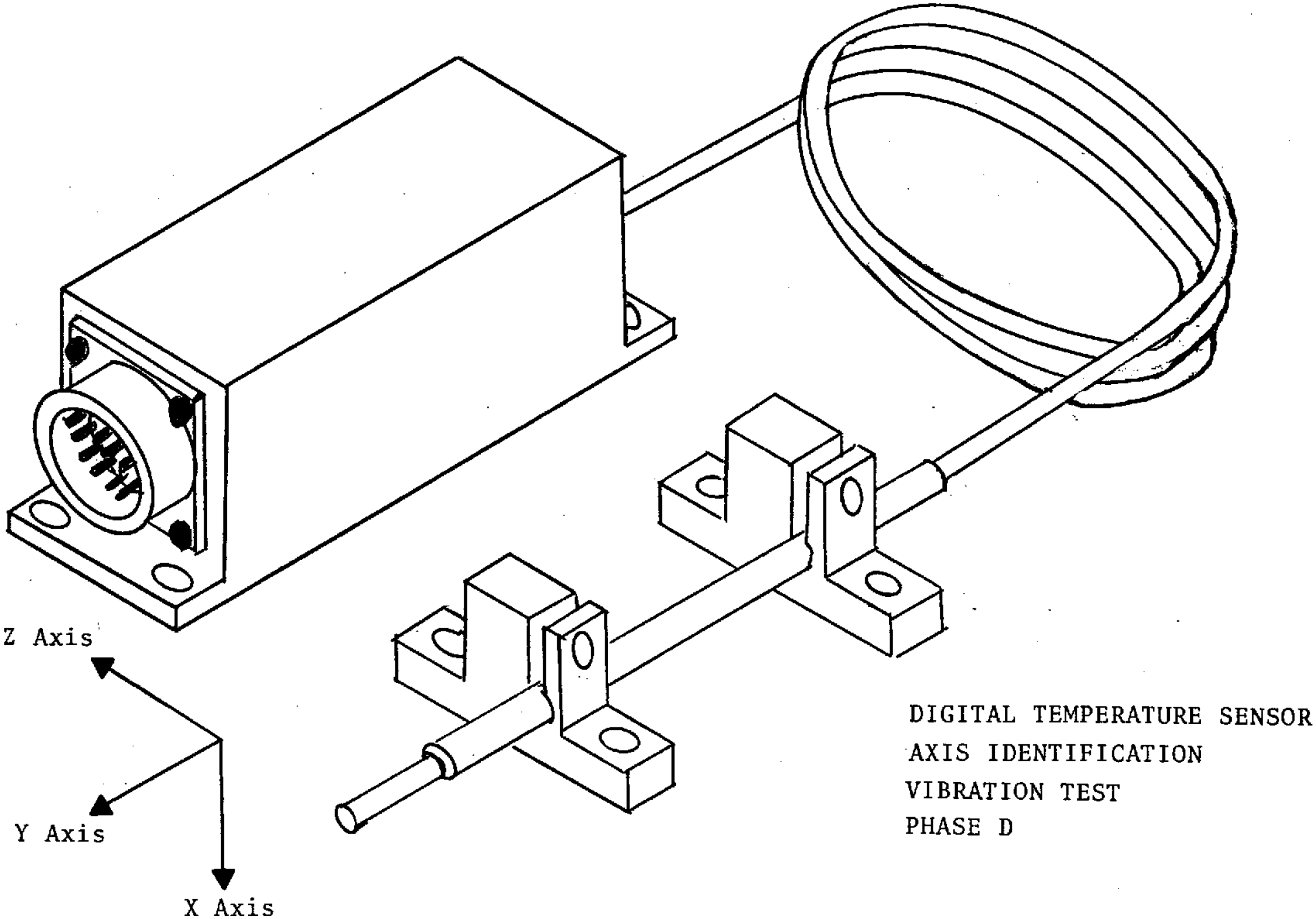

Figure B-2. – Digital temperature transducer axes designations.

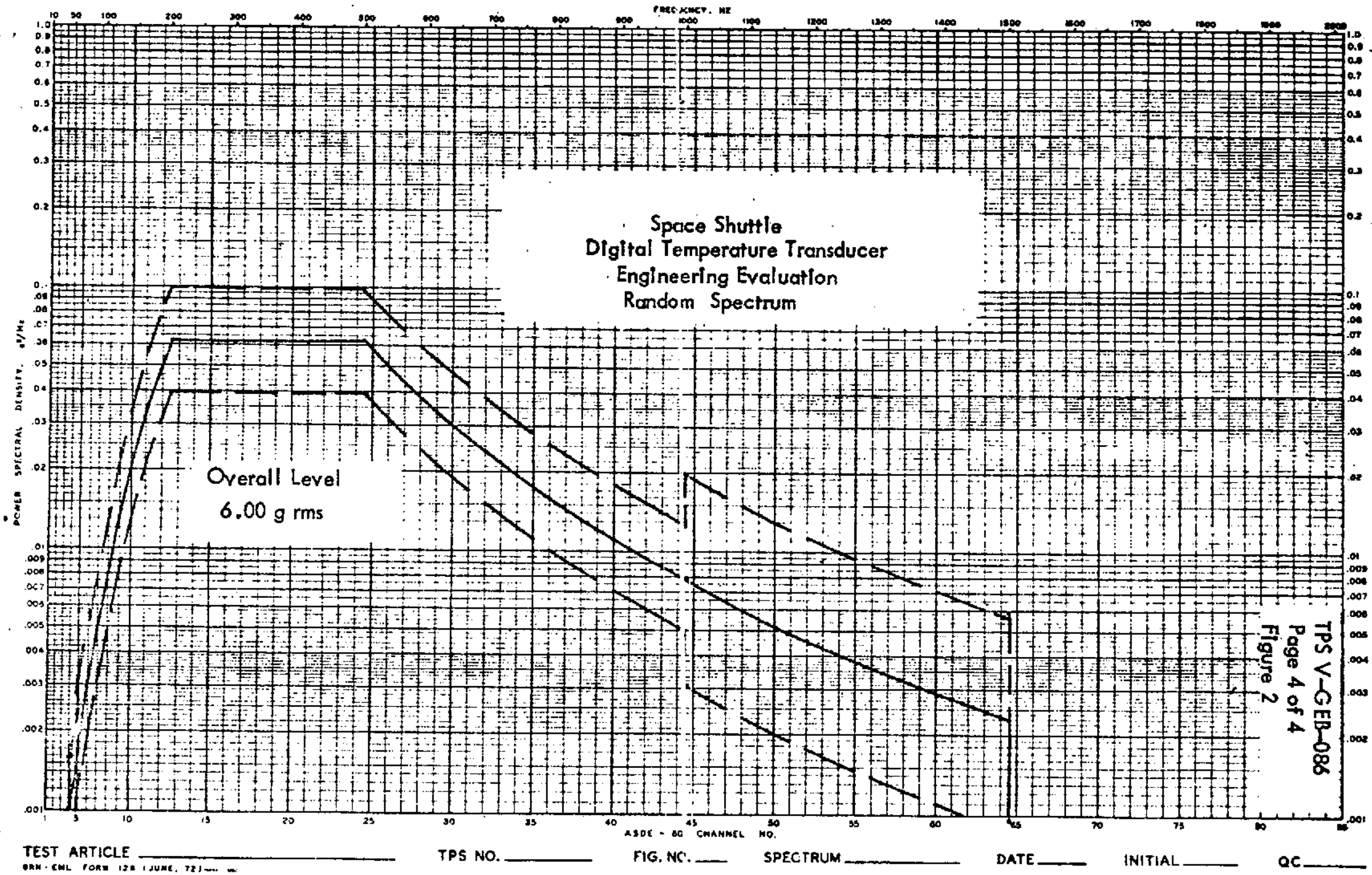

Figure B-3. — Random spectrum.